fhl LAB(1T)783

The vertebrate remains from Exe Bridge, Exeter

by Bruce Levitan

Introduction

The Exe Bridge assemblage, which was recovered in 1975-1976, is the first to be analysed since Maltby's study of Exeter bones from 1971-1975 excavations (Maltby 1979). Maltby's work is a model of its kind, both because it sets out to consider a number of clearly defined questions in a critical and objective fashion, and because it provides a comparative synthesis of several sites within a city thus giving a clear impression of the variations which occurred from site-to-site. This is not to suggest that the report is the last word on bones from Exeter, and Maltby himself points out that although "lateral variation has been established to be a fundamental influence on the types of animal bones represented... there is no doubt that the full range of variation has not been met", and concludes "in the case of Exeter, a more detailed study is... required of intra-site variations" (Maltby 1974: 93-4). The Exe Bridge bones must, therefore, be considered both in the light of Maltby's work, and as new information which sheds light on some of the gaps noted by Maltby. For these reasons, this report follows a similar lay-out to that used by Maltby, and is as far as possible, discussed in comparative terms. In fact it is probably more than coincidence that this site fills a chronological gap in Maltby's study - his assemblage comprised only 141 fragments from the thirteenth century (Maltby 1979: 19) and the Exe Bridge assemblage from this period comprises over 6,000 fragments. Maltby sub-divided his assemblage by period, and as far as practicable his chronological divisions will be followed here; relevant phases are:

Md7 - Features dated from 1200-1300
Md8 - Features dated to the late thirteenth to early fourteenth centuries
Md9 - Features dated to the early fourteenth century
Md10 - Features dated to the late fourteenth to fifteenth centuries
Pm1 - Features dated to the sixteenth century
Pm2 - Features dated to the late sixteenth to early seventeenth centuries
Pm3 - Features dated to the seventeenth century
Pm4 - Features dated to the late seventeenth to eighteenth centuries

The Exe Bridge assemblage fills yet another gap in Maltby's study since it is the first site to be considered which lies adjacent to the River Exe, and furthermore is an extra-mural medieval sample (see M: 2, Fig 1). Note that all further references to Maltby 1979 will be in the form M: page reference.

Maltby discussed his methods at some length, but such a topic lies outside the brief of this report. In some cases methods differ slightly from those employed by Maltby, and such cases will be mentioned where relevant. Identification records and analysis follow the methodology developed at the Ancient Monuments Laboratory for computer based osteometry (Jones, et al, 1981), but because there were no computer facilities available, a manual version of the recording system was employed. It has not been possible in the time available for analysis to fully consider all relevant topics, and the main emphasis has been placed on factors which supplement rather than complement Maltby's study.

The site falls naturally into three areas: Tenements A and B, Tenement C and St Edmunds Church area, further subdivisions of the assemblage are into "Blocks", which comprise stragraphically related groups of features within particular phases.

Quantitative analysis of the mammal bones

The number of fragments of each main species in each phase and block can be compared in order to ascertain long term variations for the major species and to assess intra-site variations (comparisons between Blocks). Some 36 Blocks may be defined, and bones were present in 32 of them, so the data are quite complex. Table 1 summarises this quantitative information (using the lay-out employed by O'Connor, 182: 8-9). Sheep and goat are not separated in the table because numbers of bones identified to species are fairly low, and a number of inconsistencies in these data suggest that the sheep: goat ratios may not be entirely representative. The normal pattern for medieval urban sites is for sheep to be in the majority (M: 42; O'Connor, 1982: 40; see also Maltby, in press) but goat appears to have been a significant member of the Exe Bridge assemblage, a point which is discussed in detail on the section on Ovicaprids (pp. 9-20). General trends for the main species are shown in Figure 1.

Much of the variation apparent in Figure 1 is due to small sample size (eg Block XXI, Tenements A and B (i)), and samples of less than 50 fragments must certainly be regarded as suspect. The largest (and consistent) sample comes from Tenement C where, apart from a distinct jump in the fourteenth century a general trend of increasing abundance of ovicaprids set against decrease of cattle can be seen, whilst pig abundances apparently behave independently of cattle and ovicaprids. In fact this pattern of pig abundances apparently is repeated in Tenements A and B,and to some extent, in the St Edmunds Church area. O'Connor suggests such results indicated that the marketing of pigs differed from that of sheep and cattle from Flaxengate, Lincoln (O'Connor, 1982: 11), and quotes evidence that pigs may well have been kept at the household level rather than farmed more widely, and Grigson also comments on such practices (Grigson, 1982 a: 302 and Fig 1). Maltby felt that pigs were both reared at the household level and marketed from outside of Exeter, particularly since pig exploitation became more intensive in later periods (M: 59). This last point is less clear here, though there does seem to be a definate rise in importance from the thirteenth to the fifteenth centuries and at Tenements A and B and the church this continues into the post-medieval period, whereas the frequencies fall after the fifteenth century at Tenement C.

The patterns for cattle and ovicaprids are unclear from Tenements A and B and from the Church area. The wild variations from Tenements A and B (i) are less apparent from A and B (ii). This is interesting because Blocks XXII - XXV represent occupation areas, whereas XXI and XXIV appear to be related to rubbish dumps (from a variety of sources?). Evidence from A and B (i) does indicate a similar pattern to Tenement C of increase in ovicaprids and decrease in cattle from thirteenth to seventeenth centuries and it is only in the eighteenth centuries (and later) that the two areas differ in this respect. The order of the changes is different: from Tenement C ovicaprids rise from c 45 to c 60% (with similar range fall for cattle). This pattern is reversed in the St Edmunds Church area with cattle increasing and sheep decreasing in importance during the medieval period (Blocks XXX - XXXIII). With the exception of the Church area results, these patterns are consistent with those noted by Maltby (M:26).

Despite the increase in ovicaprids, cattle would have remained the most important source of meat at all times, and probably rendered more meat than all the other species summed. Maltby considered his evidence in the light of documentary evidence, and the reader can do no better than to refer to his discussion on the topic (M: 26-29); suffice it to say here that the documentary evidence is generally in agreement with the above results.

The other domesticated mammals are also present but always in small numbers. Cat bone numbers are boosted by the presence of a partial skeleton (12 bones) and seven articulated bones from another (?) skeleton, but even so appear to have been more common than dogs, and this is in accordance with the other Exeter sites (M: 64). Maltby suggests that they may have been actively exploited for their skins as well as kept as pets or used to keep down vermin (M:65). There is no direct evidence for this from the bones but one need not necessarily expect butchery if skinning was carried out.

Conversely, dogs seem to have been positively abhorred by the residents of Exeter (M:64) and in 1423 they were banned from the city because they were believed to be a health hazard, and this may partly account for their relative rarity here (although it is an extra-mural site).

Again, in common with the other Exeter sites, horse bones are only rarely present in any of the periods (M:61), and Maltby points to the general scarcity of horses in Devon as one possible reason (M:62).

At least two species of deer: red and roe, are present and fallow deer (tentative identification) may also have been exploited. A very few bones are present: only five bones for the whole site. The ?fallow deer bone comes from Block XXVI, Phase Md9-10.

Both hare and rabbit were exploited, rabbit much more commonly than hare (n = 62 rabbit, n = 5 hare). This is interesting because Maltby concludes that hare was more popular than rabbit in the medieval period (M:61), only becoming uncommon in the post medieval period. It is possible that there is a real difference at Exe Bridge, but with so small a sample it would be folly to press this point too far. A few misidentifications (by the present author) may also have occurred.

The only other mammal identified is house mouse whose presence is hardly surprising. That it was not present in the other Exeter sites must reflect recovery practices, and indeed the single bone present here was recovered from one of the few small sieved samples.

Exploitation of Cattle

Ageing data

It is now generally acknowledged that ageing data from teeth and from state of epiphyseal fusion are not easily comparable, or even compatible, and that teeth ageing data are usually the more reliable (Maltby 1982: 84-6, Stallibrass n.d). Nevertheless it would be counter-productive to simply ignore epiphyseal fusion evidence, particularly when - as here - teeth ageing data are based on very small samples. In addition to these two methods, the appearance and state of horncores may be used as a guide to age, though despite the excellent descriptions and illustrations by Armitage (1982: 38-42) the determinations are somewhat subjective. The large thirteenth century horncore sample from Exe Bridge thus provides a good source for ageing data in this case. Results from the three methods are summarised in Tables 2-4. Figure 2 summarises the results from epiphyseal fusion and horncores. Note that the two histograms are not directly comparable since graph (i) displays the observed percentages for epiphyseal fusion in different bones (see Table 2) and graph (ii) illustrates the cumulative percentages of the horncore age groups (see Table 3). Both the graphs give a visual impression of the results described below and given in Tables 2 and 3, and may be used in conjunction with the following discussion.

It is immediately evident from the tables that the ageing data from each source is not compatible.

Thirteenth century.

Table 2 indicates that nearly 16% of cattle were slaughtered at under 18 months of age; Table 3 has only 1.8% horncores aged at less than one year, but a total of 28.2% at less than two years old; in the case of mandible data (Table 4), there is no evidence for cattle of less than two years old. Returning to the epiphyseal fusion data, 63.9% of bones are from under three year-olds, indicating that the peak kill-off age was between about one and a half and three years of age. The horncore evidence provides a cumulative figure of 38.5% killed by three years old (but only 10.3% killed between two and three years). The mandible ageing evidence indicates that no kill-off occurred before about three years of age. The epiphyseal fusion results give about 70% of cattle killed by four years old. This means that only about 10% were killed between three and four years old, and that about 30% were over four years of age at death. 77% of Cattle were aged less than seven years old from horncores, with nearly 40% slaughtered between three and seven years. The mandible ageing evidence gives a result of 60% kill off between about three and four years old (40% of this between three and a half and four years old) with 40% surviving beyond four years old. The horncore data gives some evidence for kill-off at over seven years of age: 17.6% of deaths were between seven and ten years and 5.5% are over ten year olds.

This apparent contrast in results from the three sources of evidence reflects the complexity of the urban situation as well as underlining the problems of using and interpreting ageing data from bones (Maltby, 1982: 81, Stallibrass, n.d). We can go some way towards sorting out the problems here. Clearly the mandible evidence must be suspect since the sample is only five jaws (Table 4). The epiphyseal fusion/horncore results are based on better samples (111 and 330) respectively). The disparities in results here can be partly explained as reflecting evidence from different sources: the large assemblage of horncores (see below for discussion) probably represents a different source of deposition from the other bones - thus the latter category is made-up of a mixture of food animals and waste from industrial processes, whilst the former is almost purely from limited industrial processes: hornworking and/or tanning. It would appear, therefore, that most cattle were killed betwen two and three years old (Table 2) for food,and additionally that the horners/tanners used horns from a variety of age ranges, but particularly from adults (over 60% over three years old). To some extent their sources would be dictated by food animals since this would have been the primary reason for rearing the cattle, so that very few adult/old adult horns would have been available, even if preferred, thus the age range is partially coloured by the food market economy.

Fourteenth Century

The evidence from the thirteenth century has been discussed in some detail in order to deal with the problems of interpreting the ageing evidence, and because this period has the largest sample of horncores. Horncores are much fewer from subsequent periods and it does not appear that such pure horner/tanner deposits were present. The epiphyseal fusion evidence (Table 2) indicates a kill-off pattern very different from the preceeding century: generally cattle were killed much older; no evidence for slaughter at under eighteen months is present, and only about 38% were killed by four years of age. Thus over 66% survived beyond four years, compared with 30% from the thirteenth century. The horncore sample is rather small (Table 3) but it is not greatly at variance with the above: apart from a high kill-off level of one to two years old (25%), the main kill-off is again in over four years of age (three years in the case of horncores): c 70%. The small mandible sample (six jaws) is completely at odds with this, all mandible coming from cattle of under three years old, and 50% under four months old, but this evidence must not be taken as representative; it merely shows that there was a small element of kill-off of young animals which is not reflected in the other evidence.

Fifteenth to seventeenth centuries

Evidence from these periods is similar, and therefore described together. The epiphyseal fusion evidence gives results more similar to the thirteenth than the fourteenth century, but with a rather higher kill-off of young animals (in excess of 35% kill-off before eighteen months). The level of slaughter was similar in the next eighteen month period (eighteen to thirty-six months) with about 30% of deaths in this range in the fifteenth century and about 25% in the sixteenth-seventeenth centuries. The kill-off levels of three to four year olds are low, (at only three percent or so) and approximately 40% of cattle were killed at ages of over four years. The small horncore samples give a different kill-off result for under three years olds (nine percent or less) and indicates that most cattle survived beyond seven years of age (over 65%). However, these samples are small and differential preservation may also partly account for variations. The mandible sample is too small to be worth comment.

Eighteenth century onwards (Recent)

The majority of cattle were killed between three and four years of age (c 79%) with only about 17% killed younger and 11% killed older. The horncore sample is somewhat different with c 45% killed between two and seven years and the remainder killed at older ages. Small sample size may again account for differences here. The mandible sample is again too small for comment.

These results may be compared with those from Exeter generally (M: 161, Table 62), though note that the periods are not directly comparable except for the thirteenth century. In this latter case, there is a notably higher infant mortality from the present site (15.8% compared with 2.65%), furthermore only 42.97% were killed by four years old compared with 70.3% from this site, so the bones here are mainly from younger animals than the other Exeter sites. Maltby notes that the importation of younger animals rose in the fourteenth to fifteenth centuries (M:31), but again the proportion of young animals is higher from Exe Bridge (particularly in the fifteenth century). Maltby deduced from his samples that "the majority of the stock was allowed to mature. The value of the species as a beast of burden was probably the major factor in its exploitation" (M: 31), and concluded that this is in accordance with the Domesday records. It is interesting to reflect that the sample from the present site contains a majority of younger animals, and possibly this could reflect deposits from a more prosperous source. The rise in slaughter of younger animals from Maltby's sites continued into the post-medieval period (M:163, Table 64), and these results are more similar to the Exe Bridge results - Maltby notes that if this result "is typical of the rest of Exeter, it does not reflect the true cattle population of its period" (M:32) since dairy and plough animals were still of great importance according to documentary sources: "Oxen have ever been the plough team of the District: sometimes with horses before them; but more generally above: four aged oxen, or six growing steers, are the usual 'plow' of the District.. Oxen are here worked to a full age: sometimes to ten or twelve year old" (Marshall, 1796: Volume I, 116-7), and Marshall also notes that the district is not generally a grazing area, and that fattering for the meat market is not commonly practiced (Marshall, 1796: Volume I, 246-247). However the fattening up for local markets did become more common during the seventeenth century and after, as a result of the tremendous growth in urban populations, most particularly London (M:32).

Metrical analysis

Horncores. It would be tempting to view the horncore dimensions illustrated in Figure 3 as an indication of sexual dimorphism, with males at the large extreme of the range, but recent work, particularly that of Armitage and Clutton-Brock (1976) and Grigson (1982c), has shown that the dimensions are more complicated. Armitage and Clutton-Brock divide the horncores on the basis of length into a number of size categories, all of which are present here (Armitage and Clutton-Brock, 1976: 331. After dividing the cores into the size categories, it should then be possible to sex the cores using a number of characteristics defined by Armitage and Clutton-Brock (1976: 32), but in common with other authors, it was found to be difficult to assign sex to many cores (M: 38, O'Connor 1982: 22). Indeed some of the larger cores in each size category had characteristics of cows and there did not appear any distinct differences in terms of the dimensions in Figure 3. Another possible distinction is in terms of basal cross-section with bulls flattened and oval, cows circular in cross-section and oxen similar to bulls in size and appearance, but of circular cross-section. The major and minor basal diameters are illustrated in Figure 4. This distribution is practically identical to the one from tenth to thirteenth century levels in Lincoln (O'Connor, 1982: 22, Figure 21) and it is obvious in both distributions that there is no separation between oval and round cross section horncores. O'Connor concluded that this represents a large genetic diversity combined with different timings and manner of castration in males which give a high degree of overlap between male-famale distinctions as described by Armitage and Clutton-Brock (O'Connor, 1982: 22). Size and shape relationships are illustrated in Figure 5. Here again there is no obvious sexual dimorphism though there is some indication that the large cores with relatively small shape indecies are males (top left) and the small cores with high indecies are females (bottom right). The middle area may represent oxen, whose size-shape distribution overlaps into the other two groups. Note that this analysis did appear to show a clearer distinction at Lincoln (O'Connor, 1982: 22 Figure 22). Finally it is worth noting that the numbers of cores in the size categories illustrated in Figure 3 are of similar proportions to those from the other Exeter sites (M: 38), short-horned variations being most common and long-horn cattle entirely absent in medieval times.

Other bones. The number of complete specimens from the post-cranial skeleton is small, with, for example, only four metacarpals, fourteen astragali and three metatarsals. With so small a sample it is not possible to investigate in detail the important factors of sex dimorphism, cattle sizes, and temporal change; and had this site been in isolation, the measurements would have been of little use in deducing anything about the cattle in more general terms, but it is possible here to compare the measurements with those from the other Exeter sites. This is done in Table 5 which compares ranges and means of measurements from this site and from the other Exeter sites (M:164-7, Table 65). It is very difficult to assess how the Exe Bridge material compares with the other sites since it is obvious that there is a lot of variation from dimension to dimension: for example thirteenth century metacarpals are smaller in the Dp dimension, equal in the Bd dimension and larger in the Bp and Gl dimensions! In order to assess this a little more clearly, a criterion of a 1mm difference in mean values has been used, so that Exe Bridge means over 1mm smaller are listed with a negative symbol, and those over 1mm greater are listed with a positive symbol; those which fall with the 1mm range are given the equality symbol. This information has been condensed and summarised in Table 6 which shows that the only clear difference occurs in the sixteenth to seventeenth centuries where all dimensions are smaller, though all are based on small samples. In previous periods the majority of dimensions are larger, but this does not necessarily indicate larger cattle (particularly since we are only dealing with a 1mm difference!) A final note of caution is that this kind of comparison may be somewhat arbitrary in that the individual inter-site variation between Maltby's sites may be similar to or even greater than the observed differences here, and such variation might well result from small samples, as no sample exceeds 30 specimens (Table 5).

Fragmentation patterns

This topic is complex and recent papers on the subject indicate that the complications of taphonomy, scavenging, etc cannot yet be fully accounted for. Analysis of fragmentation can provide clues about several aspects of bone studies: exploitation in the sense of butchery processes (Wilson, 1978), effects of scavenging and post-depositional processes (Binford, 1981) and even excavation/post-excavation damage. With assemblages over about 5,000 fragments analysis of fragmentation patterns is difficult and time consuming if computer facilities are not available, and it has not been possible to separate modern and ancient breakage so that the results are, to some extent, biased in this respect.

The fragmentation in the bones was divided into four size categories according to the amount of the bone present: less than 25%, 25-50%, 50-75% and over 75%. For each bone element, these results are then calculated as relative proportions of the total for the element and illustrated in terms of pie graphs (Figures 6-11).

Although there are small differences in detail, the general picture to be gained from these figures is of little change from 13th-19th centuries, perhaps reflecting conservatism in butchery practices (note that there are greater differences between cattle and ovicaprids than between periods in the same species). In the case of cattle, fragmentation patterns fall into four very general groupings:

a) mandibles, skull excluding horncores, vertebrae excluding caudal, ribs - predominantly very fragmentary

b) upper limb bones (humerus, radius, ulna, femur, tibia) and girdles (scapula, pelvis) - also predominantly fragmentary but forming a distinct set of proportions of size categories in contrast to (a),

c) carpals, tarsals, phalanges, sesamoid bones (patella), caudal vertebrae - predominantly of over 3/4 completeness

d) horncores *c* 40% less than ¼ complete, and 40% over 3/4 complete, *c* ¼-3/4 complete.

These groups exclude the metapodials because they neither fit into the above nor form a different group because their fragmentation patterns are quite variable. This may reflect changing uses: they are not primarily meat bearing bones, but are often utilised for bone working, and perhaps this latter has been subject to greater variation than butchery techniques. Groups (a) and (b) include the main meat bearing bones (and the skull and mandibles may also have been subjected to butchery for food): these are the most fragmentary bones in contrast to groups (c) and (d) which are not meat bearing. Horncores have been subjected to a greater degree of fragmentation than group (c) and this may reflect use for tanning and/or hornworking. Some caution must be exercised in interpreting these results since these breakage patterns may also reflect the differing robustness of different elements.

Butchery marks

The processes of butchery - ranging from primary slaughtering to kitchen preparation and even table treatment - often leave marks on the bones in the form of chopmarks, knifecuts and saw-marks. These clues must be treated with caution because it is not always possible to accurately deduce the instrument used from the mark on the bone and in some cases so-called knife marks were made by choppers and in others deep cuts which have been called chopper marks were made by knives (Coy, pers. comm). Recording of butchery here has been in terms of "cut", ?"chopped" or "sawn" but with no intended reflection on the instruments concerned. A cut refers to a surface scoring on the bone which has not left a deep mark or severed part of the bone. A chop refers to an action which has resulted in a deep gouge in the bone or the severence of part of the bone. A saw mark is one where the cut surface of the bone bears a series of lines such as might be made by a saw or heavily serrated instrument. This evidence is summarised in Figures 12-15.

Here again the apparent conservatism in butchery is evidence as the marks are concentrated at the same locations in all periods - the shoulder, especially scapula, the elbow, the hip and the knee. There is also a concentration on the ilium near the sacral symphysis which presumably reflects removal of the pelvis from the sacrum. A number of cuts and chops are evident in the ankle region, particularly on the astragalus, but also on the medial surface of the calcaneum and distal tibia. Ribs and vertebrae were also commonly chopped, vertebrae mainly axially indicating that the carcase was hung and split in half down the vertebral column. The head was sometimes chopped off as evidenced by transverse chops across the altas and proximal aspect of the axis.

Maltby notes that some deposits from Exeter were distinct and related to primary butchery processes (M: 38), but was unable to discern such patterns in material of medieval date; he further notes that most parts of the carcase were utilised for food, including skull and mandibles, and this is similar to the evidence from Exe Bridge. The patterns of breakage and butchery described for the long bones (M: 34) is also similar to that discussed above and Maltby concludes "the major meat bearing bones were intensively butchered. Usually they were severed in several places for the removal of marrow. The presence of so many of these bones amongst... medieval domestic refuse suggests that meat was sold on the bone". It is interesting to find that butchery of the vertebrae appears to have differed in the case of Exe Bridge, as Maltby found that most medieval vertebrae were cut laterally, whereas the majority were cut axially (or dorso-ventrally) from Exe Bridge. It is not surprising to find such differences since butchery techniques would almost inevitably have differed in different parts of the city. Thus, at Exe Bridge, hanging of the carcase for splitting appears to have been more common than in the other Exeter sites.

Anatomical representation

O'Connor discusses the problems of analysing anatomical distribution, and concludes that some form of weighting procedure is necessary in order to get rid of fragmentatation bias (O'Connor, 1982: 19). His solution was to calculate an index based on number of elements present (which were only counted when a non-reproducible character is present: eg epiphysis) divided by number usually present. This method has been slightly simplified here in order to save time, and because the sample is not so large, so that proximal and distal epiphysis are not considered separately and loose teeth are not categorised (Table 7). Essentially, the exact details of index factors used are probably not important so long as they are both logical and consistant (O'Connor, pers. comm). These results are illustrated in summary form in Figure 16, from which the outstandingly high porportions of horncores - most particularly in the thirteenth century - are evident: in no period does another element rival the horncore proportions and this important contrast reflects the fact that this area was primarily the dumping ground from horning industries (tanning and/or hornworking). This was particularly so in the 13th century when the great majority of cattle bones were horncores (see also ovicaprids), but the fact that horncore proportions remain high in later periods indicates that this industry remained an important one in this area, and that this location was continually used to dump waste. One can speculate from this that the industry was situated near at hand, if not directly adjacent to the site.

There are no other consistent patterns in these results, but differences between periods are too minor to indicate any great changes. All elements are better represented in the 13th century than in later periods, and this perhaps reflects the fact that there was little building at the site and the location was primarily used for dumping industrial and domestic refuse. In later periods, refuse accumulation continued, but with a number of buildings being built (Tenements A, B and C), overall representation of elements dropped (reflected, also, by sample sizes - Tables 1 and 7).

Skeletal abnormalities

In common with the other Exeter sites, presence of pathological anomalies was rare (M:40) - at Exe Bridge only 0.4% of fragments bear pathological anomalies. The most common abnormalities occurred on the skull with nine out of a total of seventeen abnormalities (52.9%). Two specimens are of distorted horncores (Plate I), in both cases with a "pinched-in" appearance which may well be developmental abnormalities. The other seven specimens are all examples of holes in the posterior aspect of the skull. These are discussed by Baker and Brothwell (1980: 37-8) which they conclude to be congenital abnormalities, but another explanation may, again, be a developmental cause (Plate II). Whatever the reason, such abnormalities may not have affected the health of the cattle and would thus have been meaningless in terms of the site economy.

Three further anomalies are examples of possible congenital or development problems, all are cases of variation in the conformation of the medial rim of the acetabulum, ranging from a hole in the rim, to a small notch in the surface of the rim. Such abnormalities are not noted in Baker and Brothwell (1980), but appear to be relatively common (in comparison with other abnormalities in archaeological remains (eg from Middleton Stoney, Levitan in press; West Hill Uley, Levitan in prep); see also Noddle (1983: 63). As with the cranial anomalies, these may not have had any deleterious affect on the health of the cattle. In the "normal" sequence of growth a notch does form soon after union of the acetabulum elements, but does not often persist late into life, and the formation of a hole in the rim is fairly uncommon in the author's experience, though it does appear to be more common elsewhere (O'Connor, pers. comm).

The remaining five anomalies all occur on lower limb bones and may be interpreted as age related and, to some extent, the result of extensive strain due to use for ploughing etc. Examples of exostoses and "lipping" of bone around the joint surface are seen in a proximal metatarsal and first phalanx. A second first phalanx and a carpal have exostoses and the latter has a small area of eburnation on the proximal joint surface. All these could be said to be early stages of osteo-arthritis, though none are far enough developed to rate as this condition (Baker and Brothwell, 1980: 115). A distal metatarsus, however, is almost definately a case of osteo-arthritis with heavy eburnation, exostoses and extra bone growth (Plate III). Plate IV illustrates a fused pair of lumbar vertebrae, this presumably being a case of spondylosis (Bourdillon and Coy, 1981: 92) due to an arthritic condition. Finally a metacarpal has a fused accessary (fourth) metacarpal and related ossification of ligament, again probably an age related condition.

All the pathological anomalies are of minor severity, and many (the developmental/congenital examples) may not have had any effect on health or value of the animals. The set of age-related abnormalities may have caused slight lameness which conceivably could have been the reason for slaughter, but in all cases the examples are less severe than can sometimes be seen in archaeological remains (eg Baker and Brothwell, 1980: 114-7, Figure 8).

Summary: the exploitation of cattle

The evidence for the exploitation of cattle from Exe Bridge does not greatly differ from that of other Exeter sites (M: 40), except in the case of horncores, so it is possible to conclude that Exe Bridge both fits into the background of medieval and post-medieval exploitation patterns described by Maltby (M:40), and underlines the variations in detail which one may find and can expect in a complex urban situation: here the major difference being in terms of the horncore deposits discussed above.

The exploition of sheep/goat

Proportion of sheep to goat

Sheep: goat ratios are given in Table 8, which lists numbers of fragments for each anotomical element identified to species level.

The totals for each period except the 13th century show that sheep was predominant, and sheep are in the majority even from the 13th century if horncores are excluded. In fact, besides horncores, pelvis, astragalus and phalanges, sheep elements all outnumber goat in every period. Besides horncores, the exceptions are minor (but for phalanges, 13th century), so the predominance of sheep throughout the period concerned was substantial.

It is also possible to separate the species using metrical characteristics on some bones; these are discussed by Maltby (M:41) and Payne (1969). Generally sample sizes were too small for successful attempts at metrical analysis except in the case of metapodials, where the distal epiphysis index described by Boessneck (1969: 354-5) has been calculated; the results are illustrated in Figures 17 and 18.

These figures substantiate the morphological evidence, indicating that sheep predominate. The divisions between the species are those given by Boessneck, and it should be bourne in mind that such divisions may not have been the same for archaeological remains. The slim documentary evidence is in support of these results (M: 42).

Ageing data

The use of ageing data - and indeed of other data - is limited by the fact that it is difficult to differentiate sheep and goat bones. The reader is referred to Maltby for a discussion on this point (M: 42).

Fortunately the mandible sample is larger for ovicaprids than for cattle, and 200 mandibles provided ageing data. The methods of Payne (1973), Grant (1982) and Deniz and Payne (1982) were employed. These results are summarised in Tables 9 and 10. In order to utilise mandibles with fewer than the four teeth used for age-stage definitions (three teeth with Grant's method), Payne's corrected count method was employed, and this method was also applied to Grant's method since it was possible to assign an age-stage range to mandibles with less than the whole complement of teeth using the wear stage charts in Grant (1980: 100-1, Table 3). Note, however, that Grant's charts are based on too small a sample size to be really reliable in this respect; however in the lack of anything better (a much larger corpus of information is required) the Grant charts are the best available data. In Table 10, wear stages are grouped into nine sets of ranges which approximate to but do not exactly coincide with Payne's nine wear stages: this is in order that the two sets of results can be compared. It should be noted that the summary of the Grant wear stages in this manner is somewhat arbitrary as the suggested age groups would in reality produce overlapping wear stage ranges. The tables show that results from the two methods are broadly similar, though differences do exist, particularly in the smaller samples. The ageing results are illustrated in Figures 19 and 20. The figures confirm the impression that the two methods have provided similar results. Both methods also indicate that whilst there was apparently little change in kill-off patterns, perhaps sheep and goats were slaughtered a little later after the 13th century. In the latter period, maximum kill-off was in stage E (Figure 19), whilst in later periods, it was in stage F, and there was a fairly consistant rise in proprotions of individuals surviving beyond stage F. This is not quite so clear in Figure 20 which indicates that kill-off in all period was mainly in stages 34-36, but note that the early kill-off 'tail' of the 13th century distribution is much more marked than in later periods, thus indicating a higher level of kill-off in stages before 34. Furthermore the late kill-off 'tail' in the 13th century is weaker than in later periods (ie stages later than 36). Converting this information into suggested ages, the peak kill-off in the 13th century was at two to three years old, with a large minority of slaughter at three to four years of age, and in later periods, three to four years olds provided the majority of the sheep and goats. Note also that in later periods, a small but perhaps increasing proportion of young animals were killed (ie less than two year olds). These results may be compared with the other Exeter sites (M: 174, 178, Tables 72 and 76). Maltby's stages 1-6 are approximately equivalent to Payne's stages C, D, E, F-G, G, H respectively. In the 13th century the main kill-off was in stage 3(E), but appreciable kill-off also occurred in all the later stages, particularly 4 and 6. Such evidence is not entirely at odds with that from Exe Bridge, but here there were notably fewer old animals. In the 14th-15th centuries, the differences are more marked, as kill-off from the other Exeter sites is fairly evenly distributed across all age-stages from stage 2 to post-stage 6 (15-18% in each stage). In the post-medieval period (M:178, Table 76), a high proportion of young animals were killed (c 22%) but a large number were also killed in stages 5 and 6, in dictating two main kill-off periods for this phase; again in contrast to Exe Bridge.

The epiphyseal fusion data are given in Table 11 and illustrated in Figure 21 (in which, as for cattle, the percentages plotted are not cumulative). In the 13th century and 14th century slaughter of young animals was fairly common, particularly in the 13th century, with 31% less than ten months old. Kill-off levels remained high in the two to three year olds, and in the oldest fusing group, more than half the ovicaprids had been killed by 3½ years of age in 13th and 14th centuries. In the 18th century this pattern changes with young kill-off reduced to a small proportion (4.2% unfused at 10 months, 9.5% unfused at 2 years) and with an apparently large proportion surviving beyond 3½ years old (25% unfused). The post-medieval period had slightly higher young kill-off levels, but the majority survived beyond 3½ years as with the previous period (23.5% unfused).

Comparisons between tooth wear and epiphyseal fusion are extremely difficult, and the problems are not yet fully understood; some aspects are discussed by Maltby (1982: 84-6) and Stallibrass (n.d). It is beyond the brief of this report to explore such problems so it must be rather unsatisfactorily concluded that there are some apparent differences between the two sets of data: eg high kill-off of young animals in 13th century is indicated by epiphyseal fusion, but not by tooth wear (Tables 9-11). These differences cannot be fully assessed, however, and factors such as differential disposal patterns (Maltby, 1982: 86), differential preservation, accuracy of ageing estimates, etc. may all have a part to play.

Discussion of ageing data

Maltby notes that over half the animals eaten in Exeter in the thirteenth century were less than two years old (M: 45) indicating a high proportion must have been bred for meat rather than wool (sheep yield their first fleece at about 15 months of age). He concludes that these results are unlikely to represent a cross-section of the sheep population, but are a result of marketing practices whereby non-breeders and animals surplus to the wool-grower supply were culled for the urban market and the infant mortalities/older cullings did not reach the market (M:46). The tooth wear results from Exe Bridge are rather different, with most animals aged between 2-4 years. These could well have been wool growers since they would have yielded 2 or 3 fleeces before being killed. The epiphyseal fusion results, however, are more in line with the other Exeter sites, with more than half under 3 years old, and 30% under 1 year old. Thus there are present in the evidence from Exeter sites, contrasting and conflicting ageing results which may represent the complexity of marketing in an urban context. The relationship between urban and rural sites certainly requires further investigation, but despite Maltby's comments on this very point, there are not contemporary rural sites with which comparisons can be made.

The exploitation patterns for Exeter sites remained fairly constant until the fifteenth century, and Maltby concluded that wool production was the main reason for this, drawing on documentary evidence which shows that the manufacture and exportation of the Devon 'Kerseys', a woollen Broadcloth, snowballed between the 15th and 17th centuries (M: 47). This boom encouraged flock owners to concentrate on wool production, so culling of young sheep would have fallen since wool production had become more important than lamb meat. The other Exeter sites provided no evidence for the fifteenth century, so it is fortunate that there is some evidence from Exe Bridge, even though the sample is rather small. This does show, however, that kill-off of younger animals was significantly less than in previous periods, particularly in the epiphyseal fusion data (Table II, Figure 21), so there seems to be a confirmation that the marketing of sheep did change at this time, and this trend continued into the sixteenth and seventeenth centuries.

Metrical analysis

Horncores A large number of goat horncores were recovered (see Table 8), particularly from the 13th century deposits. The scattergraph of horncore length and basal circumference falls into two or three groups which are more or less distinct. It would be tempting to regard these groups as indications of sex dimorphism with the largest group (smallest cores) - possibly females, and one or two groups of larger horncores which may be males or males and castrates. Certainly this second group is distinct in terms of horncore length (range 130-250mm) and basal circumference (110-140mm). In fact, although the range of length over laps with the ?female group (88-142mm) the basal circumferences do not overlap (?female group 66-100mm). Another possibility is that these groups represent different sizes ("breeds") of goat. Which ever the explanation, there does not seem to be a size change through time, as the 13th century group contains both the smallest and the largest horncores. These measurements are summarised in Table 12 which shows that when the entire range of measurements is considered, the variation is large (coefficient of variation 20%) but when the groups using basal circ. are considered separately (using scatter-graphs for group definitions). The variation is much smaller (c.v. 11%). If the basal circumference represents a true dimorphism feature, a consideration of basal dimensions should shed further light on this aspect. Figure 23 and Table 12 confirm the dimorphism in basal dimensions, though in the large 13th century sample there is a small degree of overlap. Note also the two outlying large measurements which must have come from two very large horned individials. The post-13th century samples are plotted together and confirm the impression that the dimorphism is real, and also that there was no temporal change. There is an overlapping range in least basal diameter, with the smaller cores at 11 - c 27mm and larger cores c 25-45mm, but the overlap between greatest basal diameter groups is minimal: 21-36mm and 38-61mm but note that the range of the smaller group in post 13th century cores is 25-39mm with the larger cores 41-54mm.

The sheep horncore sample is much smaller, and only three were complete so length-based diameter comparisons are not possible. Figure 24 is a plot of greatest and least basal diameters. This shows no obvious dimorphism, but it is interesting to note that all but the three largest cores fall into one of two distinct groups in horncore basal dimensions from Lincoln (O'Connor, 1982: 29, Figure 29). The Exe Bridge group is thus 'equivalent' to O'Connor's smaller cores group. O'Connor notes that the larger cores were generally "triangular in cross-sectional shape with a distinctly flattened interior surface, and a greater degree of torsion.... the large cores had a more rugose surface, but this was not a wholly reliable feature". Such cores were present here, and O'Connor notes that the large form was scarce in Lincoln after 1200 AD. He considers possible interpretations of these size differences, and concludes that these represent different 'types' of sheep rather than sex differences. Thus the sheep cores from the Exe Bridge appear to be similar to "the fairly small oval-sectioned cores typical of most medieval sheep", O'Connor (1982: 30)

Humerus. Maltby used the width of the distal epiphysis as a guide to size of sheep, but pointed out that the early fusion date of the epiphysis which increases in size a little after fusion, so that any small fluctuations in size may be due to differing proportions of young and adult animals rather than actual size changes (M:49). There is some hint in the Exe Bridge histogram of an increase in size from 13th to 14th centuries (Figure 25), but samples are small so that caution must be exercised. The histograms for medieval, 16th century and post-16th centuries from the other Exeter sites (M:50, Figure 12), indicate that the Exe Bridge humeri in fact fall within the overall range of measurements, so that the size change is probably not real.

Radius. Use of distal epiphysis measurements of the radius overcomes the young/old problem of humeri since the fusion date is much later. The Exe Bridge sample is rather small, but it is clear from the measurements available that no size change occurred (Figure 26), and this accords fairly well with the other Exeter sites (M:52, Figure 13).

Metacarpus Various measurements have been used to discriminate sex in sheep, and these are discussed by O'Connor (1982: 2-9), and the most successful method appears to be O'Connor's method based on distal epiphysis measurements (1982: 29). The results for Exe Bridge indicate that males were common in the metacarpus sample, particularly in the 13th century; 2.4 males: 1 female. Ratios for later periods are: 14th century 1:1.3, 15th century: 3:1, post-medieval 1.5:1 (male: female in all cases).

Pelvis Measurement of the acetabulum medial rim depth may be used to distinguish sex (Armitage, 1977: 75-80). Results for Exe Bridge are, for sheep (male: female) - 13th century 1:5, 15th century 1:1, post medieval 1:1, for goat - 13th century 1.5:1, 15th century 1:10, post-medieval 2:1. The samples for both metacarpals and pelvis are small, so ratios may be unreliable, and the apparent disparities in the two sets of data may be a reflection of this.

Tibia The histograms of maximum distal width in tibiae indicate no size change at Exe Bridge (Figure 27), somewhat in contrast to the other Exeter sites where there is a gradual increase, with increasing proportions larger than 25mm in each successive period (M:48-9, Figure 11). There is just a hint from Exe Bridge that this size increase occurs, but the sample is too small to be reliable. In the 13th century, 16.7% were over 25mm in the 14th century the proportion is 20.0%, in the 15th century 41.7%, and in the post medieval period 50%. (but in no case is the sample over 20).

The overall size of the stock Maltby found that there was little change in size of stock in the medieval period, but that some improvement occurred in post-medieval stock, with the sixteenth century a period of transition rather than dramatic change (M:49). This impression is largely bourne out by the Exe Bridge bones, where mean values of most measurements show little change, but indicate a gradual improvement (Table 13). Maltby also pointed out that the Exeter sheep seemed smaller than sheep from other sites in England, and if this is so the same is true of the Exe Bridge since the Exe Bridge values are generally very close to those from the other Exeter sites (Table 13). A comparison of the Exe Bridge sites with Lincoln (O'Connor 1982: fiche pp.25-31) indicates that sheep from Lincoln in the 12th Century were generally larger than those from Exe Bridge in the 13th century, particularly greatest length measurements of metapodials.

Analysis of the types of sheep represented

As Maltby pointed out (M:51) it is extremely difficult to assess the types of sheep represented, despite the publication of several useful papers on the subject, recent examples including Armitage and Woodall (1977), Armitage (1983), and Ryder (1983). Previous authors have sometimes used the presence of polled and horned varieties to represent different types (or sexes), but it is now generally acknowledged that both males and females may be horned, whilst it is also possible to have a polled type in both sexes (Armitage and Woodall, 1977: 84; M:51). O'Connor used the dimensions of horncores from Lincoln to suggest the presence of at least two different types of horned sheep (1982:30) and we have seen that the Exe Bridge cores are similar to one of these groups. Polled forms were also present at Exe Bridge, but were fairly rare (n=3). After the medieval period and particularly after the 18th Century specialised breeding increased greatly, and the variety of types of sheep increased. Marshall describes distinction between horned and polled varieties in Devon: 'their heads are various characterized: those of some individuals are horned, others polled, or hornless - provincially "nots"' (Marshall, 1796, Vol 1: 259). Interestingly, the polled forms from Exe Bridge are all post-medieval in date, two of which are post-18th century.

Evidence from the post-cranial bones is more limited since samples are generally quite small, the only exception being in the case of metapodials. Armitage and Goodall note that medieval sheep are characterised by long slender necks and fine boned limbs, with a small, compact body and long pendulous tail. The first two (and major) characteristics were eradicated during the 18th century (Armitage and Goodall, 1977: 80-82). In his review of the evidence of long wood sheep, Armitage enlarges on the above by tracing three major changes, ranging from a small (soay-sized) form with the above characteristics to a larger but still unimproved form in the 17th-18th centuries and finally to the improved forms of the late 18th century onwards (Armitage 1983: 91-94, and Figure 2). Presumably if such changes occurred here, this would be reflected in bone dimensions, but the length breadth ratio in metacarpals shows that there is no temporal grouping in the results (Figure 23); however, there is considerable variation between the characters, and particularly so in the post-medieval and recent samples.

Maltby concludes that the Exeter sheep showed little change or improvement before the post-medieval period, but the small post-17th century sample indicated that improvement did occur after this, with some improvements dating even from the 16th century (M:52). There is some evidence that similar changes occurred at Exe Bridge, but again the post-medieval sample is small, and it is not possible to get more than just a hint of change from this assemblage.

Fragmentation patterns

A comparison between the ovicaprid and cattle fragmentation patterns illustrates that there are greater differences between the species than between periods. This may reflect both the different butchery techniques applied to the different species, and a conservatism in butchery practices for one species. The temporal differences in the sheep-goat bones are greater than for cattle. Thus it is more difficult to define fragmentation "groups" as in the case of cattle, conversely it is possible to see some temporal trends which was not the case for cattle. These are summarised below:

i) Limb long-bones. Generally for each period, the fragmentation patterns for all limb long-bones are similar. In the 13th century about 20% of bones were 3/4 or more complete, and about 35% less than ¼ complete (Figure 29). The ¼-½ and ½-3/4 complete groups are generally of the order 20% and 30% though metalcarpals differ slightly. In the 14th century (Figure 30) the 3/4 complete group is much expanded (c. 35% except tibiae) and the less than ¼ complete group much diminished. The ¼-½ and ½-3/4 group are variable. The 15th century is essentially similar to the 14th century (Figure 31), though femora and tibiae are noteable exceptions with c 60% in the ¼-½ complete group. The post-medieval period is much more variable, with upper limb bones more fragmentary than lower, and fore-limb less fragmentary than hind-limb (Figure 32). Finally in the recent period, the results are very variable with no obvious (or logical?) pattern (Figure 32). Note that ulnae are not considered in this anatomical group since the slender shaft is invariably broken near the proximal end, so fragmentation patterns differ. Thus two trends can be seen: reduction in fragmentation, increase in variability. Note also that sheep limb bones are generally less fragmentary than corresponding cattle limb bones.

ii) Carpals, tarsals and phalanges. Essentially similar to cattle patterns, but consistently less fragmented in all periods.

iii) Horncores. Little change in fragmentation temporally. Patterns similar to cattle 13th century, but generally there is less fragmentation in sheep-goat, with about 33% in the 3/4 complete group.

iv) Other bones. Here there are no obvious trends and temporal changes are quite variable. Scapulae generally appear to become less fragmentary in more recent periods, except in the final ("recent") period, and a similar though more variable "trend?" occurs for pelves. Vertebrae patterns are very varied and there seems to be no apparent trend or logic in the difference. Cranial bones are consistently fragmentary (in the less than ¼ complete group) but with larger proportions in the ¼-½ complete group than cattle, and mandibles appear to become more fragmentary in later periods.

Butchery Practice

Horncore. Most of the butchery marks observed on sheep-goat bones were on horncores or related to horncore removal, particularly in the 18th century. The patterns of butchery are summarised in Figures 34-38 and these show that there was no change in horncore butchery, and that horns were removed either by dropping off the horn with an oblique blow which ended at the midline of the skull (frontal suture) having started at a line across the top of the orbit, or by chopping through the horn near the base of the core. In a study of bones from Taunton, the author found that these two techniques were very much related to species, with the former technique employed for goats and the latter for sheep (Levitan, in press). Such differences were less clear at Exe Bridge but this pattern does appear to have been followed to some extent here.

Butchery on the mandibles and post cranial skeleton is shown on Figures 34-38 and illustrates that there was little change, with major zones of butchery at the shoulder, elbow, hip and knee, and that the carcase was hung and halved (since vertebrae were chopped through axially). Mandibles were sometimes butchered, invariably in the diastema and presumably related to removal of tongue. Occasionally skulls were chopped in half, so removal of brains seems likely. Interestingly relatively few hind legs were severed in the mid-tibia shaft region as from other Exeter sites (M:53), and some were chopped through in the proximal region; but butchery evidence here was limited. The leg was commenly removed at the hip, sometimes by chopping off the proximal femur (eg Figure 34) or by inserting a knife into the joint and cutting the ligament (eg Figure 37). Related butchery of the pelvis is centred around the acetabulum. Maltby suggested that the scapula and humerus were removed as a single unit (M:53) but evidence here is for severance of the scapula through the collum. In common with the other Exeter sites, the elbow was a major target for jointing and also the distal radius/proximal metacarpal (M:53). The halving of vertebrae axially is seemingly an earlier practice here than elsewhere in Exeter (M:54) but a note of caution is that the Exe Bridge butchery sample is small and some vetebrae were certainly chopped laterally as if the carcase were not hung and halved. Thus, in common with the other Exeter sites, there was a conservatism in butchery. Butchery patterns here were not greatly different to other Exeter sites, although some differences are of interest and are noted above.

Anatomical representation

We have seen that horncore dumping was the major characteristic of cattle remains, and it is obvious from Table 14 and Figure 39 that this is repeated for sheep-goat remains, and again particularly in the 13th century. Table 8 indicates that these horncore dumps were mainly goat, especially in the 13th century, where the sheep goat ratio is 1:15.

Other elements also show-up as particularly common, these are mandible, metacarpals and metatarsals, and this trend remains fairly constant in all periods, though there is a general reduction in the scale of this pattern in later periods. Those bones could be said to be characteristic of butchers' waste (especially if they are associated with carpals, tarsals and phalanges). The relative absence of other waste-type bones could be due to differential recovery since the other bones are all small. It is interesting to see that loose teeth are not common, but this again may reflect differential recovery.

All elements are better represented in the 13th century than in later periods, and this may reflect the nature of the deposits and the site history (see cattle:

Anatomical Representation). Otherwise there is no obvious trend or pattern in the results.

Skeletal Abnormalities

Maltby notes that periodontal disease was the most common defect in sheep and goat bones, and that overcrowding was also common (M:54). This is also true of the Exe Bridge material, and a detailed analysis of mandibular anomalies has the potential for providing information about planes of nutrition and health not available from other sources (see Baker and Brothwell, 1980: 154 and Figure 11). Studies by the author on bones from other sites have shown that scoring of mandibular defects provides much unexpected information (eg Levitan, in press; Levitan forthcoming). A summary of results for mandible is given in Table 15 which lists the anomalies which are present and gives the numbers of occurrences in each Period. It is important to note that this table cannot be used to interpret frequency of occurrence because no account of missing teeth or missing portions of mandible is taken (for example, one cannot say that in 13th century 55 out of 143 mandibles had extra-numerary foremena because some mandibles were not complete enough to tell if extra foramena were present). It is, however, a useful tool for providing crude estimates of occurrence. Furthermore, in assessing occurrence of individual anomalies, it is necessary to take into account single teeth: this is the case where the anomally affects individual teeth, and in such cases the occurrance of the anomaly is calculated for each tooth as follows: no. occurrences divided by total no. of tooth concerned (no/nt). Where the anomaly affects the mandible (eg foramena) the occurrence is calculated: no. occurrences divided by total no. mandibles with relevant portion present (no/nm).

The anomalies have been grouped into broad categories, but some overlap may occur, for instance absence of P2 may be due to disease, so may 'platey' deposits; pigmentation could be congenital or developmental. However, since modern veterinary studies are lacking on this subject, the selection of these groupings is based on what veteninary literature there is, and on experience based on other sites (eg Levitan, forthcoming).

Overcrowding. This was by far the most common defect, particularly in the case of intra-dental attrition (this is the attrition between adjacent teeth in the tooth row, and is scored as positive occurrence where the enamel border of the tooth has been worn away). Figure 40 illustrates occurrence of intra-dental attrition. The main impact of these results is to illustrate that occurrence in deciduous teeth was very variable, but this is most likely a reflection of small samples since frequencies in the 13th century are based on three juvenile mandibles, and in 14th century and post-medieval on one mandible each. Occurrence in the permanent teeth is also variable, though more constant. No attrition occurred between second and third permanent premolars (P2 and P3), which is mainly a result of the room for movement which is present in P2 which may consequently be pushed aside. All the other teeth interfaces gave rise to intra-dental attrition, with the single exception of P4 anterior cusp in the Recent Period. Generally attrition is more frequent on the posterior cusp than the anterior cusp in both P3 and P4, except in the case of P4, 15th century. This is reversed for the molars where attrition is greater on the anterior cusp. Such a patterning is a logical result of the eruption sequence; also it is notlable that greatest frequencies occur in the first molar (M1) - except in Recent Period - the tooth with earliest eruption date in the permanent teeth. Thus intra-dental attrition can be seen to be common in these mandibles, and also to follow a patterning imposed by the eruption sequence.

Anomalous crown height could result from several factors such as loss of an opposing tooth, delays in the eruption sequence, etc. It can result from overcrowding because intra-dental attrition may weaken the cutting surface of the tooth (by reducing amount of enamel exposed). It is fairly infrequent here, and occurs in only about 9% of mandibles from the 13th century 8% from the 14th century, 14% from the 15th century and 8% from the post medieval period. Sample size is too small to interpret the anomaly in terms of patterning or frequency, P4-M2 is the most frequently affected region, though it does occur in all permanent teeth to some extent. No examples in deciduous teeth were found.

Tooth displacement is even less frequent (Table 15) and examples were only found from the 13th century and 15th centuries. Displacement may take on several manisfestations (see Levitan, in press; Levitan, forthcoming). In common with other sites (West Hill: Levitan, in prep; Middleton Stoney: Levitan, in press) the permanent premolars - particularly P3 and P4 - are the most frequently affected. Thus, rotation through 90^0 has occurred on a P3 from the 13th century and one from the 15th century. The third specimen is a P4 with labial rotation. The evidence here is too limited to define trends, but it is similar to the sites quoted above where the displacement occurs mainly in P3 and P4 and is presumably related to the eruption sequence: these are amongst the last teeth to erupt, and the P4 in particular is often in malocclusion with the M1 and this may lead to excessive distortions in extreme cases. The main reason appears to be related to the fact that the P4 is smaller in length than the p4 so often erupts at an angle which occludes the posterior crown against the leading edge of the M1 anterior crown, (examples illustrated in Levitan, forthcoming).

Developmental anomalies are those which appear to result from a developmental condition, but seem not to be genetic in nature. Ventral penetration is extremely rare, but "early stages" are more common. This is a condition where the developing tooth bud of a permanent tooth does not have enough room in the width of the ramus and so pushes out on the ventral margin of the mandible: usually only a small lump is formed (as here), but sometimes the margin may be completely penetrated. It is a complicated condition, and possible causes are discussed elsewhere (Levitan, forthcoming). Here it occurs in only 6.3% of mandibles, all from the 13th century, and in eight of the nine specimens it is due to the developing P4 bud; the ninth case was beneath the M2. This is interesting because the P4 is the largest permanent premolar, and in domestic sheep it would appear that the mandible is sometimes too thin to accommodate it: it would be of value to discover if this occurs in wild sheep.

The 'platey' deposits, which here occurred in the 13th century infrequently (4.2%), are quite common from other sites. It is described and discussed in Levitan (forthcoming), and seems mainly to be related to the eruption process in juvenile - sub-adult mandibles. At Middleton Stoney 30.8% of mandibles had platey deposits, and of these 71.4% were juvenile (ie deciduous dention), (Levitan, in press).

Genetic and congenital anomalies The commonest of these anomalies is the occurrence of extra-numerary foramena nutricum, and rather surprisingly it is not a condition which has previously received much attention. Often there is a single accessary foramen, usually near the P2 or P3, but sometimes it occurs in other locations, and infrequently there may be more than one accessory foramen. There are [illegible] mandibles from the 13th century which have the diasterna complete: and 61.1% have extra-numerary foramena. Similarly frequencies for the 14th century are 78.6%, 15th century: 55.7%, Post-medieval: 55.6%, Recent: 50% (Table 16). These frequencies are much higher than other sites for which this anomaly has been recorded (eg Levitan in prep). A small number of mandibles have two extra foramena, eight from the 13th century (14.5% of affected mandibles) and one from the fourteenth century (9.1%). The remaining mandibles all have one extra foramen.

Location is varied, ranging from anterior to the major foramen nutricum to beneath the P4, but Table 16, which gives details of frequency of occurrence and location shows that the clear majority are located in the P2 and P3 region. Interestingly the commonest location in the 13th century was in the P2 region (45.4%) whereas in all other periods it was in the P3 region (except 15th century where P2 and P3 occurrence was equal). Whether or not such differences - which at face value seem minor - are of importance and can be linked with factors such as "breed" or "type" is at present uncertain, but continued analysis of such characteristics will clarify the situation, particularly if related to a study in modern breeds.

Absence of P2 is a frequently noted condition, and Maltby notes it for other Exeter sites (M:54); most cases must be ones of congenitally absent teeth but a note of caution is necessary since ante-mortem loss of P2 may leave no superficial trace of the tooth and only an X-ray will reveal the resorbed alveolus (Levitan, forthcoming). Occurrence of this defect was relatively infrequent here: proportions of absence versus presence are as follows: 13th century 7.3%, 15th century 8.3%, post-medieval 5.9%, other periods no occurrence. Thus it is an infrequent defect and like extra-numerary foramena is of uncertain but possibly useful potential in analysing population variability.

A not unrelated defect is the presence of extra columns or cusps, and these include bovine columns which sometimes occur on P4, M1 and M2 (Levitan forthcoming). The single occurrence of an extra column from Exe Bridge (Plate V) is a gross deformity which has severly distorted and affected the conformation of the mandible and constitution of the tooth row. There is also infection and root distortion present, but whether these result from the deformed M2 is uncertain, though the M2 must have had a profound effect in the course if not the cause of the other complications.

Disease and infection Maltby notes that periodontal disease was the most common defect (M:54) along with overcrowding, but he did not attempt to quantify these anomalies. In fact periodontal disease was relatively infrequent in the Exe Bridge assemblage with occurrence ranging from 25% (recent) to 4.9% (13th century) and all but recent less than 20%. It is possible to score periodontal disease on a scale of severity which is discussed and discribed elsewhere (Levitan, forthcoming) with Stage 1 the earliest stage and stage 5 the most advanced stage of the disease. Figure 4 illustrates the occurrence of the disease and relative severity. The histograms are drawn at different scales in order to accommodate the figure at a reasonable size and to illustrate the detail for each period; thus relative frequency is greatest in the 15th century and least in the 13th century. Post-medieval and Recent are not shown since sample size too small. Although the peaks of occurrence differ in the periods, the pattern of severity of infection remains centred on P4-M1 where greatest severity is concentrated. This follows the pattern seen on other sites (Levitan, in press; Levitan, in prep) and is related to the eruption process, and probably also to presence of dental calculus (discussed in detail in Levitan, forthcoming). Relatively high occurrence in P2 is unusual in comparison with other sites and it is interesting to note in this respect that peaks in occurrence shift from P4-M1 in 13th century to P3-P4 in 14th century and to P2 in 15th century. However, with such small samples it is not advisable to imply any changes in planes of nutrition/health status.

The occurrence of a porous margin of the alveolar cavity is often related to periodontal disease, but sometimes it occurs in isolation (e.g. one specimen from the recent Period) or associated with other defects (eg the specimen in Plate VI and discussed above under Genetic and congenital). The former is sometimes related to the eruption sequence, with actively erupting teeth presumably causing much alteration in the aveolus and affecting the margin in this way, and the Recent Period specimen may be one such since the M3 is in the process of eruption (Grant stage E) and this is the area affected. The other specimen is probably a result of severe abscess or periodental disease.

Root disfigurement is difficult to record since in situ teeth cannot be scored unless removed or the mandible X-rayed. One specimen with obvious root disfigurement is the mandible in Plate V, thus adding another condition to the complicated pathology of this jawbone.

Pigmentation was almost ubiquitous at Exe Bridge (Table 15) and whilst it is not uncommon on other sites, such high frequencies are unusual. However in this case it seems to be related to the context of deposition, and has presumably resulted from staining by the surrounding sediments, a situation which seems common from urban sites where partial or complete waterlogging has taken place. Thus the occurrence of "pathological" pigmentation is here masked by this staining effect.

Finally, the mandible illustrated in Plate Vl has a condition which is entirely unknown to the author, and can only be described here. The defect has affected the incisors and mandibular symphysis. Indeed all the incisors have been shed ante-mortem, and large, smooth, dense formation of bone protruding from the symphysis has formed. Whether or not the opposing mandible was similarly affected is unknown.

Other anomalies Dental calculus is not a pathological anomaly, but it is an important feature since it seems to be partially responsible for the occurrence of periodontal disease (Levitan, forthcoming; Baker and Brothwell, 1980: 151-2). Unfortunately the cleaning of the mandibles has here resulted in removal of calculus deposits from the majority of the specimens, and the apparently infrequent occurrence is unrepresentative (Table 15).

Non-mandibular pathology. The skeletal abnormalities from other bones totalled only 25 specimens. Three simple fractures had occurred, one in a thoracic vertebra neural spine, and two in rib shafts (Plate VII). These were from 14th, 15th centuries and post-medieval. Exostosis was recorded from three specimens: on the medial aspect of a metatarsal shaft, a goat third phalanx (13th century) and a rib shaft (Post-medieval). In the case of the phalanx this may be related to a condition known as ring bone (Plate VII). Ossification of ligaments/tendons was the commonest anomaly, with nine metapodials (mostly metacarpals) having fused accessory metapodials (digits II and IV) and one rib with an ossified "thorn" attached to the shaft - presumably a tendon. This, and three metacarpals are 13th century. One metatarsal and one metacarpal are 14th century, two metarcarpals 15th century, a metatarsal post-medieval and a metacarpal recent. The remaining nine specimens are all horncores or associated with horncores. So called thumb-print marks on horncores are sometimes reported, for example from Saxon Hamwih where it is tentatively ascribed to the effects of malnutrition, and at Hamwih seems to be related to castration (Bourdillon and Coy, 1980: 92). Three examples in sheep and one in goat are present here spanning the period 14th century - recent (Plate VIII). In one sheep there is also a large, deep depression (30 x 12 mm by c 8 mm deep). There are three examples of gross distortion in horncores (all sheep) and these are illustrated in Plate IX. Causes for these deformities seem obscure and perhaps are related to developmental or congenital conditions, though disease cannot be ruled out, nor, indeed, can late artefical polling in the case of the stunted specimens (Plate IX a+b). The goat frontale illustated in Plate X is polled, possibly artificially, and there is a large, deep depression (30 x 25 mm by c 10 mm deep). Finally Plate XI illustrates a goat horncore with a split end of the horncore, a condition which in sheep is often related to breeds where a polycerate (four-horned) condition is common. Note the polled sheep skull in the same plate, presumably a naturally polled individual.

Summary: The Exploitation of sheep/goat

There are a number of inconsistencies between the Exe Bridge and other Exeter sites. For instance the predominance of goat horncores here is entirely at odds with the evidence from the other sites (M:54). However it has been shown that the post-cranial bones from Exe Bridge confirm the impression conveyed by Maltby that sheep outnumbered goats. Then the horncore deposits stand out as very much in contrast to the background of evidence from this and the other sites.

There are differences in detail in the ageing data which have been discussed above (Discussion of ageing data), but the evidence from Exe Bridge is not so different as to suggest major differences in slaughter patterns, and the main impact of the evidence is to suggest that sheep and goats brought to market at Exeter were surplus to requirements of stock, breeding and wool supply. The post-medieval cloth boom had a profound effect on sheep rearing and this too is reflected in the Exe Bridge assemblage.

Size of the sheep generally was small, and this, in common with the other Exeter sites, suggests that only one type was reared until late in the post-medieval period when improved breeds were introduced.

Butchery practices seem to be somewhat different from the other Exeter sites, and possibly hanging and halving of carcases seems earlier here than elsewhere in Exeter.

The Exploitation of Pig

Ageing data

In contrast with the other Exeter sites, the pig mandible sample is very small, and only fourteen mandibles provided ageing estimates using the method of Grant. In the 13th century six out of eight mandibles had Grant wear stages of 21 or less, ie were at Stage 4 or less of Maltby (M:55) and the remaining two were at stage 5 of Grant so that all had been slaughtered before the eruption sequence was fully complete. There were no aged mandibles from the 14th century. From the fifteenth century one mandible was at stage 21 of Grant (Stage 2-3 of Maltby), two were at stage 28-30 of Grant (Stage 5 of Maltby) and one was at stage 6 of Maltby, stage 48+ of Grant. Thus besides the one mandible with extreme wear on the third molar, all were slaughtered before stage 6, though age of death was slightly older than from 13th century. One mandible from the 16th century was at stage 27-28 of Grant, stage 4-5 of Maltby. Thus, as with the other Exeter sites, the pigs were mostly killed very young (M:55).

In common with the other Exeter sites, the epiphyseal fusion data indicate that a very small proportion of pigs reached maturity: never more than 25% surviving beyond 3-4 years (Table 17), though here the sample size is somewhat small to be taken as representative in an absolute sense, indeed, if the 24-30 and 36-42 month fusion groups are combined, the majority of pig from all periods (75-100%) were killed before 2 years old. In slight contrast to Maltby's finding (M:55), the earliest fusion group from Exe Bridge displays very high unfused percentages (except recent) with 45-66.7% of pigs killed by about one year old. Thus kill-off at Exe Bridge is earlier than the other Exeter sites, and relatively large number of perinatal/immature bones were present. Maltby notes that variations in mortality rates occurred, but samples here are too small to consider the Exe Bridge results at this level.

Documentary evidence largely supports this picture of early slaughter in pigs with sources from the 13th century indicating that fattening for the table occurred at about 18 months of age. In the 14th century they were killed at almost any age, and interestingly age of slaughter decreased in the post medieval-period with fattening in sties between nine to twelve months, and similar advances occurred in Devon (M:57).

Metrical analysis of pig

The small pig sample resulted in a limited number of measureable bones. Distal widths of humeri follow the medieval pattern from Exeter, with no bones as large as Maltby's Roman specimens' mean (M:57, Figure 16), and 37.1mm. Similary, proximal width of radius gave a similar result (mean: 28.3mm though, interestingly, a radius with a proximal width of 32.4mm from the 15th century is larger than any from Maltby's sites (M:193, Table 87(i)). Finally the width of the distal tibia - all 13th century specimens here - falls into the range of measurements from the other Exeter sites, though the Exe Bridge mean (27.3mm) is higher (M:193, Table 87(ii)). Also, in accordance with Maltby's findings, there was no evidence for wild boar. Thus the Exe Bridge sample, with the single exception described above, forms a group which falls squarely within the medieval and post-medieval size groups from Maltby's survey.

Fragmentation patterns

Fragmentation patterns are shown in Figurs 42-45. These were much more variable temporally than the cattle and ovicaprid results. The explanation for this may partly be that samples are small; also the high proportion of immature bones may have contributed (though in a less random way). Thus these results cannot be used to interpret the butchery practices in the same way as the cattle and sheep/goat but the high fragmentation cannot simply be a result of deposition or excavation damage and must result from butchery. The absence of data from several anatomical elements in each period is a further indication of unreliability due to small sample size.

Butchery Practice

Maltby notes that five burials of young pigs which had no butchery might indicate that these were diseased or casualty animals which had not been eaten, but the fact that they were so young indicates that they may have been reared in the town (M:58). The presence of perinatal and immature bones from Exe Bridge also indicates a similar hypothesis, and pig was known to have been kept in cities in the medieval period from documentary sources and illustrations (Grigson, 1982a: 302-3).

Maltby also notes the high degree of fragmentation of pig, and a similar result has been found from Exe Bridge (see above and Figures 41-45). Most cut marks were on upper long bones (Figure 47) where butchery was concentrated at the distal scapula and distal humerus for the fore-limb and at the ilium, proximal femur and distal femur/proximal tibia for the hind limb: essentialy similar to sheep and goat. In addition vertebrae were chopped axially (though lumber mostly on the lateral sides) and ribs were also chopped and cut. One canine tooth and one skull fragment also bore cut marks. These results are all similar to those from the other Exeter sites and indicate that pigs were essentially treated in a similar manner to sheep and goats.

Anatomical representation

Table 18 summarises the anatomical distribution for pig bones. The most obvious result is the generally low representation of all elements, and no single element is outstandingly represented as were horncores in the ovicaprids and cattle. Figure 48 illustrates these results and the only major trend which can be seen is that representation of all elements decreases more or less consistantly from the 13th century onwards. Other less consistent trends are noticeable. Mandibles are generally well represented, particularly in the 13th and 14th centuries where they outnumber the other elements, but this decreases in relation to other elements after that. The upper limb bones, and scapula, are also well represented, although inconsistent, and in the 15th century and post-medieval period are the most common parts. Interestingly, in the 13th century, cranium and extremity bones are better represented than in later periods, and taken in conjunction with high mandible representation, could indicate a large proportion of butchers' waste bones. Otherwise the distribution is a general mixture, indicating, perhaps, that the bones came from several sources; alternatively if pigs were reared by private householders, then the waste and food bones might all be included together in domestic rubbish.

Skeletal abnormalities

The pig skeletal abnormalities comprised two specimens, both limb bones. A metacarpal has a pitted extra growth of bone around the proximal epiphysis (Plate XIb) possibly due to an osteo-arthritic type of infection. An ulna has a greenstick fracture at the proximal joint surface which has resulted in a pitted, malformed articulation facet, and extra bone formation in the region of the fracture (Plate XIa).

Summary: the exploitation of pig

Pigs - all of which were domestic - were breed for meat and lard, and consequently were fattened for slaughter early in life with only a very few allowed to survive to maturity: their high fecundity and early maturation enabling them to produce an economy based on high infant/juvenile slaughter rates. Some pigs may have been kept within the city, and this is reflected by the presence of perinatal bones, and perhaps in the anatomical distribution evidence. They were of a similar size to those from other Exeter sites (M:59), and butchery techniques were more-or-less similar to those employed for sheep/goat.

The exploitation of other mammals

Table 1 shows that a minimum of nine other mammalion species were present, most of which would have been exploited for food. They were generally uncommon, with no species rising above 5% of the mammalion totals.

Deer

A mere five bones of deer were recovered, 0.05% of the mammalion total. Roe deer were commonest, with three bones, with one bone of red deer and one of (possibly) fallow deer. Two roe deer bones were measurable: a distal metacarpal (distal breadth 20.6mm) and a scapula (GLp 38.4mm, Lg 29.0mm, Slc 19.2mm). The (?) fallow deer bone is a distal tibia which has a distal breadth of 34.2mm, and thus falls into the range of fallow deer survey by Coy, but smaller than the red deer sample (Coy, pers comm); but some red deer tibiae measured by Noddle (1982: Table 7) are as small as this. All bones were fused. This sample is too small to draw any conclusions about exploitation of deer and nothing additional or contrary to the analysis by Maltby can be written (M:60-1).

Lagomorphs

Rabbit was present from the 13th century onwards and was at all times more common than hare. Though some of the more fragmentary bones may have been identified as rabbit; however rabbit outnumbered hare, even if the proportions are slightly inaccurate. The hare sample consists of 5 bones (0.05% of mamalian total) had the rabbit of 62 bones (0.7%). At face value this result is in contrast with Maltby's analysis (M:61) where hare outnumbered rabbit until the post-medieval period. However, as Table 19 illustrates, the inverse relationship of hare to rabbit noted by Maltby is repeated here, with hare commonest in the 13th century, and rabbit only becoming really common from the 15th century onwards. Fusion evidence indicated that most were mature when killed: all hare bones were fused and the majority of rabbit bones also. One rabbit tibia had been cut through at the distal end. The sample is again too small to add anything to Maltby's account of exploitation (M:61).

Horse

Horse was rarely represented, with only 23 bones recovered (0.2% of mammalion total). It was present in all periods except recent (Table 1), the majority being 13th century in date (n = 15). This scarcity of horse bones reflects the fact that horses seem to have been rare in Devon during the middle ages, and most documentary evidence suggests horses were only rarely used in plough teams in the post-medieval period (M:62).

No immature specimens were recovered indicating that horses were kept as a working animal, but two bones were butchered: a longitudinally split tibia and a scapula chopped through the collum, indicating that horses were sometimes eaten when their usefulness was over, - and in common with Maltby's findings - the bones were all fragmentary, supporting the idea that butchery was carried out.

Measurements of horse bones included a radius of length 310mm, a metarcarpus of length 211.5mm and two astragali of greatest height 47.8 and 54.8 mm, all indicating rather small individuals. Trow-Smith (quoted in Maltby, M:62) suggests that Devon horses were bred small for nimbleness for use as pack horses rather than on the plough team, and the latter use only became more important in the post-medieval period.

Dog

Dog bones were less common than those of horse (n = 14, 0.1% of mammalian bones). They were recovered from periods ranging from the 13th century to recent, but none from the 15th century or 17th century. There was little evidence for mortality rates, and all bones were fused except two articulated metatarsals with unfused distal epiphyses. It would appear that the majority of dogs reached maturity, though some puppies were present.

There was no evidence of any butchery, and if the bones were noticably less fragmentary than the food animals discussed above, none of the long bones was complete so that height estimation was not possible. The only skeletal abnormality was a fractured fibula whose shaft had adhered to the tibia as a result.

Maltby concluded that many of the dogs were likely to be scavengers, and that as late as the 16th century people who allowed their dogs to roam free were fined (M:64). However since this site is outside the city wall, it is possible that such legal rulings did not operate here, so it is interesting that dog bone was so rare: perhaps the stray dog problem was severe in the sub-urban and extra-mural locations also, and similar constraints operated here too.

Cat

The larger number of cat bones is boosted by the presence of one partial skeleton (17 bones) and seven articulated bones from a second skeleton (Table 1). Even if these are discounted, cat bones still outnumber dog bones (n = 31). In common with dogs, no cat bones were recovered from 15th or 17th century contexts.

Maltby noted high mortality rates in cats in medieval and post-medieval periods (M:64 and Table 92), and though a number of kittens were present at Exe Bridge, the majority of cats were mature (Table 20). Maltby compared fragmentation in cat and hare bones and found that hare were much more fragmentary; this fact and the lack of any butchery lead him to conclude that cats were not butchered. One skull bone from Exe Bridge (13th century) had fine cut marks, but this is more likely to be the result of skinning for the pelt than butchery for food. The cat bones were less fragmentary than dog bones, and a number of complete specimens were preserved. Measurements of these bones are given in Table 21. These measurements are similar to those given by Maltby (M: 200, Table 93), and some were as large as the largest from the other Exeter sites, which - as Maltby points out - are as big as wild cats (M:64). However, it is unlikely that any were wild cats.

The presence of a partial skeleton and a group of seven articulated bones indicated that some dead cats were dumped along with general rubbish. These may have been scavengers or pets. Maltby suggests that aside from these two methods of "exploitation" cats may have been skinned, and the cat skull is an interesting find in this light (M:65). The partial skeleton also has two fractured metatersals (rest not recovered) (Plate XII).

House mouse

The single house mouse bone is from a post-medieval context. These would have been common inhabitants of the urban environment, and their rarity reflects recovery techniques rather than lack of presence.

Quantitative analysis of the bird bones

The sample of bird bones - taking only the periods contemporary to Exe Bridge - from Maltby's sites amounted to 13.2% of the total identifiable bones assemblage; for Exe Bridge this proportion was 52%, so that bird bone was more common in the other sites (overall). Furthermore a larger number of species was represented: a minimum of 41 species compared with a mimimum of eleven from Exe Bridge. Note, however, that the Exe Bridge assemblage adds one further species to Maltby's list: peafowl (see Table 1 and M:66-67). The relative richness of bird remains from Maltby's sites is not consistently so for all periods, and his Table 94 (M:201) shows that between the 13th and 19th centuries proportions of bird ranged from 1.64 - 29.62%. Particularly high concentrations occurred in the periods Md4, Md9, md10, and Pm 1-3. Thus the contrast between Exe Bridge and the other Exeter sites is not so great as it would first appear. In common with the other extras and indeed with other sites elsewhere, birds are probably under represented here due to recovery biases (Levitan, 1982a: 30-31).

The greatest part of the bird bone assemblage was made up by domestic fowl, followed by domestic goose and duck (Table 1). The temporal changes in these three species are compared in Figure 4. This shows, rather strikingly, that there is an almost direct inverse relationship between geese and fowls. This has been found on a number of other medieval sites, a particularly good example being Flaxengate, Lincoln (O'Connor, 1982: 11 and Figure 6). The general trend in Figure 48 is an increase in fowl and decrease in geese from the 13th century onwards, though fowl experienced a reduction in importance between 15th and 18th centuries and goose increased over the period 15th to 17th century. Ducks generally increased inimportance up until the 17th century, after which there were no duck bones present, in any case duck can never have been an important domestic bird in comparision with fowl and goose. Details of bird occurrence and frequency are given in Table 22.

Landfowl

As with the other Exeter sites, domestic fowl were always the commonest of the birds though the overall percentage (57% of bird bones: Table 1) was lower here, and furthermore fowl were less than 50% from the 13th century whereas they were always over 50% in Maltby's sites (M:67). (Note that the figure of 44.2% from the 14th century - Table 1 - is due to the presence of a partial duck skeleton; if this is disregarded, the fowl percentage is 68.4%). Fowl has generally been the most important bird from Roman times onwards, and Maltby quotes several examples, to which can be added sites such as Flaxengate, Lincoln (O'Connor, 1982: 11, Figure 6), and from the S W region, Okehampton Castle (Maltby, in press) Ilchester (Levitan, 1982b: 280, Table 15) and Taunton (Levitan, in press), though Maltby also draws attention to a small number of medieval sites where goose appear to have been as important as fowl (M:67).

Figure 49 illustrates that fowl generally became more common after the 13th century, indicating increasing intensification of fowl exploitation, in common with the other Exeter sites. Following up on this point, Maltby noted that the proportion of immature fowl bone was higher in medieval periods than in Roman (M:67). There is no obvious trend at Exe Bridge, where the proportion of immature fowl (based on fusion of long bones) ranged from 0-50%. In the medieval period the proportion of immature fowl ranged from 8.6% (15th century) to 50% (14th century) with an average of 29.2%. The post-medieval proportion is 37.7% and the recent period contained no immature bones. Thus the broad trend into medieval and post-medieval periods was of intensification of exploitation. The fusion data are given in Table 23.

The sample is not large enough to compare the metrical analysis of the fowl bones with the other Exeter sites in terms of variation, but Table 24 summarises the greatest length dimensions for Exe Bridge and compares this with corresponding means from Maltby's analysis. Maltby found that there was a significant increase in size from medieval to post-medieval: no such obvious trend is present from Exe Bridge, but since ranges are overlapping (even in Maltby's analysis: M:67) the small sample size may account for the contrast between Exe Bridge and the other Exeter sites. Interestingly, many of the Exe Bridge means are larger than those from the other Exeter sites.

Maltby also comments on the large amount of size variation, and though the Exe Bridge samples are too small to submit to statistical analysis, Figure 50 indicates that a large variation existed here too. A comparison between Figure 50 and Figure 18 of Maltby (M: 68) shows that the humerus measurements were generally similar to the other Exeter sites, but note the large, outlying humerus from Exe Bridge. There is an outlying measurement from the femur results also, but here it is a much smaller bone than the other Exeter sites (compare Figure 50 with Maltby's Figure 19, p.69). The Exe Bridge sample is too small to ascribe such variation to sex dimorphism or breed, but Maltby noted that the bimodality in his samples may have been due to sex dimorphism (M:68).

It is possible to ascertain sex from an analysis of the medullary cavity of long bones (Driver, 1982), but this has not been attempted here due to time limitations. The presence of a spur on the tarsometatarsus can be related to sex (male), and of 25 tarsometatarsi, five are spurred. This indicates that the majority may have been females, though sixteen were immature and this may have biasing effect. Interestingly the single complete unspurned, mature specimen was larger than the single complete spurred specimen (Table 24). The possibilty that caponising was practiced is a complicating issue (M:71), and evidence from Exe Bridge is limited and inconclusive.

The small size of the fowl skeleton means that little butchery was required; consequently butchery markings are rare. One humerus has a series of cuts on the proximal epiphysis, a femur has cuts near the distal epiphysis, and a tibiotarsus cuts on the distal epiphysis. Finally a coracoid has been cut through at the proximal end.

Skeletal abnormalities were uncommon. The keel of a sternum is twisted and distorted; a tibiotersus has a nodule of extra bone at the distal end (lateral side); a tarsometatarsus has extra bone growth and lipping on the medial side of the proximal epiphysis and a tibiotarsus has a slightly distorted (bent) shaft. (Plate XIII).

Although there are a number of differences between Exe Bridge and Maltby's analysis, these are not great enough to indicate a major difference in exploitation, so that Maltby's summary may be applied here also (M:71).

The only other land fowl species was peafowl. This is an important find because no peafowl were present in Maltby's samples (M:71) and this find - a 15th century peahen carpometacarpus (identification confirmed by J Coy) - is a useful corroboration of the documentary evidence (16th century) quoted by Maltby.

Geese and ducks

Goose was the second most common species of bird exploited in the city of Exeter, the overall proportion (16.1%) was larger than from the other Exeter sites (M:71) though this is due to inclusion of Roman proportions in Maltby's result of 12.01%, since goose was unimportant in Roman Exeter. In the medieval period goose varied between 14% and 29% in Maltby's samples and this compares favourably with Exe Bridge (8.6% - 35.9%). Maltby notes a decrease in popularity of geese in post-medieval/recent periods and this, too, is reflected by the Exe Bridge assemblage (Tables 1 and 22).
Maltby found that geese were generally allowed to reach maturity before being fattened up for slaughter (M:71) and this was so for Exe Bridge where immature bones were very uncommon, and only in the 15th century group were any unfused long bones present (12.5%, out of 8 bones).

Measurements of goose carpo- and tarsometatarsi are very similar to Maltby's samples (Table 5), and Maltby notes that there was no significant size change between medieval and post-medieval periods (M:72).

The problem of recognising the difference between domestic goose and its wild ancestor greylag goose are discussed by O'Connor (1982: 42-43), and the two tarsometatarsi measured from Exe Bridge fall into the domestic grouping on the basis of their shaft width/greatest length ratios.

Five goose bones bare cut marks, and bones are generally more fragmentary than fowl: goose is a larger bird, so a greater amount of butchery is to be expected.

Third in the bird abundance ranking was duck (Table 1 and 2) with an overall percentage of 8.3% (somewhat inflated by a skeleton of 27 bones from the 13th century). The medieval proportion (disregarding the skeleton) is 1.9%, and the post-medieval percentage 8.0%, thus there is an apparent increase in popularity of duck over this period (see Figure 49): a result paralleled by the other Exeter sites (M:72).

In common with goose (and with duck from Maltby's analysis) immature ducks were rare, so adult birds were favoured (in fact no unfused duck bones were recovered). The presence of the skeleton from the 14th century is interesting since it appears not to have been eaten (articulated remains) and possibly was a natural death from a bird living on the river. Measurements of duck bones are in the site archive. The uncertainty about differences between domestic duck and mallard are discussed by O'Connor (1982: 43-44), and two carpometacarpi from Exe Bridge of c 53mm length could be mallard; a bird of 58 mm is almost definately domestic duck.

A single bone from teal was recovered (Table 22) - this was probably living on the river, so the occurrence of a bone here is not surprising.

Other Birds

A small number of other birds were recovered, of which woodcock was by far the commonest (Table 22), and in fact outnumbered ducks if the 14th century skeleton is disregarded. Thus, in common with Maltby's samples, woodcock was actually the third most common species, rather than duck! Unlike the other Exeter sites, it was commonest in the post-medieval period when it accounted for 10% of bird bones. It was a common winter visitor in Devon, and was much in demand as a food bird, so its presence here in relatively large numbers is not surprising.

Pigeons (or doves) were less common, but were best represented in the post-medieval. One would expect their occurrence to have been both more consistent and perhaps more frequent. Maltby comments on this point, and the scarcity here is in keeping with Maltby's findings (M:73).

Next most common were corvids of which one raven bone is the only identified to species level (Table 22). Maltby's discussion of the Exeter crows is probably relevant to Exe Bridge also (M:73).

Four bones from birds of the thrush family were recovered, and there is one of herring/lesser black-backed gull. These may well have been chance occurrences, or they may have been caught and eaten, but in any case would have been only a rare source of food.

Summary: the exploitation of birds

The bird assemblage from Exe Bridge does not differ significantly from the other Exeter sites, and beyond the odd contrast, or point of interest (eg occurrence of peafowl) the summary given by Maltby is equally applicable here (M:74).

The Fish Remains

A minimum of twenty species of fish were recovered, and I am grateful to Sarah Colley (Southampton Faunal Remains Project) for helping me with the majority of the identifications.

All but three species have previously been identified from Exeter (Wilkinson, 1979, in Maltby's report: M:74-81). Thus Wilkinson's analysis of a much larger assemblage probably adequately describes the Exe Bridge assemblage too. It is possible that one or two differences existed between Exe Bridge and the rest of Exeter, but these will have been minor, and the odd larger specimen or more common species would not necessarily be a meaningful result. Thus, because of the above and due to time limitations, the fish remains have not been analysed in detail.

The three species not previously identified are Saith, Flounder and Spurdog. In the case of flounder, Wilkinson comments that although plaice was the only positively identified species, others are likely to have been present (M:76).

The saith is a common North Atlantic fish, caught in trawls and seines. It is common in inshore waters around Scotland and northwards and can peak sizes of 130 cm (14 kg). It is also known as coley, billet, coalfish, etc (Wheeler, 1978:159-160). The Exe Bridge specimens are quite small, approximating to specimens of around 3kg in the Southampton Faunal Remains reference collection.

Spurdog (*Squalus acanthius*) is a small shark which can attain sizes of up to 120 cm (9kg). It is very common in coastal and off-shore waters of Northern Europe (Wheeler, 1978:74). A single spine was recovered from this species).
A species which has been previously identified is Pandora (*Pagellus erythrimus*) (M:76). rare fish in northern European seas, though common in the mediterranean and southern Biscay. The northern fish migrate from the latter locations in the summer, so this is almost certaily a summer migrant (Locker, pers comm). I am grateful to Alison Locker for identifying this specimen.

Conclusion

Maltby's report provided an extensive and concise consideration of Exeter's role in animal husbandry, and the Exe Bridge assemblage provided no substantial evidence to differ from this (M: 82-93).

A major contribution in terms of new evidence is in the horncore assemblage which figures so largely and significantly amongst the cattle and sheep/goat bones. The fact that no such group occurred in any of Maltby's samples is a further testimony to the importance of inter- and intra-site variability and lends more weight to Maltby's argument that sites such as this require more work and analysis (M:93-4). It is worth concluding this report with a quote from Maltby's pioneering study of the Exeter bones; for more work is still required before an adequate understanding of the evolution and role of Exeter as a market and an influence as regional animal husbandry:

"Lateral variation has been established to be a fundamental influence on the types of animal bones represented on an urban site. There is no doubt that the full range of variation has not been met... This places doubts on whether the data are representative of the city as a whole and makes any broader interpretation merely tentative. On complex urban sites the goal must be to examine a representative cross-section of the animal bones deposited. Evidence of lateral variation itself is important because it is the key to the understanding of the redistribution and organisation of the meat supply from faunal remains". (M: 93-94).

Thus Exe Bridge is merely another piece in the jig-saw, and whilst in itself it provides relatively little information about Exeter, it is an important addition to their knowledge of Exeter's past when taken in relation to and comparison with other similar studies; particularly since it so needfully fills the gap in knowledge concerning the 13th century from Maltby's analysis (see Introduction).

Bibliography

Armitage, P L 1977 — *The Mammalian Remains from the Tudor site of Baynard's Castle, London: A Biometrical and Historical Analysis.* Phd thesis, London (unpublished)

Armitage, P L 1982 — A system for Ageing and sexing the Horncores of Cattle from British Post-medieval sites (with special reference to unimproved British Longhorn Cattle) in: B Wilson *et al*, op. cit, 37-54.

Armitage, P L 1983 — The Early History of English Longwool sheep, *Ark* 10, No 3: 90

Armitage, P L and Clutton-Brock J 1976 — A system for Classification and Description of the Horn-cores of Cattle from Archaeological Sites, *Jour Arch Sci* 3; 329-348.

Armitage, P L and Goodall J A 1977 — Medieval horned and polled sheep; the archaeological and iconographic evidence, *The Antiq Jour* 57: 73-89.

Baker J and Brothwell D 1980 — *Animal Diseases in Archaeology,* London: Academic Press

Binford, L R 1981 — *Bones: Ancient Men and Modern Myths,* London: Academic Press

Boessneck, J 1969 — Osteological differences between sheep (*Ovis aries* Linne) and goat (*Capra hircus* Linne) in: D Brothwell and E Higgs (ed) *Science in Archaeology*, London: Thames and Hudson, 331-358

Bourdillon, J and Coy, J 1980 — The Animal Bones in: R Holdsworth (ed) *Excavations at Melbourne Street, Southampton,* 1971-76 CBA Res Rpt 3, 79-137

Deniz, E and Payne, S 1982 — Eruption and wear in the mandibalar dentition as a guide to ageing Turkish Angora goats, in: B Wilson *et al* op. cit, 155-206.

Grant, A 1982 — The use of tooth wear as a guide to the age of domestic ungulates in: B Wilson *et al*, op cit, 91-108

Grigson, C 1982 a — Porridge and pannage: pig husbandry in Neolithic England, in: M Bell and S Limbrey (eds) *Archaeological Aspects of Woodland Ecology*, Oxford: BAR, 297-314

Grigson, C 1982 b — Sex and age determination of some bones and teeth of domestic cattle: a review of the literature, in: B Wilson *et al*, op. cit 7-24

Grigson, C 1982 c — Sexing Neolithic domestic cattle skulls and horncores, in: B Wilson *et al*, op. cit, 25-36

Jones, R T, Wall, S M, Locker, A M, Coy J and Maltby, M 1981 — *Computer based Osteometry Data Capture Manual (1)*, Anc Mon Lab Rpt 3342

Levitan B 1982 a — *Excavations at West Hill Uley: 1979 The Sieving and Sampling Programme*, Western Arch Trust Occ Paper 10, Bristol

Levitan B 1982 b — The Faunal Remains, in: P Leach, *Ilchester Volume 1. Excavation 1974-75,* Western Arch Trust Exc Rpt 2, Bristol, 269-284

Levitan, B in press — The animal bones, in: S Rahtz and T Rowley: *Excavations at Middleton Stoney Castle, Oxfordshire,* Univ Oxford Dept Extra-mural studies.

Levitan, B in press — The animal bones, in: P Leach, *Excavations in Taunton, Somerset,* Western Arch Trust

Levitan, B forthcoming — A methodology for recording the pathology and other anomalies of ungulate mandibles from archaeological sites, in: D Gilbertson and N Ralph (eds) forthcoming volume of Ass of Environmental Arch Symposia

Levitan B in preparation — The animal bones from West Hill Uley, Gloucestershire

Maltby, M 1979 — *Faunal studies on urban sites. The animal bones from Exeter 1971-1975,* Exter Arch Rpt 2, Univ. Sheffield

Maltby, J M 1982 — The variability of faunal samples and their effects upon ageing data, in: B Wilson *et al*, op. cit, 81-90.

Maltby, J M in press — Mammal and Bird Bones, in: R A Higham and J P Allen, Excavations at Okehampton Castle: III, *Devon Arch. Soc. Proc* 40 (1982).

Marshall, W 1796 — *The Rural Economy of the West of England including Devonshire and parts of Somersetshire, Dorsetshire and Cornwall,* 2 vols, reprinted by David and Charles, 1970 (Newton Abbot).

Noddle, B A 1982 — The size of red deer in Britain - past and present, with some reference to fallow deer, in: M Bell and S Limbrey (eds) *Archaeological Aspects of Woodland Ecology,* Oxford: BAR, 315-333

Noddle, B A 1983 — Book Review, *Circaea* 1(3), 63-67

O'Connor, T P 1982 — *Animal Bones from Flaxengate, Lincoln c 870-1500* The Arch of Lincoln, Vol XVIII-1, CBA

Payne, S 1969 — A metrical distinction between sheep and goat metacarpals in: P Ucko and G Dimbleby (eds). *The Domestication and Exploitation of Plants and Animals,* London: Duckworth, 295-306.

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

Ryder, M L 1983 — *Sheep and Man,* London: Duckworth

Stallibrass, S n.d — Paper given in a meeting of the Association of Environmental Archaeologists, April 1983, London

Wheeler, A 1978	Key to the fishes of Northern Europe, London: Warne
Wilson, B 1978	Methods and results of bone analysis, in: M Parrington (ed) The Excavation of an Iron Age Settlement, Bronze Age ring ditches and Roman features at Ashville Trading Estates, Abingdon (Oxfordshire) 1974-76, Oxford Arch Unit Rpt 1, CBA Res Rpt 28, 110-126, 133-138
Wilson, B, Grigson, C and Payne, S 1982 (eds)	Ageing and Sexing Animal Bones from Archaeological Sites, Oxford: BAR

Tabl 1: summary of bones present

DATE LOCATION		13th CENTURY				14th CENTURY			15th CENTURY			POST-MEDIEVAL				RECENT				SITE TOTAL
		T.A+B	T.C	St.E.	TOTAL	T.A+B	T.C	TOTAL	T.C	St.E.	TOTAL	T.A+B	T.C	St.E.	TOTAL	T.A+B	T.C	St.E	TOTAL	
CATTLE	n	686	2073	1	2760	171	280	451	438	73	511	185	121	306	612	294	54	3	351	4685
	%	48.5	51.4	50.0	50.7	48.4	54.4	52.0	40.7	47.7	41.6	34.2	41.6	65.0	47.0	68.7	43.9	27.3	62.5	49.3
OVICAPRID	n	636	1821	1	2458	239	199	438	510	61	571	315	145	137	597	107	63	6	176	4240
	%	45.0	45.2	50.0	45.1	67.7	38.6	50.5	47.4	39.9	46.5	58.2	49.8	29.1	45.8	25.0	51.2	54.5	31.3	44.6
PIG	n	57	113	0	170	12	33	45	101	13	114	10	20	24	54	14	4	2	20	403
	%	4.0	2.3		3.1	3.4	6.4	5.2	9.4	8.5	9.3	1.9	6.9	5.2	4.1	3.3	3.3	18.2	3.6	4.2
HORSE	n	7	8	0	15	1	0	1	1	3	4	0	0	3	3	0	0	0	0	23
	%	0.5	0.2		0.3	0.3		0.1	0.1	2.0	0.3			0.6	0.2					0.2
DOG	n	3	5	0	8	0	0	0	2	3	5	0	0	0	0	1	0	0	1	14
	%	0.2	0.1		0.2				0.2	2.0	0.4					0.2			0.2	0.1
CAT	n	12	3	0	15	20^{2}	1	21^{2}	0	0	0	5	5	1	11	7^{4}	1	0	8^{4}	55
	%	0.8	0.07		0.3	5.7	0.2	2.4				0.9	1.7	0.2	0.8	1.6	0.8		1.4	0.6
RABBIT	n	3	1	0	4	9	1	10	21	0	21	22	0	0	22	5	0	0	5	62
	%	0.2	0.02		0.1	2.5	0.2	1.2	2.0		1.7	4.1			1.7	1.2			0.9	0.7
OTHER MAMMALS[1]	n	10	8	0	18	1	1	2	3	0	3	4	0	0	4	0	1	0	1	28
	%	0.7	0.2		0.3	0.3	0.2	0.2	0.3		0.2	0.7			0.3		0.8		0.2	0.3
Σ MAMMALS	nm	1414	4032	2	5448	453	515	868	1076	153	1229	541	291	471	1303	428	123	11	562	9510
	nm/N %	77.1	87.6	100.0	84.6	70.3	80.8	73.5	56.5	87.4	59.1	73.0	67.4	95.2	78.1	78.7	87.9	100.0	80.9	78.2
DOMESTIC FOWL	n	26	15	0	41	38	14	52	123	2	125	48	39	3	90	5	3	0	8	316
	%	45.6	42.9		44.6	44.2	82.3	50.5	63.1	66.7	63.1	55.2	68.4	50.0	60.0	62.5	100.0			57.0
GOOSE	n	19	14	0	33	16	2	18	16	1	17	12	6	3	21	0	0	0	0	89
	%	33.3	40.0		35.9	18.6	11.8	17.5	8.2	33.3	8.6	13.8	10.5	50.0	14.0					16.1
DUCK	n	0	0	0	0	29^{3}	1	30^{3}	4	0	4	8	4	0	12	0	0	0	0	46
	%					33.7	5.9	29.1	2.1		2.0	9.2	7.0		8.0					8.3
OTHER BIRDS[1]	n	12	6	0	18	3	0	3	52	0	52	19	8	0	27	3	0	0		103
	%	21.1	17.1		19.6	3.5		2.9	26.7		26.3	21.8	14.0		18.0	37.5				18.6
Σ BIRDS	nb	57	35	0	92	86	17	103	195	3	198	87	57	6	150	8	3	0	11	554
	nb/N %	3.1	0.8		1.4	13.4	2.7	8.7	10.2	1.7	9.5	11.7	13.2	1.2	9.0	1.5	2.2		1.6	4.6
FISH AND AMPHIBIA[1]	n	45	32	0	77	44	7	51	310	0	310	55	37	0	92	7	0	0	7	537
	n/N %	2.4	0.7		1.2	6.8	1.1	4.3	16.3		14.9	7.4	8.6		5.5	1.3			1.0	4.4
INDETER.	n	319	503	0	822	61	98	159	324	19	343	58	47	18	123	101	14	0	115	1562
	n/N %	17.4	10.9		12.8	9.5	15.4	13.5	17.0	10.9	16.5	7.8	10.9	10.9	7.4	18.6	10.0		16.5	12.8
TOTAL	N	1835	4602	2	6439	644	637	1181	1905	175	2080	741	432	495	1668	544	140	11	695	12163^{5}

SPECIES LISTS:

MAMMALS
Cattle
Sheep
Goat
Pig
Horse
Dog
Cat
Red deer
Roe deer
Fallow deer*
Rabbit
Hare
House mouse●

BIRDS
Domestic fowl
Domestic/Greylag goose
Domestic duck/Mallard
Teal
Peafowl●
Woodcock
Raven
Corvidae (crow family)
Pigeon/Rock dove
Herring/Lesser black-backed gull
Turdidae (thrush family)

AMPHIBIANS
Common frog

FISH
Hake
Ling
Conger eel
Eel
Cod
Haddock
Mackerel
Turbot
Pollack
Saithe●
Plaice
Flounder●
Red sea bream
Gilthead*
Pandora
Salmon/Trout
Tub gurnard
Bass
Spurdog●

* identifications uncertain
● not present from previous Exeter medieval excavations (Wilkinson 1979, Maltby 1979)

Notes:- 1 : Species list above
2 : Including partial cat skeleton, 17 bones
3 : Including partial duck skeleton, 27 bones
4 : 7 articulated bones
5 : Excluding unstratified bones; Grand total ≃ 13,000

Table 2. Cattle epiphyseal fusion data

Fusion age		13th C.		14th C.		15th C.		Post-medieval		Recent	
7-18 mo.		F	NF	F	NF	F	NF	F	NF	F	NF
Scapula	D	6	0	3	0	1	1	0	0	1	0
Humerus	D	2	4	13	0	3	1	2	5	3	0
Radius	P	11	1	21	0	5	5	4	3	3	0
Phalanx 1	P	13	0	26	0	5	0	15	0	23	1
Phalanx 2	P	2	0	9	0	2	0	4	2	9	0
% unfused		15.8		0.0		30.4		28.6		2.5	
24-36mo.											
Metacarpus	D	4	6	14	3	3	6	2	4	20	3
Tibia	D	3	2	11	6	8	4	0	4	1	1
Metatarsus	D	2	12	6	2	1	8	0	7	11	3
Calcaneum	P	4	3	12	4	3	4	2	4	2	0
% unfused		63.9		25.9		59.5		82.6		17.1	
42-48mo.											
Humerus	P	2	6	3	3	2	3	6	6	0	0
Radius	D	4	0	10	1	1	6	3	4	0	4
Ulna	P	0	3	1	1	1	2	1	2	0	1
Femur	P	3	7	8	4	4	2	1	4	0	0
Femur	D	1	6	7	1	3	1	2	4	0	2
Tibia	P	1	4	6	7	1	7	5	7	1	1
% unfused		70.3		32.7		60.0		60.0		88.9	

Fusion ages from Grigson (1982b:22)

Table 3. Cattle horncore ageing data

		Tenements A-C									
Age class	Age range.	13c.		14c.		15c.		16-17c.		18-20c.	
		n	%	n	%	n	%	n	%	n	%
infant	0-1yr.	6	1.8	0	0.0	0	0.0	1	3.6	0	0.0
juvenile	1-2yr.	87	26.4	4	25.0	1	5.9	3	10.7	0	0.0
sub-adult	2-3yr.	34	10.3	1	6.3	1	5.9	2	7.1	4	36.4
young adult	3-7 yr.	127	38.5	6	37.5	5	29.4	10	35.7	1	9.1
adult	7-10yr.	58	17.6	2	12.5	7	41.1	5	17.9	3	27.3
old adult	over 10yr.	18	5.5	3	18.8	3	17.6	7	25.0	3	27.3
totals		330		16		17		28		11	

Age classes and ranges from Armitage (1982:42)

Table 4. Cattle mandible ageing data

Age class	Age range	13c.		14c.		15c.		16-17c.	
		n	%	n	%	n	%	n	%
1-3	0-4 mo.	0	0.0	3	50.0	0	0.0	1	100.0
29-32	30-32 mo.	0	0.0	1	16.7	0	0.0	0	0.0
36-40	32-40 mo.	1	20.0	2	33.3	3	50.0	0	0.0
41-44	40-50 mo.	2	40.0	0	0.0	2	33.3	0	0.0
47-49	over 50 mo.	2	40.0	0	0.0	1	16.7	0	0.0

Age classes and ranges from Grant (1982:96) and Grigson (1982:23)

Table 5. Summary of cattle bone measurements

Measurement	Date	Exe Bridge N	Exe Bridge Range	Exe Bridge Mean	Other Exeter sites N	Other Exeter sites Range	Other Exeter sites Mean
Scapula GLP –	13c.	4	51.2 – 57.0	53.3	9	68.0 – 72.2	70.3
	14c.	2	62.0 – 63.8	62.9	–	–	–
LG –	13c.	4	43.0 – 50.0	45.7	10	45.8 – 55.8	50.0
	14c.	2	51.9 – 56.1	54.0	–	–	–
Humerus Bd +	13c.	1	74.0	74.0	3	68.0 – 72.2	70.3
Radius Bp –	13c.	10	60.5 – 76.8	67.7	16	55.1 – 79.3	68.5
	14c.	1	86.1	86.1	–	–	–
Bd –	13c.	4	53.3 – 60.8	56.3	11	54.0 – 72.1	61.4
	14-15c.	2	62.6 – 73.8	68.2	–	–	–
(–)	17c.	1	60.4	60.4	5	49.6 – 85.0	70.7
Metacarpus Bp +	13c.	10	43.8 – 56.4	50.4	17	42.5 – 58.7	49.7
=	14-15c.	5	45.2 – 52.2	49.5	7	45.1 – 52.9	49.6
(–)	16-17c.	1	46.7	46.7	16	36.5 – 62.3	49.8
+	18c.	4	45.4 – 53.6	49.0	4	39.5 – 51.0	46.7
Dp –	13c.	10	26.6 – 34.0	29.5	15	25.2 – 38.6	32.3
=	14-15c.	5	26.2 – 43.8	31.9	6	29.4 – 33.6	31.7
(–)	16-17c.	1	26.3	26.3	15	21.2 – 38.2	31.1
–	18c.	4	25.3 – 30.0	27.7	4	23.2 – 33.8	29.5
Bd =	13c.	14	44.8 – 59.4	52.5	22	43.2 – 61.5	52.8
+	14-15c.	6	48.8 – 59.2	54.3	3	45.9 – 58.0	50.2
	16-17c.	2	44.4 – 48.0	46.2	–	–	–
	18c.	14	47.4 – 62.0	54.1	–	–	–
GL (+)	13c.	2	174.4 – 178.3	176.4	6	159 – 192	173.6
(+)	14-15c.	1	194.5	194.5	5	153 – 213	188.8
	18-20c.	1	164.8	164.8	–	–	–
Pelvis Amrd	13c.	4 ♀	6.2 – 7.4	6.9	–	–	–
		2 ♂/♂	12.0 – 12.4	12.2	–	–	–
	14c.	1 ♀/♂	10.8	10.8	–	–	–
		1 ♂	23.0	23.0	–	–	–
	18c.	1 ?♂	18.4	18.4	–	–	–
Tibia Bd +	13c.	8	50.0 – 66.4	55.4	29	44.8 – 60.4	54.4
–	14-15c.	1	42.9	42.9	5	49.9 – 58.8	54.6
Dd +	13c.	8	34.0 – 48.5	40.7	29	33.6 – 47.0	39.0
(–)	14-15c.	1	38.5	38.5	5	37.9 – 44.2	40.8
Astragalus GLl +	13c.	9	52.8 – 59.5	56.4	13	50.5 – 59.5	55.2
(+)	14-15c.	2	53.9 – 57.6	55.8	3	54.5 – 58.0	56.0
GLm +	13c.	9	47.4 – 55.0	51.5	15	45.5 – 56.6	50.8
(–)	14-15c.	2	43.5 – 53.9	48.7	3	50.1 – 51.9	51.1
Dl =	13c.	9	28.1 – 33.8	31.2	13	28.0 – 34.9	31.8
(=)	14-15c.	2	30.4 – 32.4	31.4	3	30.3 – 33.0	31.4
Metatarsus Bp +	13c.	16	35.0 – 46.0	42.7	26	34.4 – 45.8	41.5
+	14-15c.	8	38.6 – 49.3	42.5	4	38.3 – 46.5	41.7
(–)	16-17c.	2	39.8 – 40.2	40.0	10	31.2 – 49.3	43.3
	18c.	11	35.6 – 46.6	42.8	–	–	–
Dp. +	13c.	16	34.2 – 43.4	40.2	27	33.0 – 44.8	39.7
+	14-15c.	8	38.2 – 43.2	40.9	4	36.4 – 42.5	39.0
(–)	16-17c.	2	37.1 – 38.0	37.6	8	27.6 – 46.4	41.2
	18c.	11	34.6 – 47.2	41.2	–	–	–
Bd.	13c.	8	43.0 – 57.7	49.3	–	–	–
	18c.	9	40.2 – 65.1	48.4	–	–	–
GL. (+)	13c.	2	190.5 – 208.0	199.3	5	182.0 – 205.0	193.0
	18c.	1	244.0	244.0	–	–	–

Notes: all measurements from Dreisch, 1976 except pelvis – Amrd = acetabulum medial rim depth

+ = Exe Bridge mean >1 mm more than other sites mean

= = Exe Bridge mean within 1 mm of other sites mean

– = Exe Bridge mean >1 mm. less than other sites mean

( ) = Sample too small for comparison to be significant (<4)

Table 6. Comparison of means of cattle bone dimensions from Exeter

Date	E.B. dimension over 1mm smaller	E.B and other sites within 1mm	E.B. dimension over 1mm larger
13c.	Scapula GLP LG Radius Bp Dp. Metacarpus Dp	Metacarpus Bd Astragalus DL	Humerus Bd Metacarpus Bp (GL) Tibia Bd Dd Astragalus GLl GLm Metatarsus Bp Dp (GL)
14-15c.	Tibia Bd (Dd) Astragalus (GLm)	Metacarpus Bp Dp Astragalus (DL)	Metacarpus Bd (GL) Astragalus (GLl) Metatarsus Bp Dp (GL)
16-17c.	Radius (Bd) Metacarpus (Bp) (Dp) Metatarsus (Bp) (Dp)		
18c.	Metacarpus Dp		Metacarpus Bp

Notes: bracketed dimensions based on samples of 3 or less

Table 7. Anatomical distribution of cattle bone elements.

Index factor (N)	Anatomical element	13th. C. n	$\frac{n}{N}$	14th. C. n	$\frac{n}{N}$	15th. C. n	$\frac{n}{N}$	Post-medieval n	$\frac{n}{N}$	Recent n	$\frac{n}{N}$
2	horncore	450	225.0	24	12.0	19	9.5	42	21.0	16	8.0
12	upper teeth	10	0.8	5	0.4	8	0.7	9	0.8	1	0.1
18	lower teeth	16	0.9	5	0.3	4	0.2	4	0.2	4	0.2
2	mandible	3	1.5	6	3.0	2	1.0	2	1.0	0	0
7	cervical	29	3.9	9	1.3	7	1.0	19	2.7	3	0.4
12	thoracic	10	0.8	3	0.3	11	0.9	7	0.6	1	0.1
7	lumbar	14	2.0	5	0.7	3	0.4	7	1.0	0	0
16	caudal	39	2.4	4	0.3	4	0.3	0	0	0	0
2	scapula	12	6.0	2	1.0	1	0.5	1	0.5	1	0.5
6	humerus	11	1.8	8	1.3	4	0.7	11	1.8	1	0.2
6	radius	13	2.2	2	0.3	5	0.8	6	1.0	2	0.3
2	ulna	14	7.0	6	3.0	6	3.0	6	3.0	0	0
12	carpals	3	0.3	1	0.1	12	1.0	1	0.1	1	0.1
6	metacarpals	15	2.5	10	1.7	9	1.5	10	1.7	5	0.8
6	pelvis	2	0.3	2	0.3	0	0	4	0.7	2	0.3
6	femur	14	2.3	4	0.7	3	0.5	4	0.7	1	0.1
2	patella	2	1.0	0	0	3	1.5	1	0.5	0	0
6	tibia	12	3.0	13	2.2	13	2.2	7	1.2	1	0.1
2	astragalus	14	7.0	2	1.0	5	2.5	13	6.5	0	0
2	calcaneum	26	13.0	4	2.0	5	2.5	6	3.0	3	1.5
2	tarsals	3	1.5	1	0.5	3	1.5	0	0	0	0
6	metatarsals	15	2.5	11	1.8	4	0.7	11	1.8	1	0.2
36	phalanges	58	1.6	10	0.3	7	0.2	26	0.7	42	1.2
24	ribs	70	2.9	16	0.7	17	0.7	16	0.7	3	0.1
	totals	855		153		155		213		88	

Notes: all elements exclude fragments 25% and less complete

index factors : all are as found in single skeleton except:

long bones : 2 proximal epiphyses, 2 distal epiphyses, 2 diaphyses = 6,

pelvis : 2 ilia, 2 ischia, 2 pubes = 6,

ribs : 24 rib heads only.

ulna : proximal portion only

Table 8. Proportion of sheep to goat

Anatomical element	13th. C. sheep	goat	14th. C. sheep	goat	15th. C. sheep	goat	Post-medieval sheep	goat	Recent sheep	goat
skull	19	6	6	1	9	0	6	1	2	0
horncore	28	421	4	36	6	11	8	12	3	8
atlas/axis	2	0	1	0	4	0	3	0	0	0
scapula	4	2	2	0	5	1	2	1	1	0
humerus	8	0	8	0	13	0	9	1	2	1
radius	12	5	8	0	11	0	6	1	4	0
ulna	3	0	2	0	1	0	6	0	1	0
metacarpals	48	20	11	7	10	1	16	3	1	0
pelvis	11	5	0	0	3	2	4	4	0	2
femur	1	0	0	0	0	0	5	0	0	0
astragalus	1	1	1	1	2	0	0	0	0	0
calcaneum	3	1	0	0	2	0	1	0	0	0
metatarsals	58	20	11	6	9	3	10	0	2	1
phalanges	16	35	5	5	3	4	8	8	1	3
totals	214	517	59	56	78	22	84	31	17	15

Identifications are based on the morphological criteria of Boessneck (1969)

Table 9. Mandible ageing data for ovicaprids using the method of Payne

	Suggested age	13th.c.		14th.c.		15th.c.		Post-medieval		Recent	
		FCC	%	FCC	%	FCC	%	FCC	%	FCC	%
A	0-2mo.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
B	2-6 mo.	0.00	0.0	0.50	2.6	0.00	0.0	0.00	0.0	0.00	0.0
C	6-12 mo.	0.00	0.0	0.50	2.6	0.00	0.0	1.00	6.3	1.00	33.3
D	1-2yr.	13.81	9.8	0.00	0.0	2.00	20.0	1.00	6.3	0.00	0.0
E	2-3yr.	57.34	41.3	4.62	24.3	0.00	0.0	1.80	11.3	0.00	0.0
F	3-4yr.	44.12	31.8	8.79	46.3	5.33	53.3	6.58	41.1	0.50	16.7
G	4-6yr.	15.37	11.1	1.77	9.3	2.67	26.7	2.39	14.9	1.00	33.3
H	7-8yr.	8.36	6.0	2.82	14.8	0.00	0.0	3.23	20.2	0.50	16.7
I	8-10yr.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Total		141.00	100.0	19.00	99.9	10.00	100.0	16.00	100.1	3.00	100.0

FCC = final corrected count (Payne, 1973: 293-296); suggested ages from Payne (1973: 299)

Table 10. Mandible ageing data for ovicaprids using the method of Grant

Stage	Suggested age	13th.c.		14th.c.		15th.c.		Post-medieval		Recent	
		FCC	%	FCC	%	FCC	%	FCC	%	FCC	%
1-2	0-2mo.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
3-8	2-6mo.	0.00	0.0	1.00	5.3	0.00	0.0	0.00	0.0	0.00	0.0
9-17	6-12mo.	0.00	0.0	0.00	0.0	0.00	0.0	1.00	6.3	0.00	0.0
18-28	1-2yr.	16.87	12.0	0.00	0.0	2.00	20.0	0.00	0.0	1.00	33.3
29-34	2-3yr.	60.32	42.8	4.23	22.3	1.85	18.5	4.75	29.7	0.00	0.0
35-38	3-4yr.	39.32	27.9	7.46	39.3	5.15	51.5	5.25	32.8	1.00	33.3
39-42	4-6yr.	15.80	11.2	4.63	24.4	0.00	0.0	3.00	18.8	1.00	33.3
43-46	6-8yr.	8.69	6.2	0.68	3.6	0.00	0.0	2.00	12.5	0.00	0.0
47-52	8-10yr.	0.00	0.0	1.00	5.3	0.00	0.0	0.00	0.0	0.00	0.0
Total		141.00	100.1	19.00	100.2	10.00	100.0	16.00	100.1	3.00	99.9

FCC = final corrected count (see text).

Table 11. Ovicaprid epiphyseal fusion data

Fusion age		13th.c.		14th.c.		15th.c.		Post-medieval		Recent	
6-10 mo.		F	NF	F	NF	F	NF	F	NF	F	NF
Scapula	D	10	6	1	0	4	0	4	1	1	0
Humerus	D	11	7	9	2	10	0	13	3	4	0
Radius	P	21	6	8	1	9	1	9	0	3	0
% unfused		31.1		14.3		4.2		13.3		0.0	
18-24 mo.											
Phalanx 1	P	49	9	10	3	6	0	13	0	4	0
Phalanx 2	P	3	1	1	1	0	0	1	0	0	0
Metacarpus	D	56	24	17	4	11	3	12	3	1	1
Tibia	D	20	18	8	1	11	0	7	1	5	0
Metatarsus	D	72	17	12	3	10	1	9	1	5	1
% unfused		25.7		23.3		9.5		10.6		11.8	
30-36 mo.											
Ulna	P	2	3	1	3	0	0	2	0	1	0
Femur	P	5	12	2	3	1	3	5	3	0	1
Calcaneum	P	5	0	0	0	1	1	0	1	0	0
% unfused		55.6		66.7		66.7		36.4		50.0	
36-42 mo.											
Radius	D	12	19	4	6	4	3	5	0	2	0
Humerus	P	4	7	3	1	2	0	1	1	1	0
Femur	D	1	12	2	3	2	2	6	1	0	0
Tibia	P	8	12	1	2	7	0	1	2	1	2
% unfused		66.7		52.4		25.0		23.5		33.3	

Fusion ages from Maltby (M: 177, Table 75)

Table 12. Summary of goat horncore measurements

Measurement	Date	N	Range	Mean	S.d.	C.V.
Bc.	13c	349	63·0 – 152·5	93·1	21·5	23·0
	14c	28	70·0 – 135·0	98·1	20·1	20·5
	15c.	4	75·0 – 121·0	98·8	21·8	22·1
	16-17c.	10	77·5 – 133·5	100·0	20·3	20·3
	18-20c.	6	78·0 – 136·0	98·8	23·1	23·4
Gbd	13c.	349	23·0 – 60·3	34·7	8·8	25·5
	14c.	28	26·6 – 53·7	36·4	8·7	23·9
	15c	4	27·3 – 47·4	37·4	9·6	25·[illegible]
	16-17c.	10	28·2 – 52·2	37·5	9·2	24·5
	18-20c.	6	28·2 – 53·0	36·6	9·7	26·6
Lbd	13c.	349	15·6 – 44·9	24·2	5.1	21·1
	14c.	28	19·0 – 35·6	25·6	4·8	18·9
	15c.	4	19·2 – 30·5	24·8	5.2	20·0
	16-17c.	10	19·4 – 34·0	25·5	5·1	20·0
	18-20c.	6	19·4 – 32·6	24·8	5·6	22·6
Gl	13c.	70	88·5 – 250.0	137·0	30.2	22·0
	14c.	16	98·0 – 212·0	149.1	29·5	19·8
	16-17c	3	115.0 – 250·0	188·3	68·3	36·2

Bc group I (<110)	13c.	247	63·0 – 108·0	80·1	8·6	10·6
	14c.	17	70·0 – 100·0	83·4	9·0	10·8
	15c.	2	75·0 – 86·0	80·5	–	–
	16-17c.	6	77·5 – 98·0	84·6	8·5	10·0
	18-20c.	4	78·0 – 91·0	84·5	6·0	7·0
Bc group II (≥110)	13c.	102	111·0 – 152·5	123·5	9·0	7·3
	14c	11	112·0 – 135·0	121·0	8·2	6·8
	15c.	2	113·0 – 121·0	117·0	–	–
	16-17c.	4	115·0 – 133·5	123·1	7·7	6·3
	18-20c.	2	118·0 – 136·0	127·0	–	–

Table 13. Summary of sheep/goat bone measurements

Measurement		Date	Exe bridge			Other Exeter sites		
			N	Range	Mean	N	Range	Mean
Horncore	Bc	13c.	12	75.0 – 136.0	97.4			
		14c.	1	132.0	132.0			
		15c.	4	90.0 – 95.0	93.0			
		16-17c.	2	86.0 – 107.0	96.5			
		18-20c.	2	113.0 – 118.0	115.5			
	Gbd	13c.	12	24.2 – 48.8	36.3			
		14c.	1	45.2	45.2			
		15c.	4	32.9 – 37.5	35.2			
		16-17c.	2	29.8 – 39.2	34.5			
		18-20c.	2	42.6 – 43.3	40.1			
	Lbd	13c.	12	19.5 – 35.5	25.1			
		14c.	1	36.6	36.6			
		15c.	4	20.8 – 24.4	22.9			
		16-17c.	2	23.6 – 27.0	25.3			
		18-20c.	2	28.6 – 29.6	29.1			
	GL	15c.	1	84.0	84.0			
		16-17c.	1	105.0	105.0			
		18-20c.	1	140.0	140.0			
Scapula	GLP	13c.	3	28.9 – 30.0	29.6	17	27.0 – 31.8	29.0
		15c.	5	26.9 – 32.7	30.3	9	28.8 – 33.1	30.4
		16-17c.	1	33.6	33.6	28	28.7 – 36.6	32.4
	LG	13c.	3	23.3 – 24.8	24.2	16	22.0 – 24.4	22.6
		14c.	1	22.8	22.8	-	—	-
		15c.	6	22.2 – 25.4	23.8	8	22.3 – 24.9	23.6
		16-17c.	1	26.4	26.4	28	21.0 – 28.2	24.8
	SLC	13c.	4	17.2 – 18.2	17.7	6	16.9 – 18.1	17.6
		14c.	2	17.8 – 19.4	18.6	-	-	-
		15c.	6	15.2 – 19.2	18.0	8	17.5 – 20.0	18.9
		16-17c.	2	19.5 – 19.6	19.6	-	-	-
	SG	13c.	4	14.0 – 23.2	19.7	6	16.6 – 20.3	18.2
		14c.	2	16.2 – 19.5	17.9	-	-	-
		15c.	6	17.4 – 20.6	18.9	8	16.9 – 20.3	18.9
		16-17c.	2	19.0 – 20.6	19.8	-	-	-
Humerus	Bd	13c.	7	25.6 – 31.6	27.5	41	25.4 – 30.6	27.8
		14c.	7	28.2 – 29.5	28.9	-	-	-
		15c.	13	25.6 – 33.2	28.5	10	26.0 – 29.7	28.0
		16-17c.	11	26.2 – 30.8	28.5	42	25.2 – 32.0	29.5
		18-20c.	3	26.5 – 28.9	27.9	31	23.4 – 35.3	29.3
	GL	13c.	1	127.4	127.4	-	-	-
		14c.	1	129.9	129.9	-	-	-
		15c.	1	121.2	121.2	-	-	-
Radius	Bp	13c.	12	25.6 – 29.4	28.0	45	25.4 – 33.4	28.9
		14c.	7	26.4 – 30.2	28.8	-	-	-
		15c.	7	27.1 – 29.4	28.2	22	26.2 – 31.0	28.5
		16-17c.	3	25.2 – 30.1	28.3	53	24.9 – 35.7	30.1
		18-20c.	2	31.6 – 31.9	31.8	22	28.1 – 34.5	31.7
	Bd	13c.	7	23.6 – 30.8	26.5	13	23.9 – 27.4	25.4
		14c.	4	26.0 – 28.7	27.3	-	-	-
		15c.	5	24.3 – 27.4	25.9	7	23.5 – 27.4	25.7
		16-17c.	3	25.6 – 27.6	26.6	21	22.8 – 31.8	27.3
		18-20c.	2	25.2 – 28.8	26.7	9	25.4 – 31.0	28.5
	GL	13c.	2	135.4 – 141.8	138.6	4	128.0 – 143.0	135.8
		14c.	3	131.4 – 141.5	136.2	-	-	-
		15c.	2	128.2 – 139.2	133.7	-	-	-
		16-17c.	2	125.6 – 142.6	134.1	15	125.0 – 155.0	139.1
		18-20c.	1	138.8	138.8	-	—	—
Metacarpus	Bp	13c.	85	17.8 – 26.8	24.1	34	16.9 – 22.5	20.7
		14c.	26	18.8 – 23.6	20.8	-	-	-
		15c.	16	18.2 – 24.8	20.8	14	17.2 – 22.3	20.2
		16-17c.	18	18.4 – 26.6	21.1	22	20.0 – 24.9	22.5
		18-20c	3	22.2 – 23.6	22.9	26	19.4 – 26.7	22.5
	Dp	13c.	84	12.4 – 17.4	14.8			
		14c.	22	12.4 – 16.3	14.5			
		15c.	16	12.8 – 15.3	14.2			
		16-17c.	19	12.1 – 17.5	14.1			
		18-20c.	3	14.7 – 16.5	15.5			
	Bd	13c.	54	20.6 – 30.4	24.1			
		14c.	15	21.9 – 26.7	24.0			
		15c.	7	21.3 – 25.1	23.7			
		16-17c.	15	20.7 – 27.2	23.4			
		18-20c.	1	25.2	25.2			
	GL	13c.	14	96.5 – 112.2	105.4	7	99.0 – 124.0	114.0
		14c.	11	97.4 – 116.7	108.1	-	-	-
		15c.	6	108.4 – 120.6	114.1	-	-	-
		16-17c.	10	91.4 – 122.7	108.9	11	110.0 – 128.0	118.7
		18-20c	1	114.5	114.5	19	102.0 – 128.0	118.7
Pelvis	Amrd	♀ 13c.	7	2.9 – 4.5	3.5			
		♂/♂	4	5.4 – 6.5	6.0			
		♀ 15c.	1	4.0	4.0			
		♂/♂	3	5.2 – 9.0	6.5			
		♀ 16-17c.	2	3.0 – 3.2	3.1			
		♂/♂	3	4.2 – 7.3	5.4			
		♀ 18-20c.	1	5.2	5.2			
Femur	Bp	13c.	3	38.6 – 41.3	40.3			
		16-17c.	4	42.0 – 44.2	42.1			
	Bd	15c.	1	38.0	38.0			
		16-17c.	4	34.4 – 34.9	34.0			
Tibia	Bd	13c.	18	22.4 – 24.1	24.1	61	22.0 – 26.9	24.3
		14c.	5	20.8 – 23.2	23.2	-	-	-
		15c.	10	22.8 – 24.6	24.6	16	22.0 – 25.7	23.8
		16-17c.	6	22.0 – 24.4	24.4	24	22.5 – 28.9	26.0
		18-20c.	3	21.8 – 22.9	22.9	17	22.9 – 30.4	26.7
	Dd	13c.	18	16.6 – 18.5	18.5	61	16.9 – 20.1	18.7
		14c.	5	16.6 – 18.0	18.0	-	-	-
		15c.	10	16.9 – 19.3	19.3	16	16.9 – 19.2	18.2
		16-17c.	6	17.4 – 19.1	19.1	26	17.4 – 22.2	19.7
		18-20c.	3	17.9 – 18.1	18.1	18	18.1 – 23.7	20.5
Astragalus	GLl	13c.	2	26.4 – 28.4	27.4	11	25.0 – 29.0	26.9
		15c.	2	25.2 – 25.7	25.5	-	-	-
		16-17c.	1	25.2	25.2	14	22.1 – 29.0	26.6
	Dl	13c.	2	14.5 – 14.9	14.7	11	14.0 – 16.6	14.9

Table 14. Anatomical distribution of sheep-goat bone elements

Anatomical element	13thC.		14thC.		15thC.		Post-medieval		Recent	
	n	$\frac{n}{N}$	n	$\frac{n}{N}$	n	$\frac{n}{N}$	n	$\frac{n}{N}$	n	$\frac{n}{N}$
horncore	467	233.5	43	21.5	14	7.0	25	12.5	9	4.5
upper teeth	66	5.5	15	1.3	10	0.8	5	0.4	7	0.6
lower teeth	42	2.3	4	0.2	8	0.4	8	0.4	9	0.5
mandible	149	74.5	20	10.0	13	6.5	19	9.5	4	2.0
cervical	4	0.6	0	0	21	3.0	13	1.9	3	0.4
thoracic	1	0.1	0	0	2	0.2	15	1.3	0	0
lumbar	5	0.7	1	0.1	13	1.9	6	0.9	1	0.1
caudal	3	0.2	1	0.1	2	0.1	3	0.2	0	0
sacral	0	0	0	0	0	0	0	0	0	0
scapula	26	13.0	3	1.5	7	3.5	8	4.0	4	2.0
humerus	25	4.2	11	1.8	14	2.3	13	2.2	7	1.2
radius	68	11.3	15	2.5	18	3.0	12	2.0	3	0.5
ulna	9	4.5	5	2.5	3	1.5	6	3.0	2	1.0
carpals	0	0	0	0	0	0	0	0	0	0
metacarpals	160	26.7	22	3.7	38	6.3	31	5.2	2	0.3
pelvis	27	4.5	1	0.2	6	1.0	18	3.0	2	0.3
femur	31	5.2	12	2.0	14	2.3	15	2.5	1	0.2
patella	0	0	0	0	0	0	0	0	0	0
tibia	75	12.5	18	3.0	30	5.0	18	3.0	14	2.3
astragalus	4	2.0	0	0	1	0.5	1	0.5	0	0
calcaneum	5	2.5	0	0	2	1.0	1	0.5	0	0
tarsals	0	0	0	0	0	0	0	0	0	0
metatarsals	206	34.3	33	5.5	31	5.2	27	4.5	13	2.2
phalanges	67	1.8	14	0.4	9	0.3	16	0.4	4	0.1
ribs	58	2.4	21	0.9	24	1.0	41	1.7	11	0.5
totals	1498		239		280		301		96	

Notes: all elements exclude fragments 25% and less complete
index factors as for cattle (Table 7)
ribs: all rib heads only at all fragmentation sizes

Table 15. Summary of dental pathology and anomalies in sheep-goat mandibles

	13thC	14thC	15thC	Postmedieval	Recent
1) Overcrowding					
Intradental attrition	102	15	12	15	4
Anomalous crown height	10	1	2	1	0
Tooth displacement	2	0	0	1	0
2) Developmental					
Ventral penetration	9	0	0	0	0
'Plaley' deposits	6	0	0	0	0
3) Genetic and congenital					
Extra-numerary foramen	55	11	6	5	1
Absence of P_2	8	0	1	1	0
Extra-numerary tooth column	1	0	0	0	0
4) Disease and infection					
Periodontal disease	7	2	2	1	1
Porous margin	1	0	0	0	1
Root disfigurement	1	0	0	0	0
Pigmentation	115	14	11	13	3
Unknown	0	0	0	1	0
5) Other					
Dental calculus	2	0	1	0	0
N	143	21	15	17	4

Table 16. Location and frequency of occurrence of extra-numerary foramena in sheep-goat mandibles

Date	% $\frac{no}{nm}$ occurrence	Location of foramen nutricum relative to major foramen anterior	above	diastema	P2	P3	P4	ant+P2	dia+P2	ant+P3	ant+dia
13th. Century	61.1	7	1	2	19	15	3	4	2	1	1
14th. Century	78.6	0	0	0	4	6	0	0	0	1	0
15th Century	66.7	0	0	0	3	3	0	0	0	0	0
Post medieval	55.6	0	0	1	0	4	0	0	0	0	0
[illegible]	[illegible]	0	0	0	0	1	0	0	0	0	0

Table 17. Pig epiphyseal fusion data

Fusion age		13thC		14th.C		15th.C		Post-medieval		Recent	
by 12 mo.		F	NF	F	NF	F	NF	F	NF	F	NF
Scapula	D	0	2			1	5	0	2	1	0
Humerus	D	4	3	2	3	2	3	1	0	1	0
Radius	P	6	4	1	0	2	2	1	0	1	0
Phalanx 2	P	1	0								
% unfused		45.0		50.0		66.7		50.0		0.0	
24 mo.											
Metacarpus	D	1	7			0	3	0	1	1	1
Tibia	D	3	7	1	2	0	1	0	1		
Phalanx 1	P	2	1	0	1	1	1	1	0	0	1
% unfused		71.4		75.0		83.3		66.7		100.0	
24-30 mo.											
Metatarsus	D	0	6			0	1	0	2	0	1
Calcaneum	P	0	2			0	2	1	0		
Fibula	D					0	1				
% unfused		100.0				100.0		66.7		100.0	
36-42 mo.											
Ulna	P	0	2	1	1	0	1	0	2		
Humerus	P			0	2	1	0				
Radius	D	2	7			1	3				
Femur	P	0	2			0	2	0	1		
Femur	D	0	6			1	3	0	2	0	1
Tibia	P	0	4			0	1				
Fibula	P					0	1			0	1
% unfused		91.3		75.0		75.6		100.0		100.0	

Fusion ages from Maltby (M: 189, Table 83)

Table 18. Anatomical distribution of pig bone elements

Anatomical element	13th C. n	$\frac{n}{N}$	14th C. n	$\frac{n}{N}$	15th C. n	$\frac{n}{N}$	Post-medieval n	$\frac{n}{N}$	Recent n	$\frac{n}{N}$
cranium	1	0.5	0	0	0	0	0	0	0	0
all teeth	17	0.4	5	0.1	3	0.1	1	0.02	2	0.04
mandible	9	4.5	4	2.0	1	0.5	1	0.5	1	0.5
cervical	8	1.1	3	0.4	2	0.3	1	0.1	0	0
thoracic	1	0.1	0	0	1	0.1	4	0.3	1	0.1
lumbar	1	0.1	3	0.4	3	0.4	0	0	0	0
scapula	3	1.5	0	0	1	0.5	2	1.0	1	0.5
humerus	9	1.5	7	1.2	6	1.0	3	0.5	1	0.2
radius	12	2.0	1	0.2	4	0.6	2	0.3	1	0.2
ulna	8	1.3	4	0.7	5	0.8	2	0.3	0	0
metacarpals	7	0.4	0	0	3	0.2	1	0.1	1	0.1
pelvis	1	0.2	0	0	3	0.5	2	0.3	0	0
femur	9	1.5	3	0.5	7	1.2	3	0.5	3	0.5
tibia	11	1.8	6	1.0	7	1.2	0	0	1	0.2
fibula	2	0.3	0	0	2	0.3	1	0.2	1	0.2
tarsals	11	1.4	1	0.3	2	0.5	1	0.2	0	0
metatarsals	10	0.7	0	0	2	0.1	1	0.3	2	0.1
phalanges	5	0.1	1	0.03	3	0.1	1	0.03	1	0.03
ribs	3	0.1	1	0.04	0	0	0	0	0	0
totals	128		39		55		26		16	

Notes: calculated as for sheep/goat and cattle, except teeth, N=44; metacarpals, N=16; ulna, N=6; metatarsals, N=16.
Cranium, N=2; Fibula, N=6.

Table 19. Numbers of rabbit and hare bones recovered.

Species	13th C.	14th C.	15th C.	Post-medieval	Recent	Total
Rabbit	3	11	21	22	5	62
Hare	4	1	0	0	0	5

Table 20. Epiphyseal fusion data for cat bones

		Medieval		Post-medieval	
		F	NF	F	NF
Scapula	D			1	0
Humerus	D	3	0	2	0
Radius	P	2	1	1	0
Phalanx 1	P	1	0		
Metacarpal	D	4	0	1	0
Tibia	D			2	0
Metatarsal	D	2	0		
Ulna	P	3	0	1	0
Femur	P	2	0	1	0
Humerus	P	2	0	1	2
Radius	D	2	2	2	0
Femur	D	2	1	2	1

Table 21. Cat bone measurements

Bone	Date	Measurement
Scapula	Post-medieval	Ld: 45.8, Dha: 54.6, Hs: 63.0, Slc: 11.4, Glp 12.4, Lg: 10.7
Humerus	13th c.	Bd: 15.2
	14th c.	GL: 81.2, Dp: 13.4, Bp: 16.6, Bd: 14.8
	Recent	GL: 92.2, Dp: 15.2, Bd: 17.2
Radius	14th c.	GL: 87.7, 76.9, Bp: 7.6, 7.2, Dp: 5.3, 5.1, Bd: 11.6, 10.6
Ulna	14th c.	GL: 103.2, Lo: 9.9, Bpc: 7.9
Femur	14th c.	GL: 87.5, Dp: 7.9, Bp: 17.0, Bd: 15.4, Dd: 15.4
	Recent	Dp: 8.8, Bp: 19.2, Bd: 17.2, Dd: 15.8
Tibia	14th c.	GL: 96.6, 93.5, Bp: 16.6, 15.0, Dp: 16.4, 15.7, Bd: 12.2, 11.5

Table 22. Summary of bird species present.

	13th c.	14th c.	15th c.	Post-medieval	Recent	Total
	n	n	n	n	n	n
Fowl	41	52	125	90	8	316
Goose	33	18	17	21	0	89
Duck	0	3*	4	12	0	19
Woodcock	3	1	5	15	0	24
Teal	0	0	0	1	0	1
Peafowl	0	0	1	0	0	1
Herring gull	1	0	0	0	0	1
Raven	1	0	0	0	0	1
Corvid	0	0	4	0	0	4
Pigeon	0	0	3	4	0	7
Thrush family	0	1	3	0	0	4
unidentified	13	1	36	7	3	60
Total	92	76*	198	150	11	527

* Excluding partial skeleton, 27 bones

Table 23. Fusion data for domestic fowl

		13th c.		14th c.		15th c.		Post-medieval		Recent	
		F	NF	F	NF	F	NF	F	NF	F	NF
Humerus	P			3	2	4	0	5	1		
	D	2	2	4	2	3	2	7	1	1	0
Radius	P	6	2	3	1	6	0	7	1	1	0
	D	5	0	1	1	5	0	5	1	1	0
Ulna	P			3	3	7	0	3	2		
	D			5	3	6	0	2	1		
Femur	P	2	2	0	1	6	1	2	2		
	D	4	1	2	1	7	1	2	1	1	0
Tibio-tarsus	P	0	2	0	2	4	0	1	4		
	D	2	1	1	3	3	0	3	3	1	0
Tarso-metatarsus	P	1	1	2	4	1	0	1	3		
	D	1	1	2	3	1	1	0	3		
Total		23	11	26	26	53	5	38	23	5	0
% unfused		32.4		50.0		8.6		37.7		0.0	

Table 24. Summary of domestic fowl bone measurements

Measurement	Date	N	Range	Mean	Exeter mean (Maltby, Table 9
Furcula GL	15c	2	61.5-64.2	62.9	
	P.M	2	56.5-66.8	61.7	
Scapula GL	14c	1	66.0	66.0	
	15c	3	54.5-76.2	68.8	
	PM	4	63.5-76.2	69.9	
Coracoid GL	15c	5	55.7-64.8	60.1	52.8 (14-15c.)
	PM	1	55.1	55.1	53.0
Humerus GL	14c	3	70.8-81.6	74.9	66.8
	15c	4	72.4-73.6	73.2	
	PM	3	72.8-75.1	74.5	67.9
Radius GL	13c	4	56.7-66.6	63.0	
	14c	1	62.7	62.7	
	15c	4	62.6-66.6	65.2	
	PM	2	67.9-78.7	73.3	
	Recent	1	61.2	61.2	
Ulna GL	14c	3	61.4-77.6	69.6	68.2
	15c	6	65.9-84.4	73.5	
	PM	1	74.3	74.3	67.2
Carpometacarpus GL	14c	1	41.4	41.4	
	15c	2	39.8-40.2	40.0	
	PM	1	40.2	40.2	41.7
Femur GL	13c	1	82.2	82.2	73.4
	15c	5	57.8-90.6	75.3	75.1 (14-15c.)
	PM	1	81.9	81.9	77.7
Tibiotarsus GL	15c	1	114.4	114.4	103.9 (14-15c.)
Tarsometatarsus GL	14c*	1	74.6	74.6	77.4 (14-15c.)
	15c	1	92.4	92.4	63.8 (14-15c.)

* spurred

Table 25. Summary of goose bone measurements

Measurement	Date	N	Range	Mean	Exeter mean (Maltby, Table 1
Carpometacarpus GL	Medieval	3	91.2-95.7	93.4	92.5
	P-medieval	3	88.2-91.1	89.4	91.0
Tarsometatarsus GL	Medieval	2	84.6-87.5	86.1	85.8

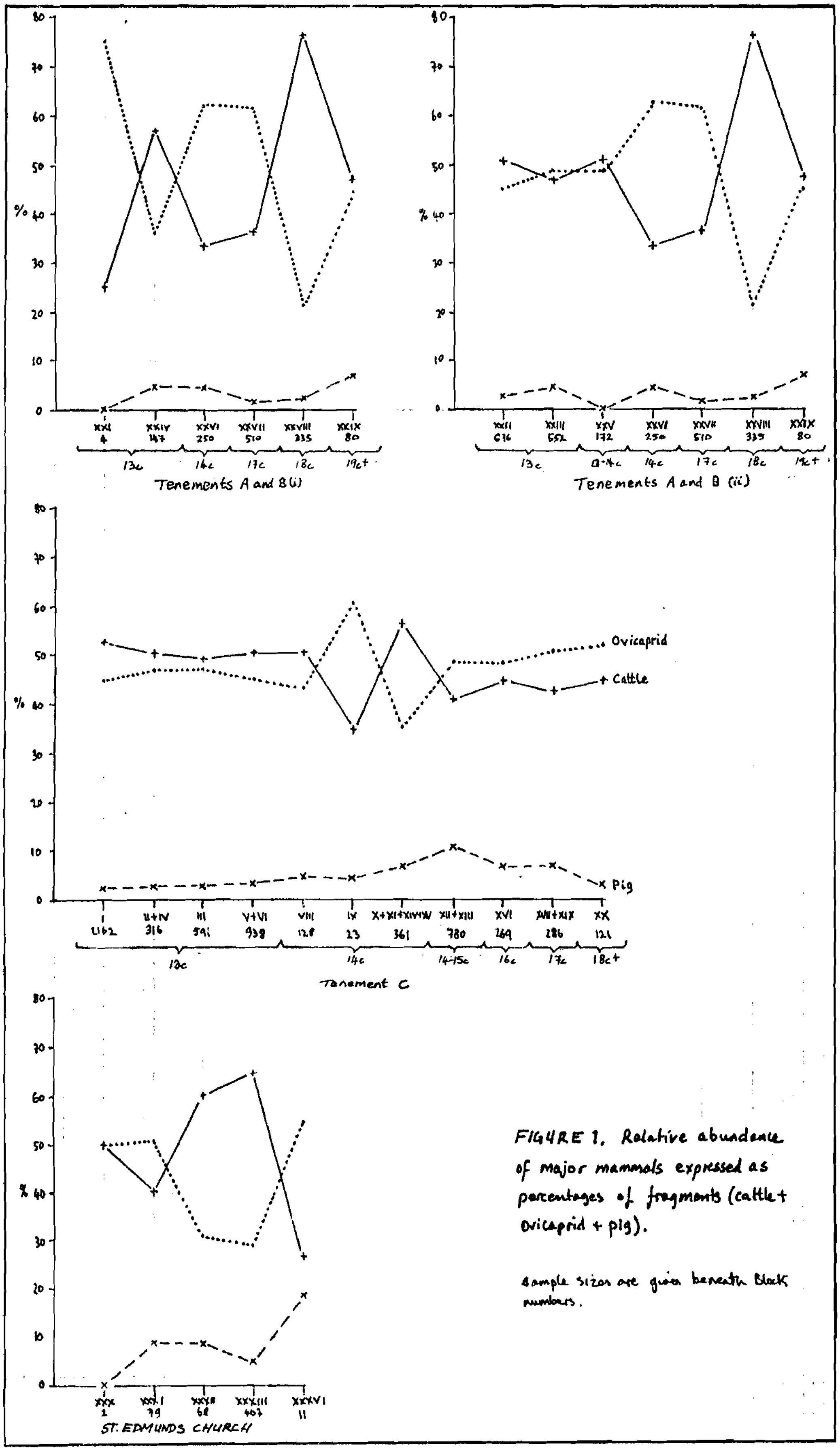


FIGURE 1. Relative abundance of major mammals expressed as percentages of fragments (cattle + ovicaprid + pig).

Sample sizes are given beneath block numbers.

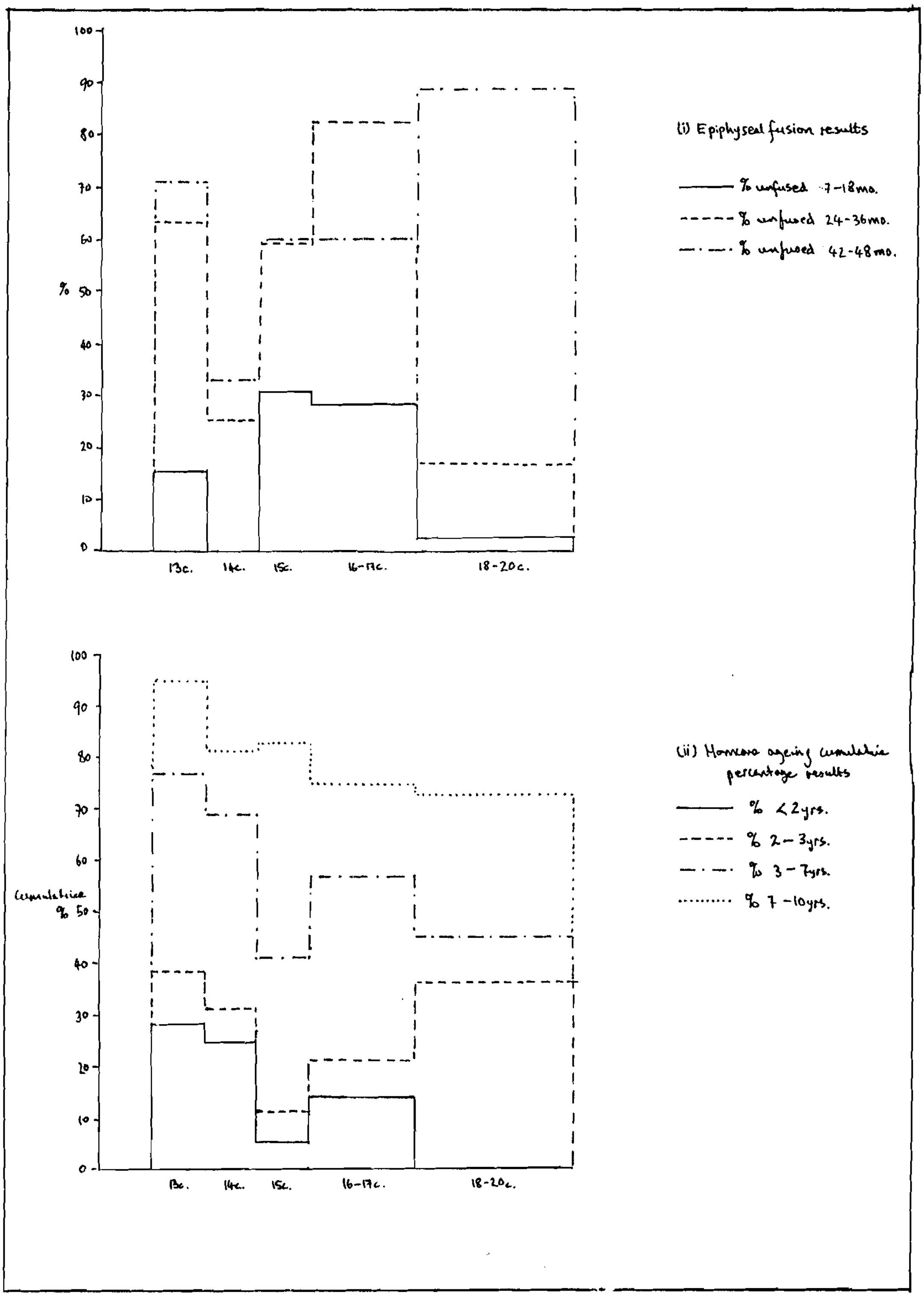


Figure 2. Summary of ageing data for cattle bones.

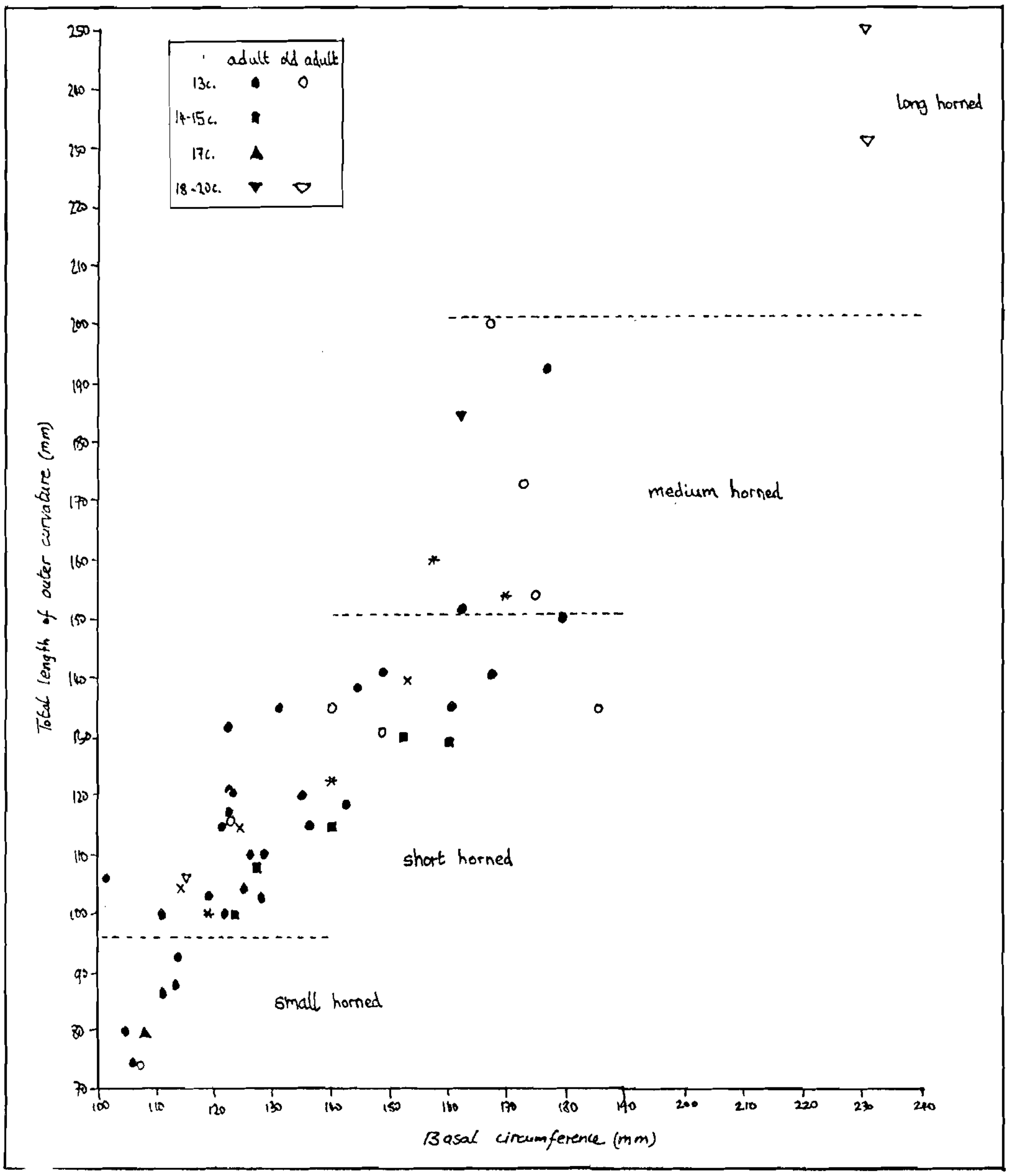


Figure 3. Length/ basal circumference dimensions in cattle horncores.

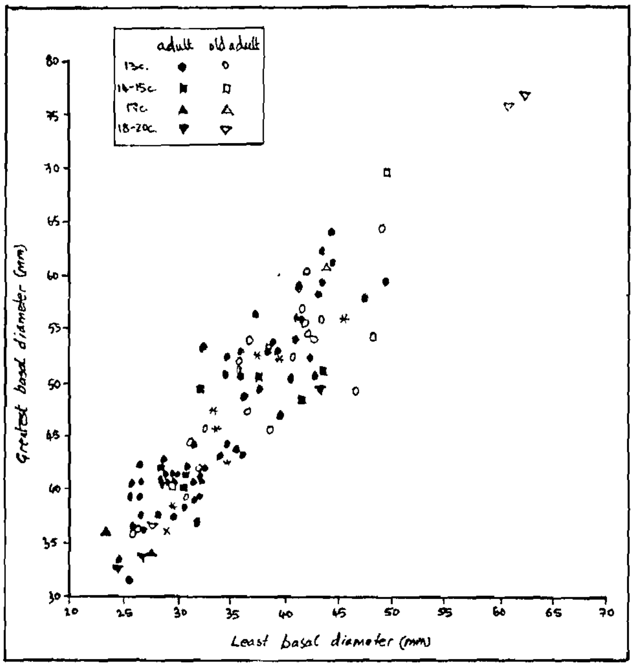


Figure 4. Greatest and least basal diameters of adult cattle horncores.

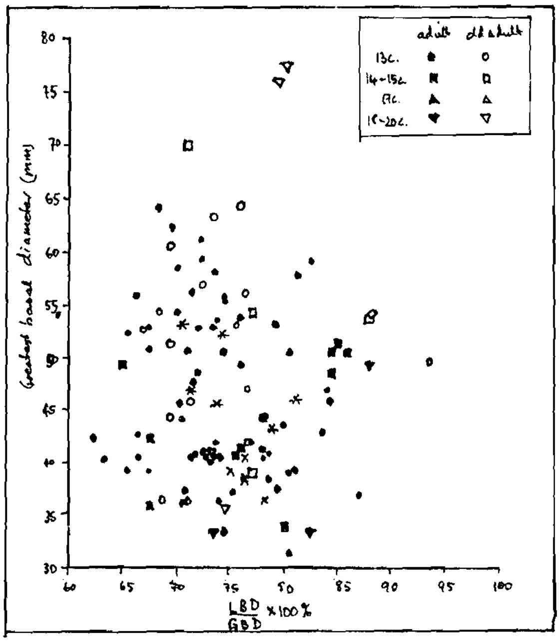


Figure 5. Size and shape variation in adult cattle horncores.

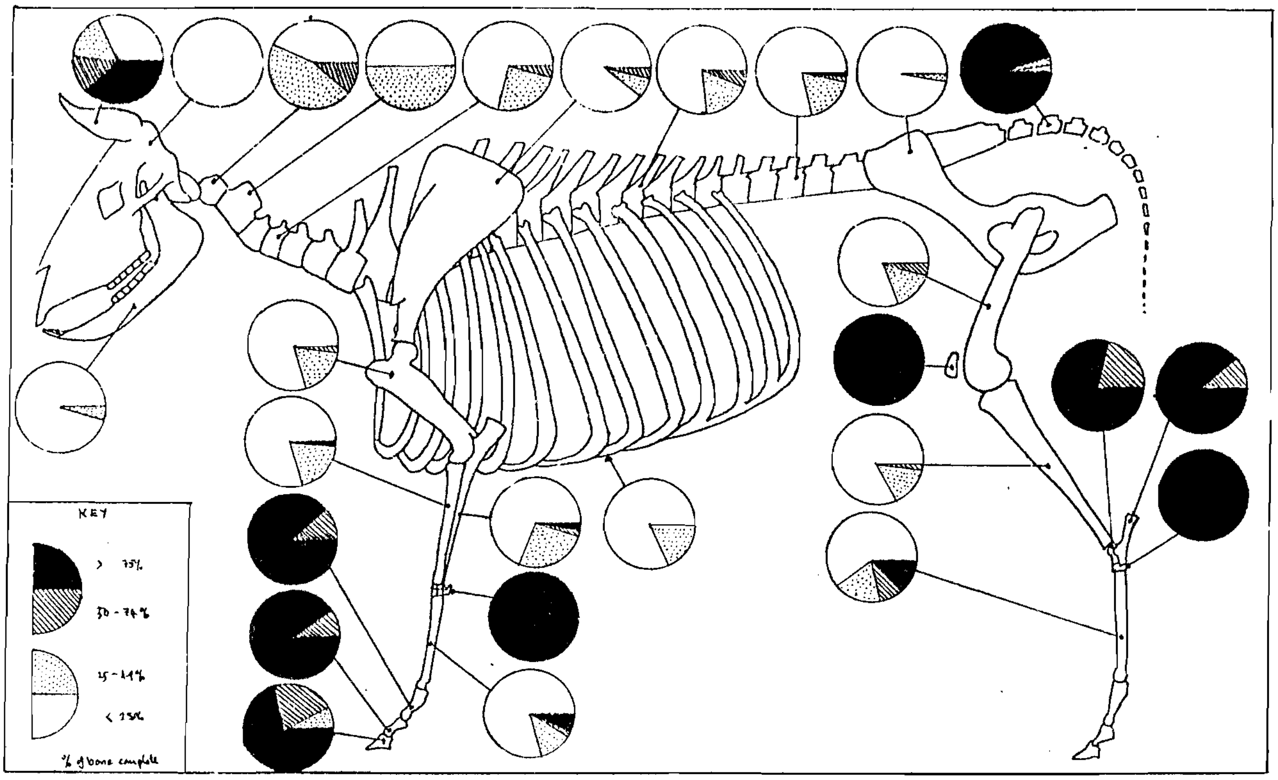


Figure 6. Fragmentation patterns in cattle bones, 13th Century.

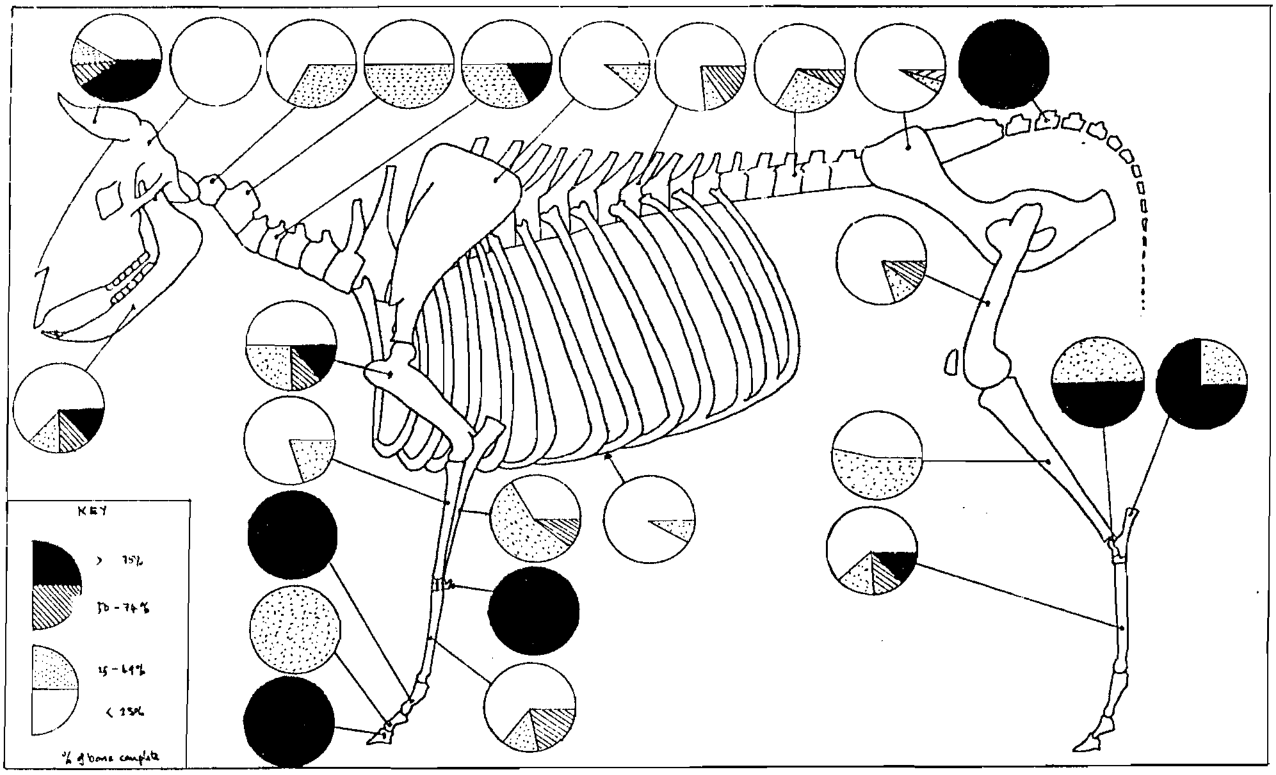


Figure 7. Fragmentation patterns in cattle bones, 14th Century

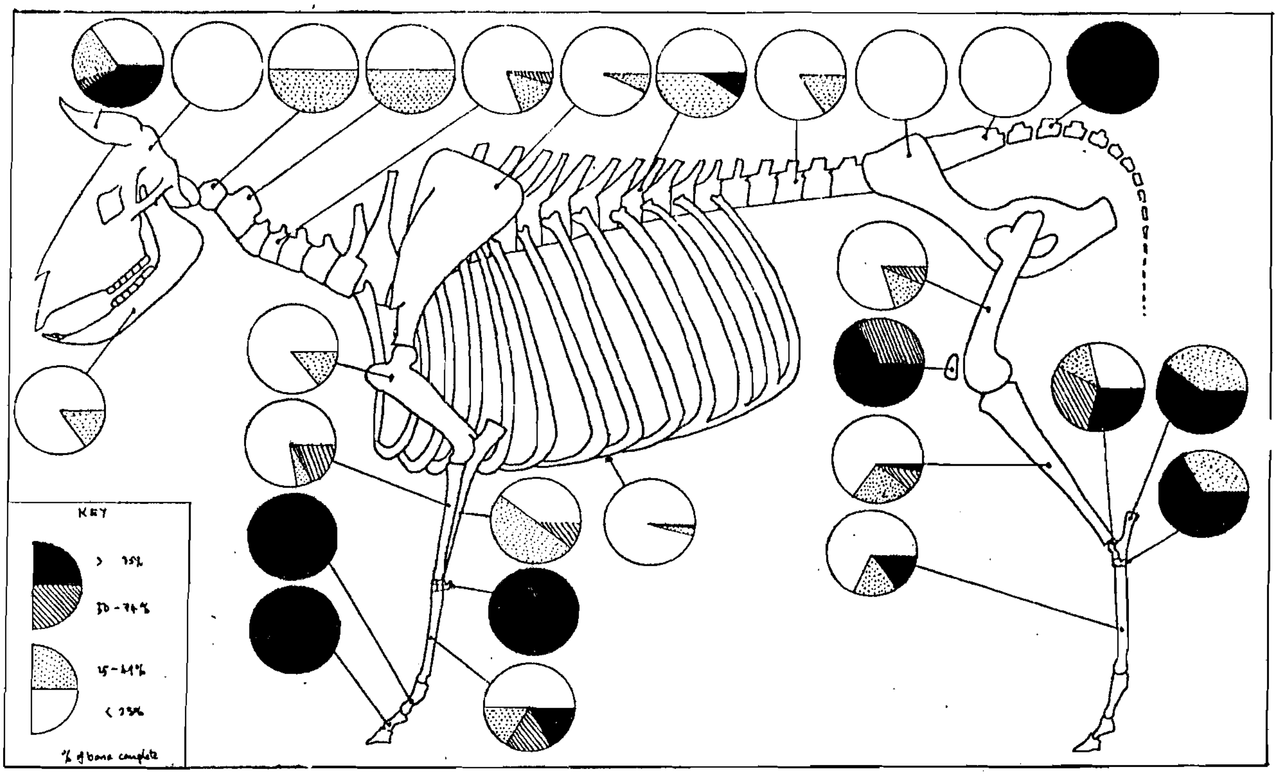


Figure 8. Fragmentation patterns in cattle bones, 15th Century

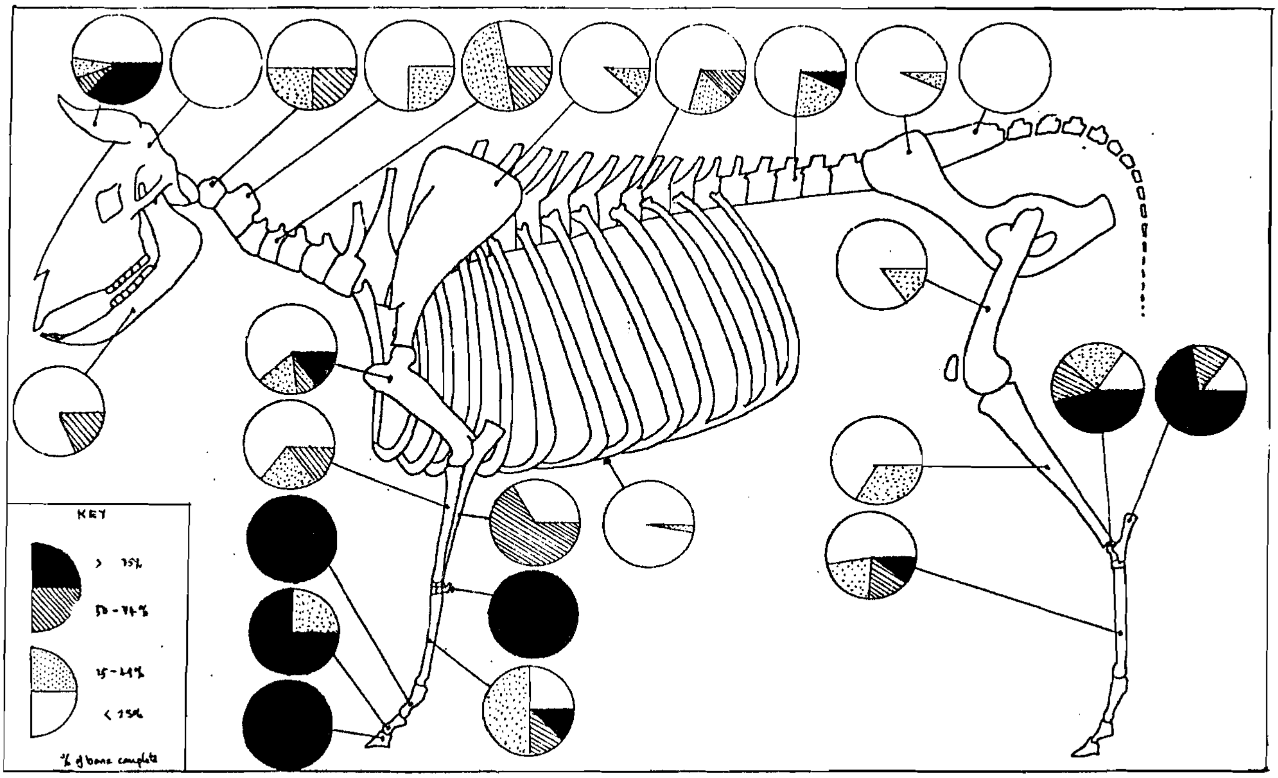


Figure 9. Fragmentation patterns in cattle bones, 16th Century

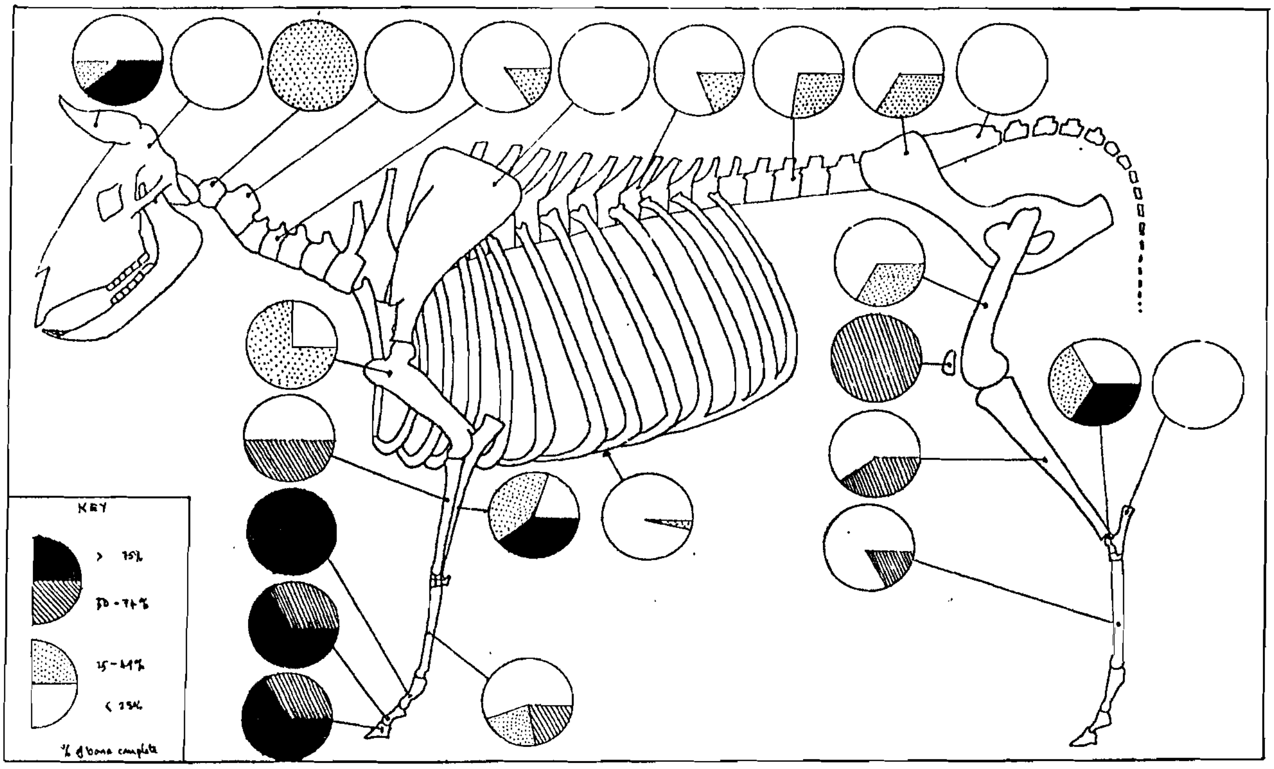


Figure 10. Fragmentation patterns in cattle bones, 17th century

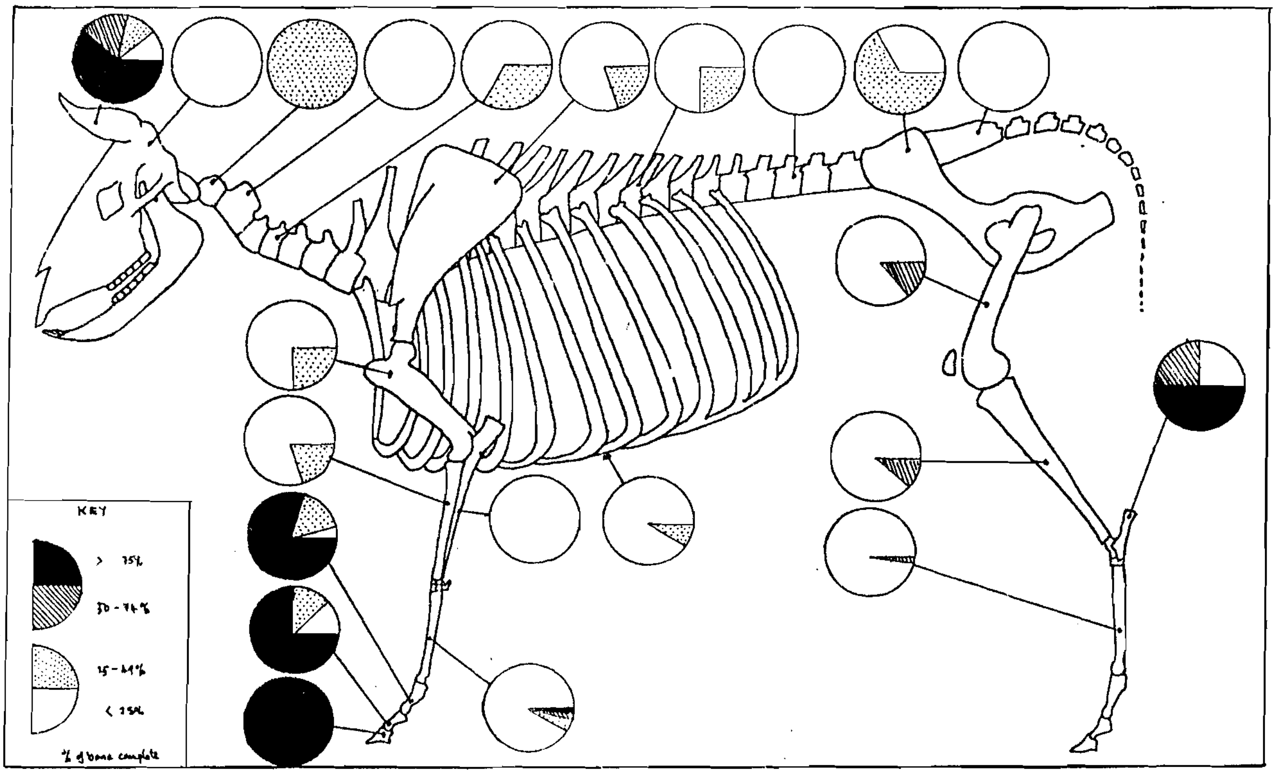


Figure 11. Fragmentation patterns in cattle bones, 18-19th centuries

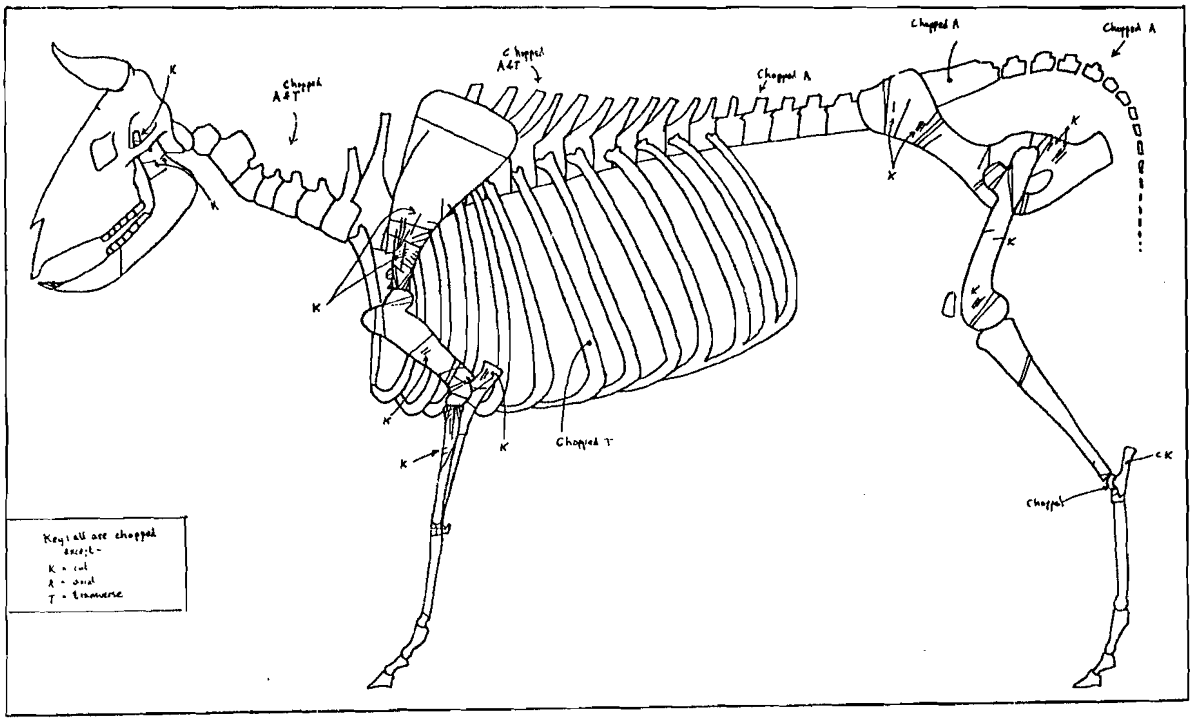


Figure 12. Diagrammatic summary of butchery marks on cattle bones, 13th Century

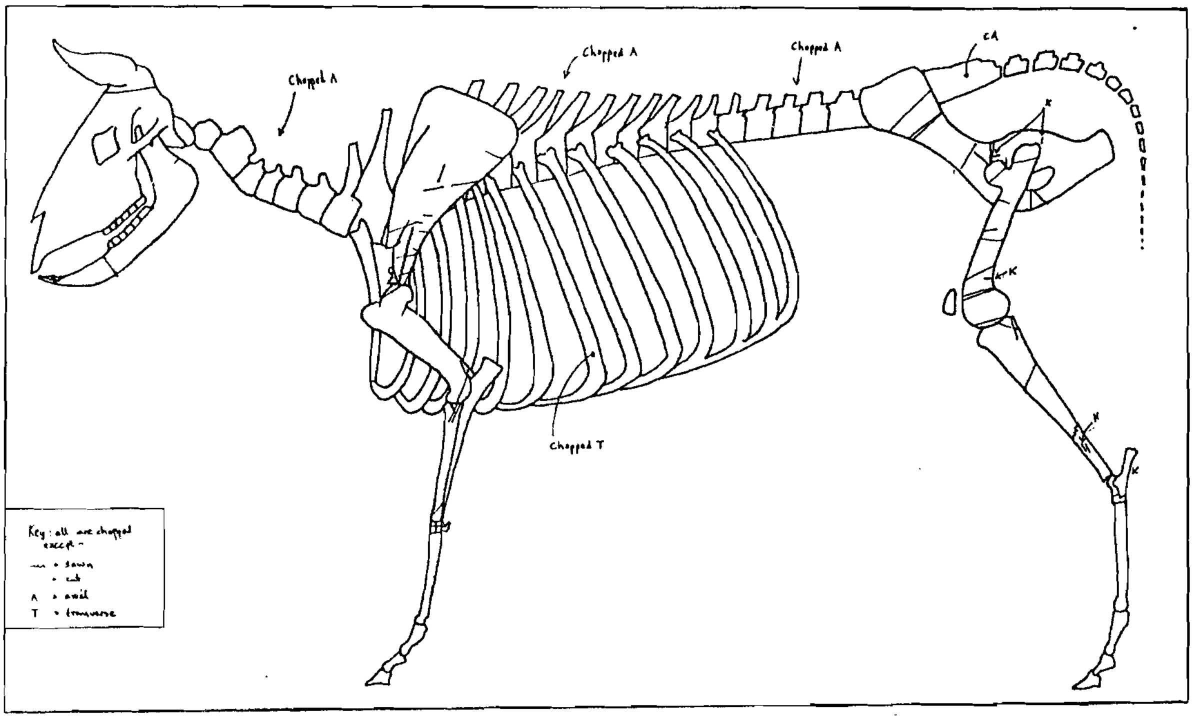


Figure 13. Diagrammatic summary of butchery marks on cattle bones, 14th century

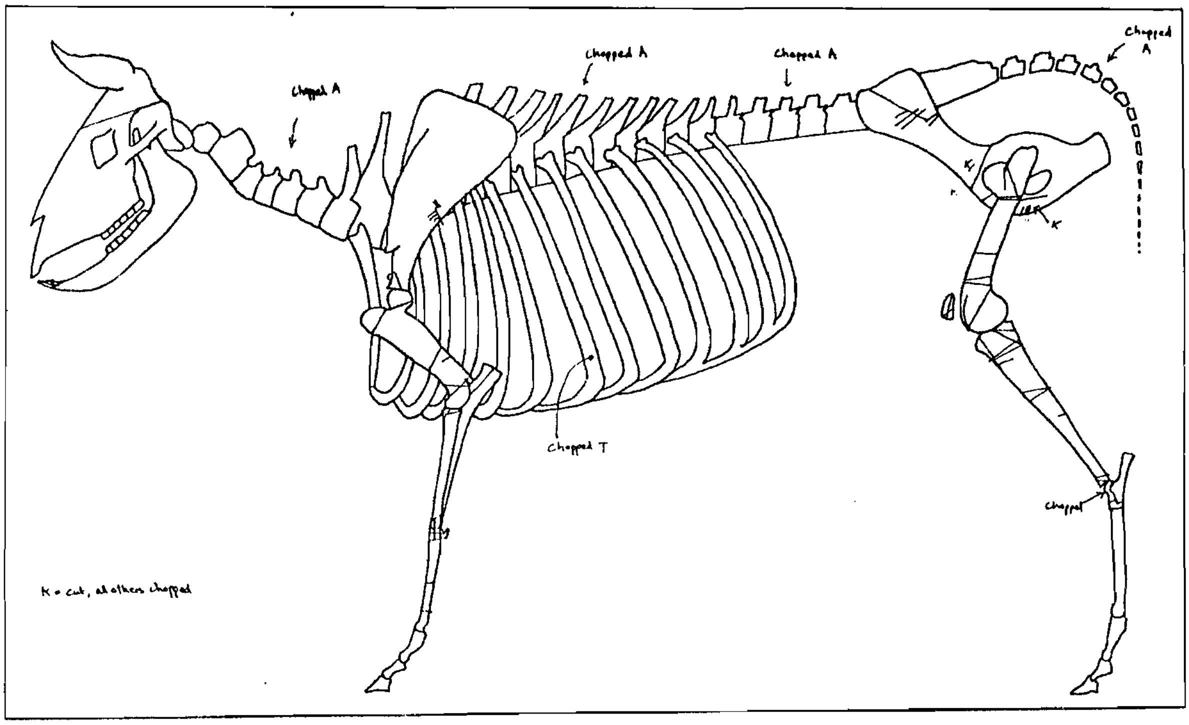


Figure 14. Diagrammatic summary of butchery marks on cattle bones, 15th century

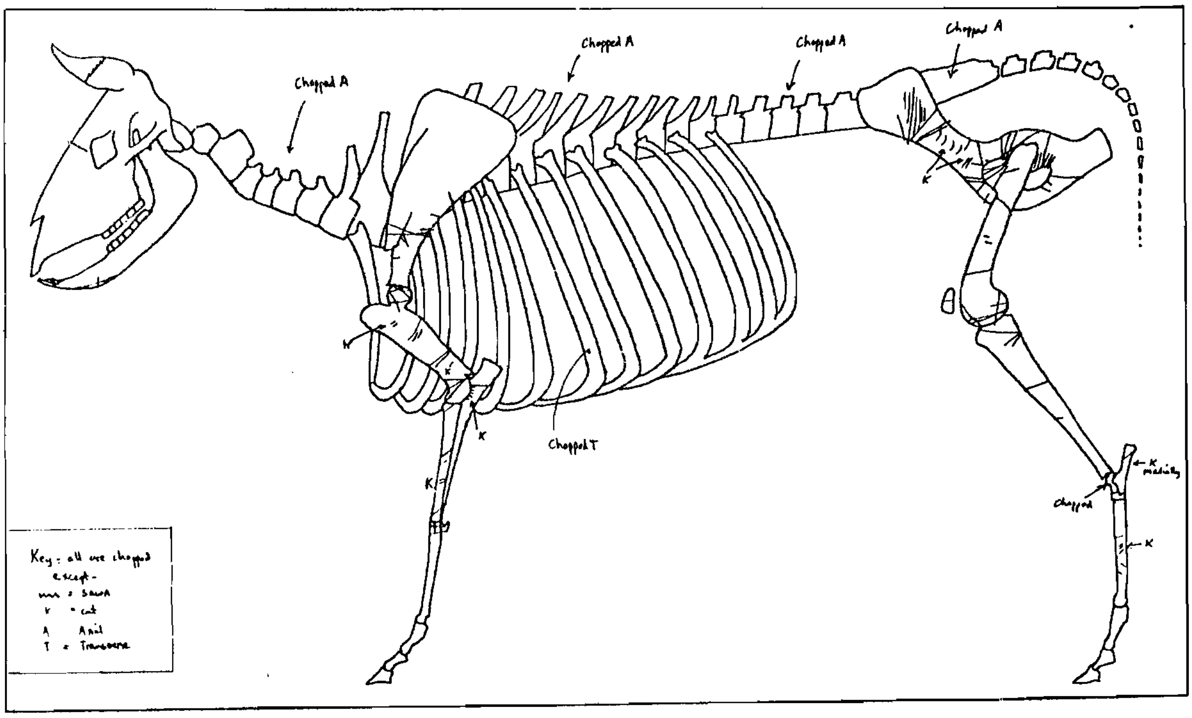


Figure 15. Diagrammatic summary of butchery marks on cattle bones, post medieval and recent.

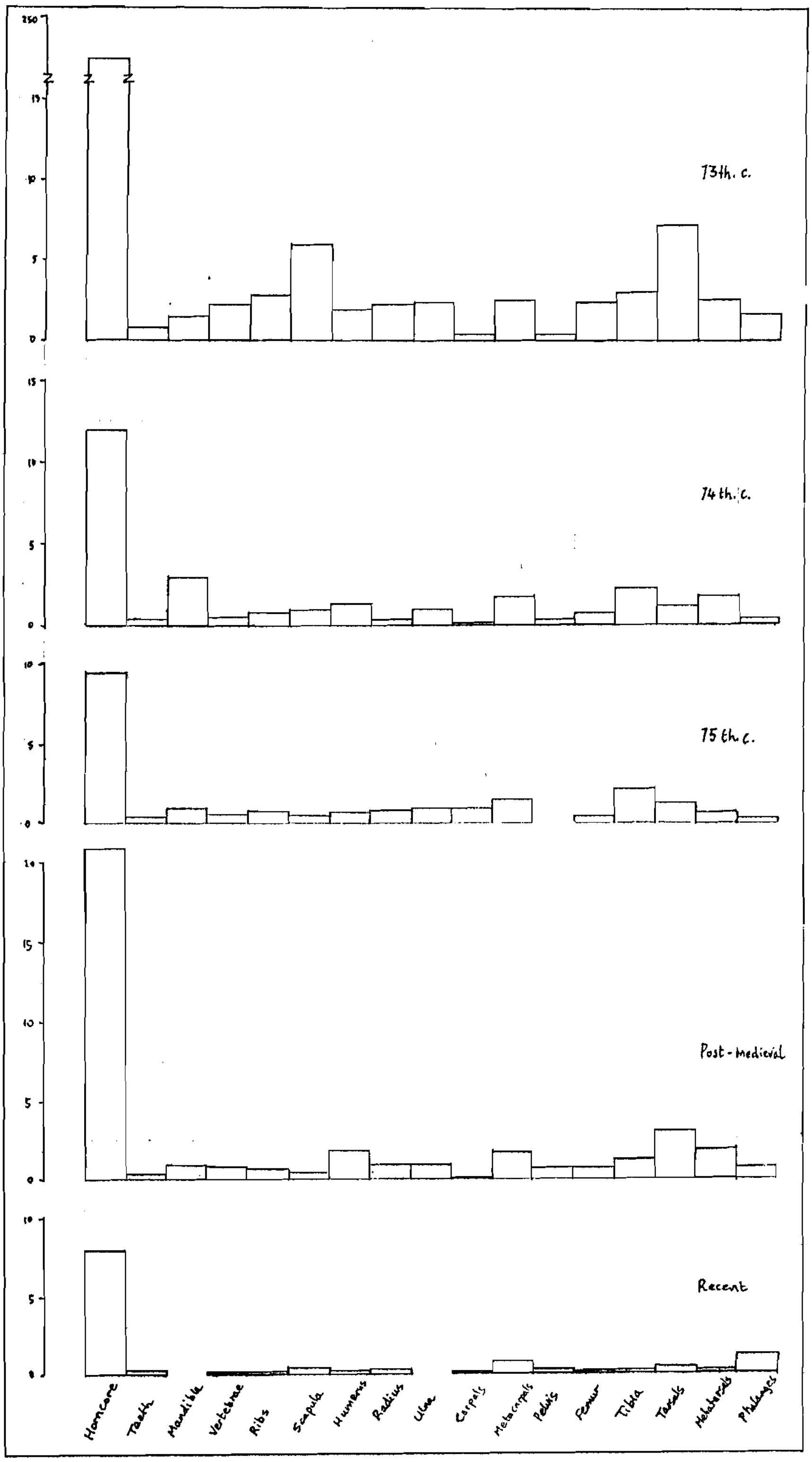


Figure 16. Anatomical distribution of cattle elements. Vertical. Scale index $\frac{n}{N}$

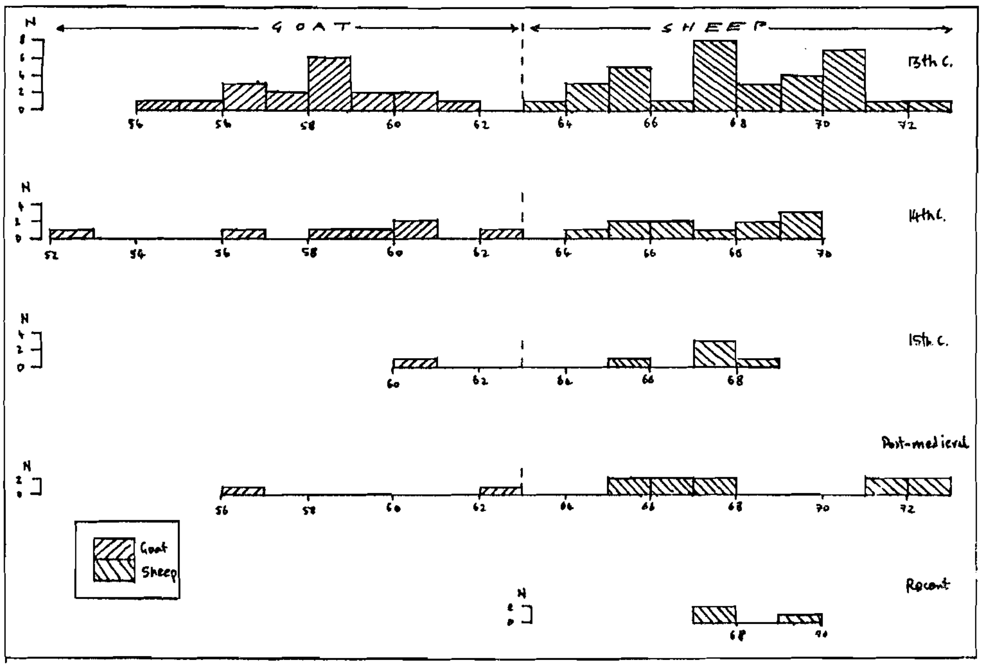


Figure 17. Distal epiphysis indecies of metacarpus in sheep and goat.

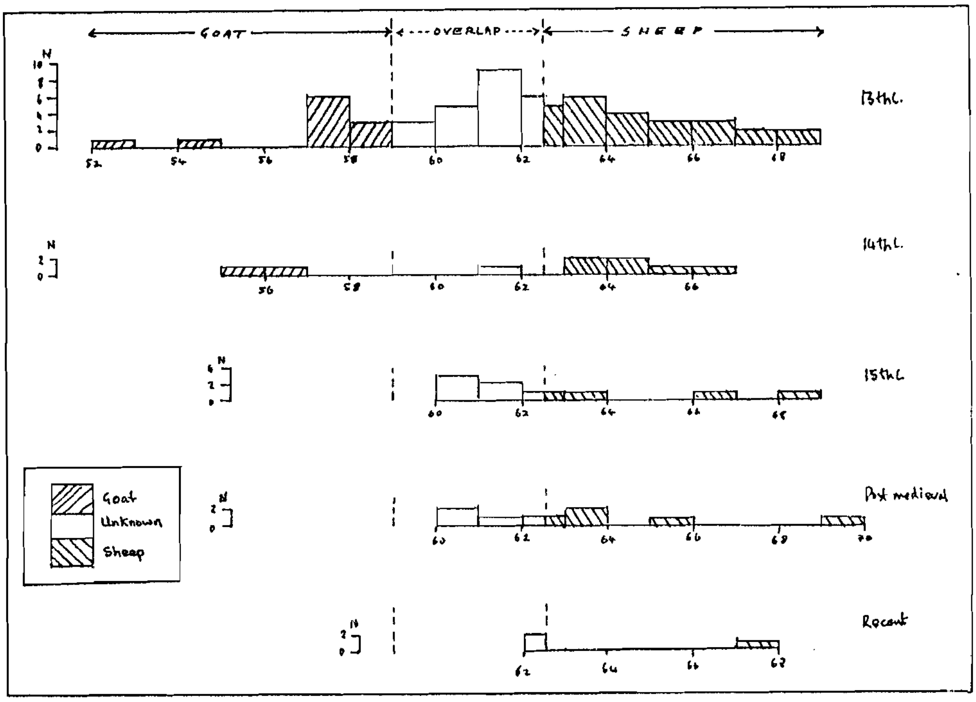


Figure 18. Distal epiphysis indecies of metatarsus in sheep and goat

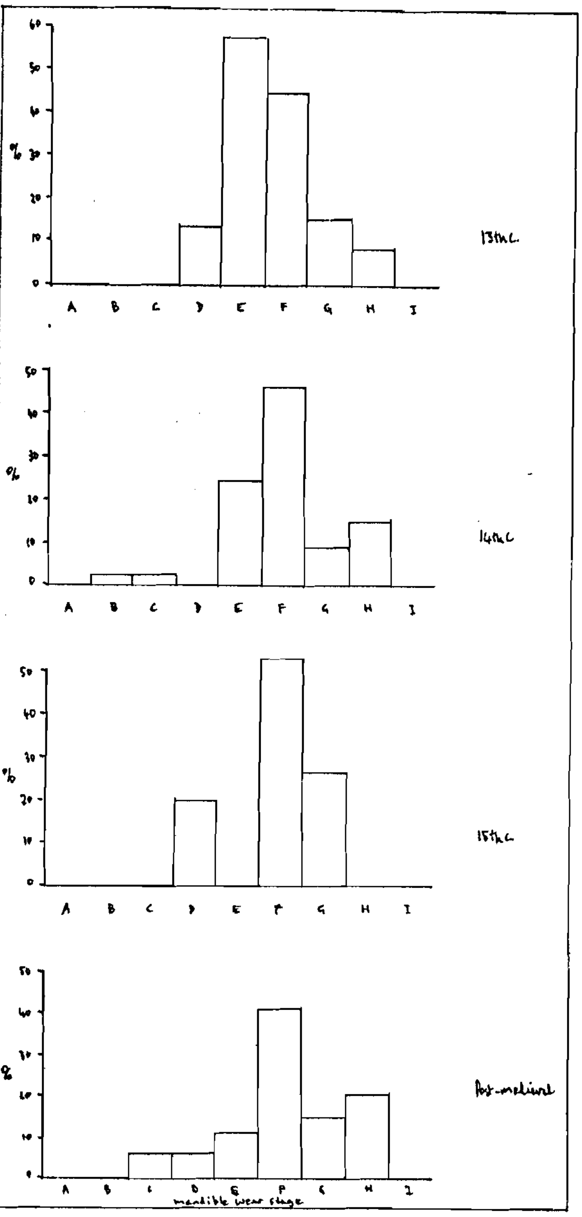


Figure 19.

Mandible ageing data, method of Payne.

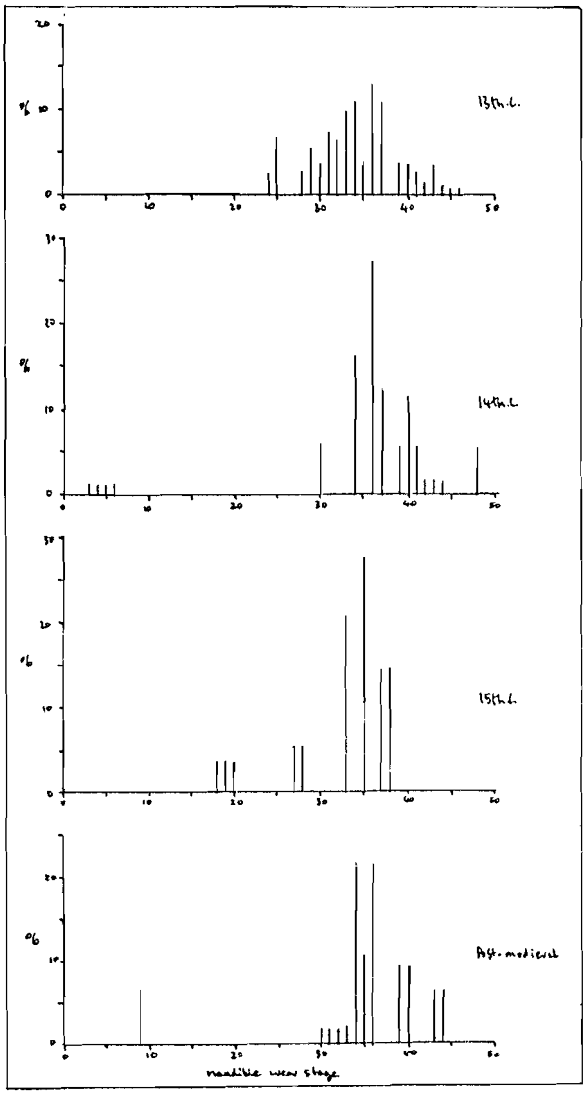


Figure 20.

Mandible ageing data, method of Grant.

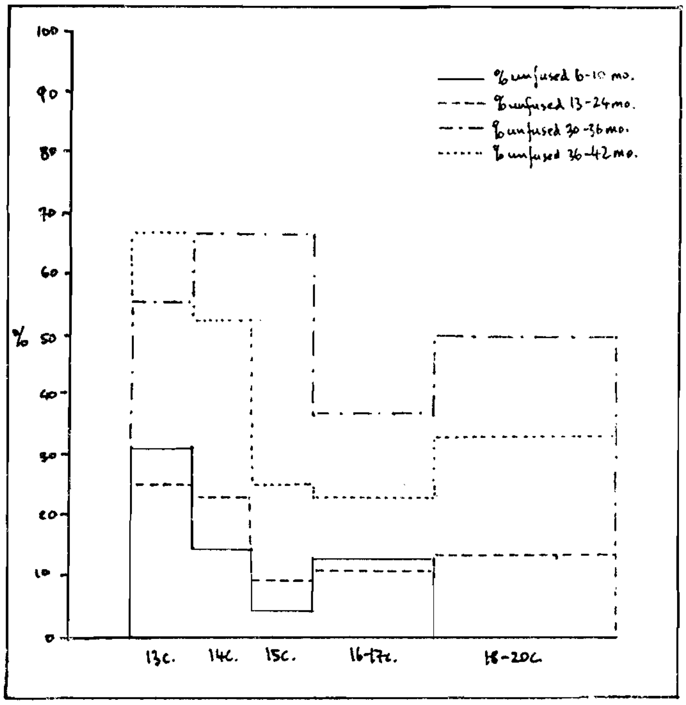


Figure 21. Summary of epiphyseal fusion data for ovicaprids

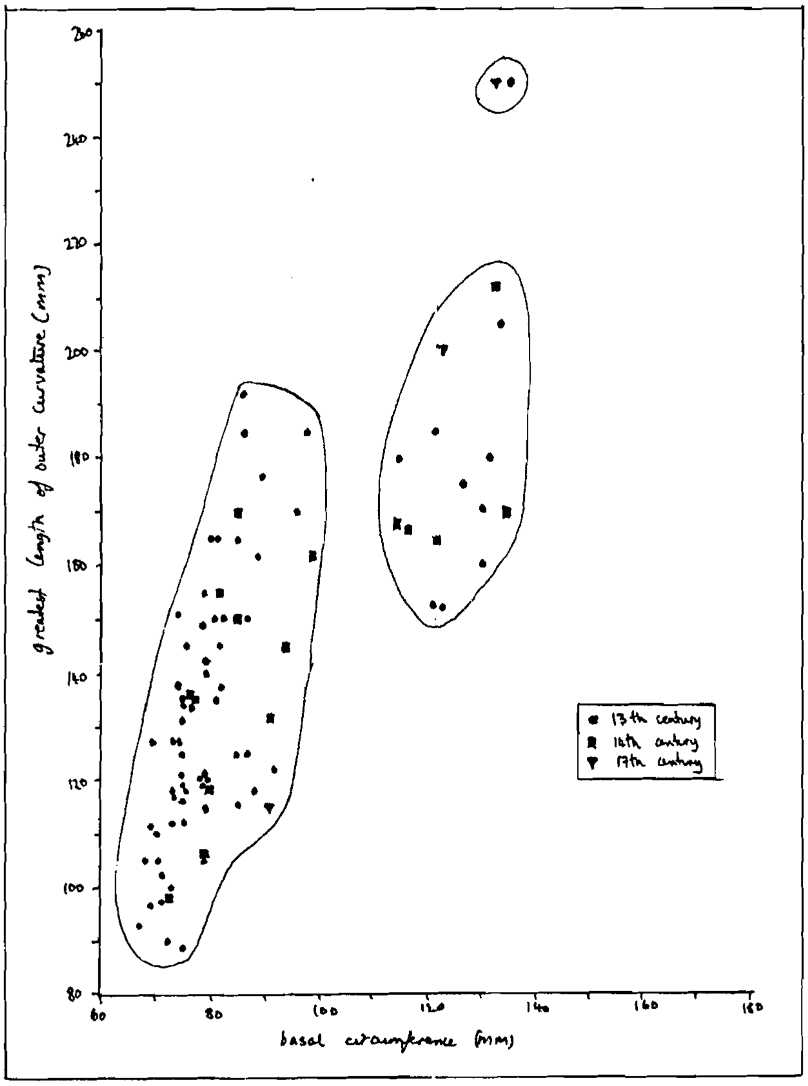


Figure 22. Length/basal circumference dimensions, goat horncores

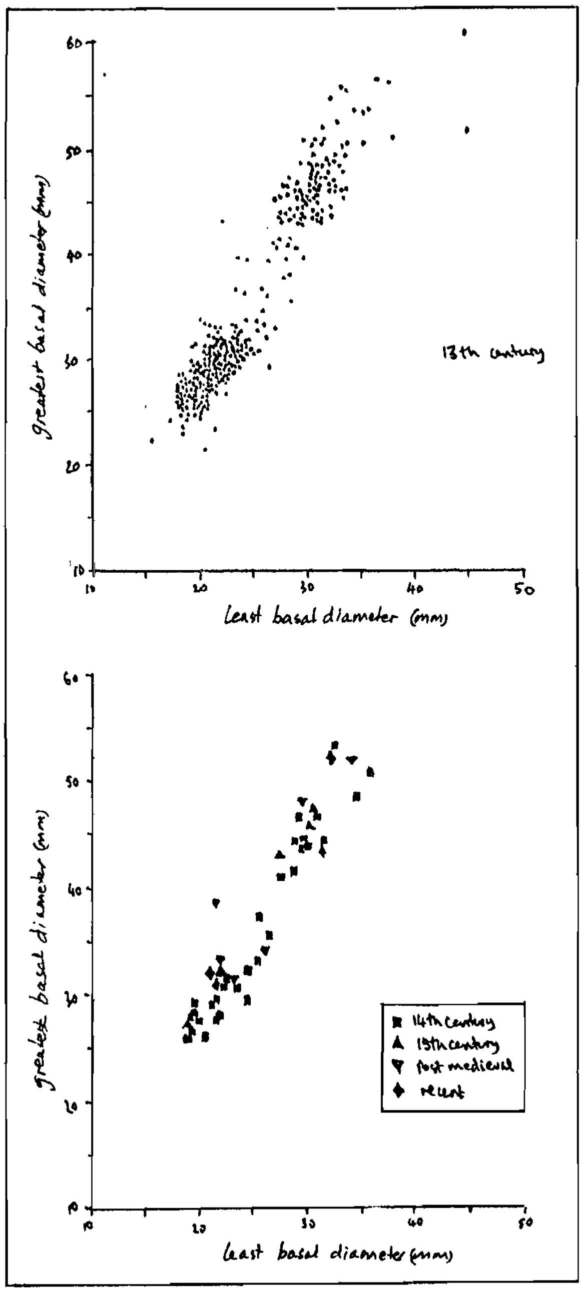


Figure 23. Greatest and least basal diameters of ~~goat~~ horncores

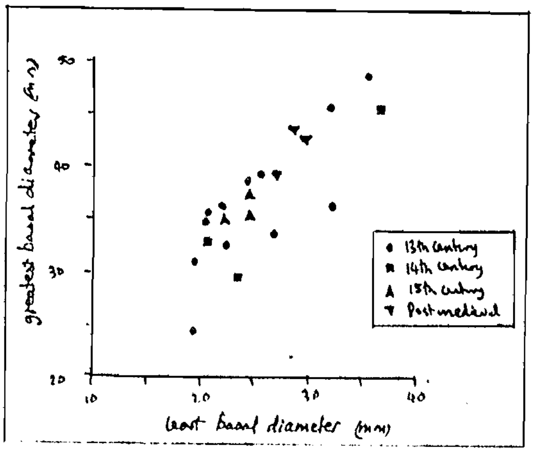


Figure 24. Greatest and least basal diameters of sheep horncores

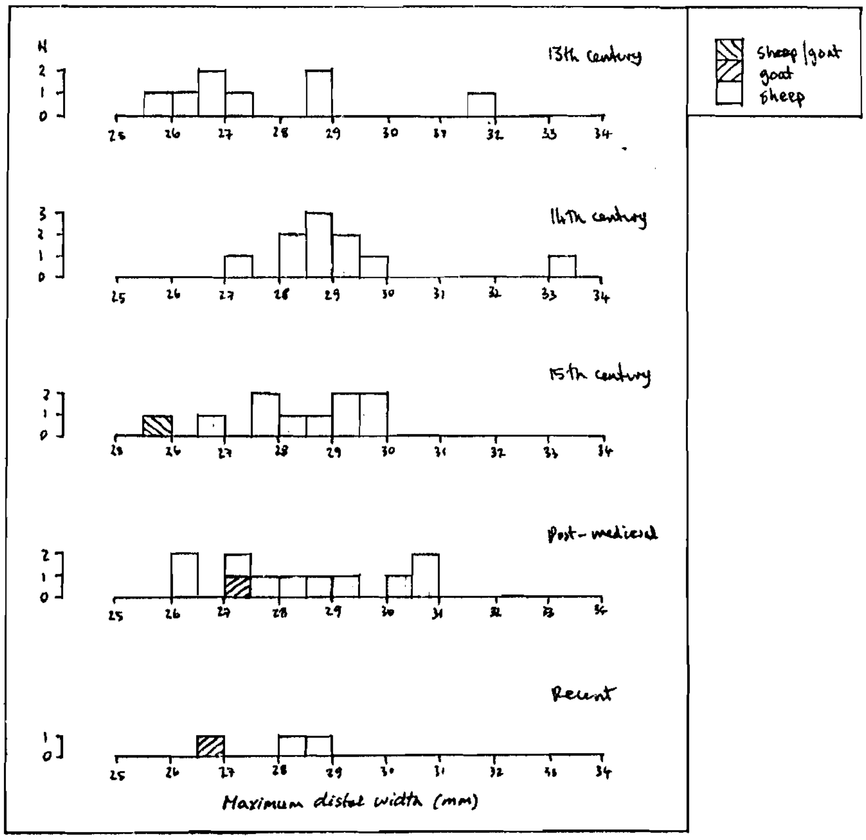


Figure 25. Maximum distal width in sheep/goat humeri

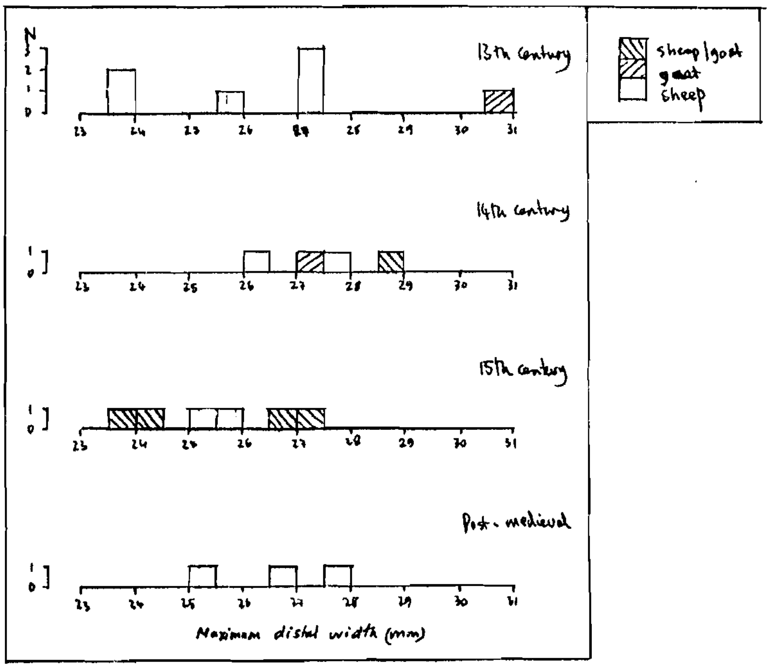


Figure 26. Maximum distal width in sheep/goat radii

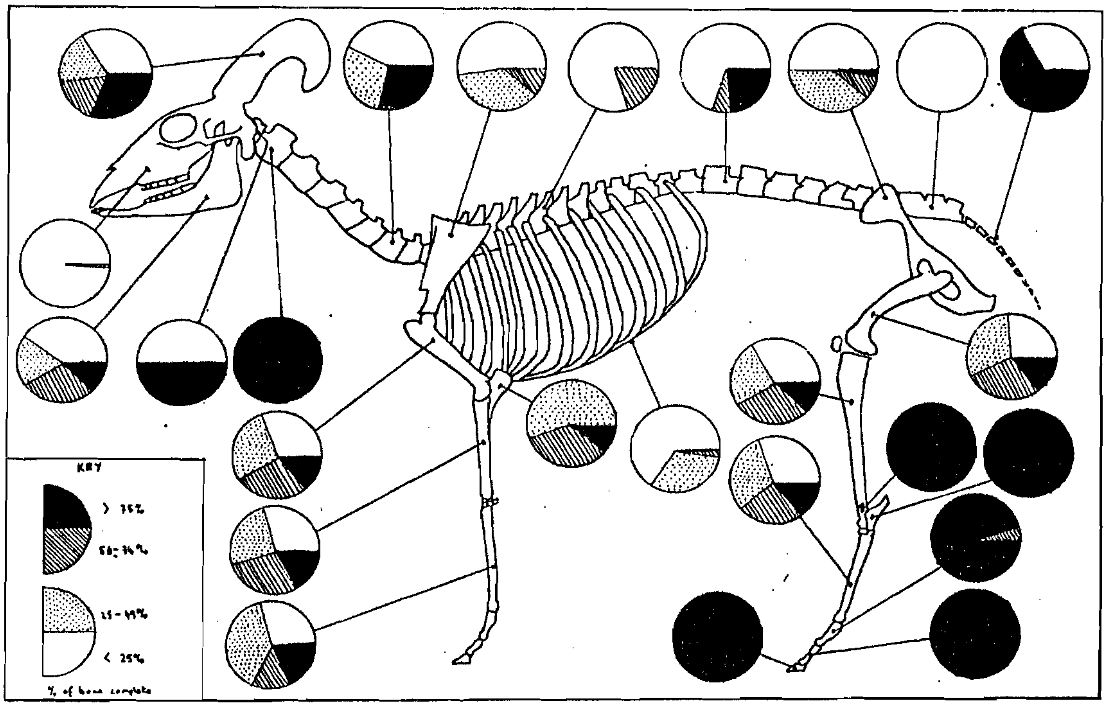


Figure 29. Fragmentation patterns in sheep-goat bones, 13th century

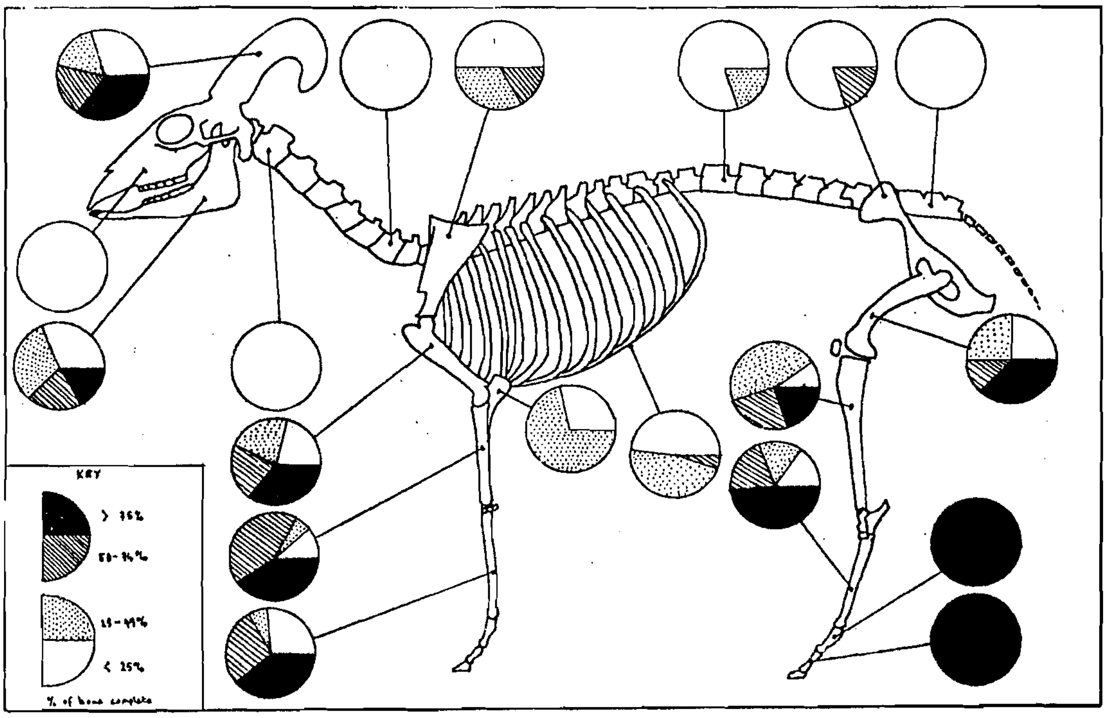


Figure 30. Fragmentation patterns in sheep-goat bones, 14th century

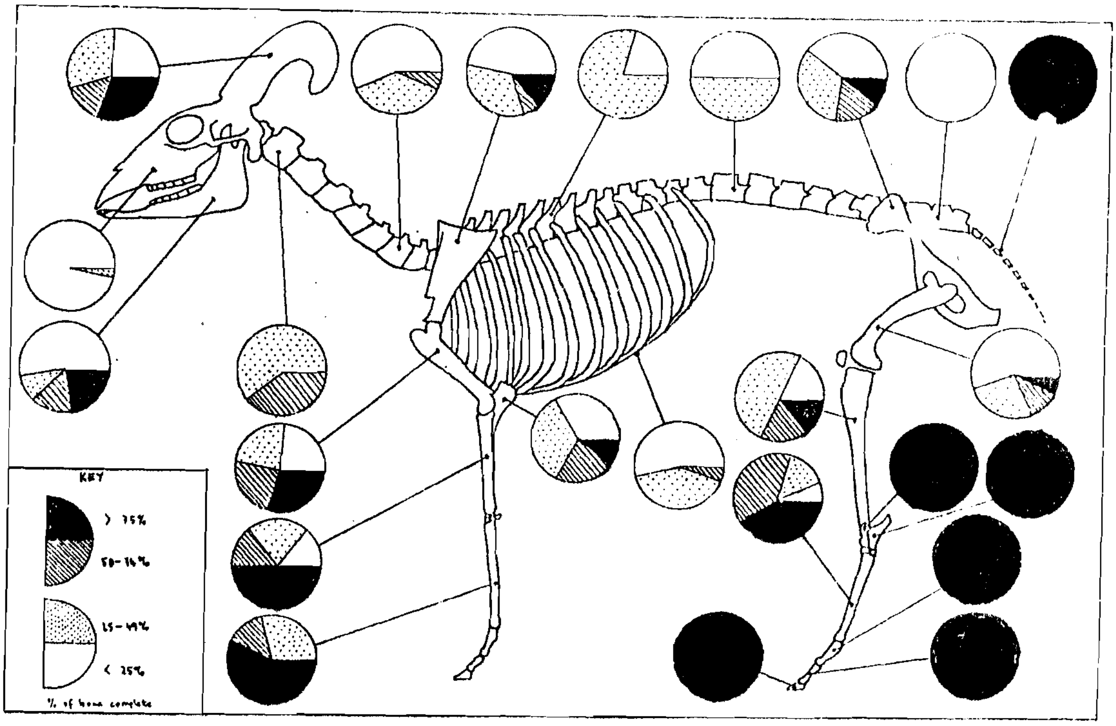


Figure 32. Fragmentation patterns in sheep-goat bones, Post-medieval

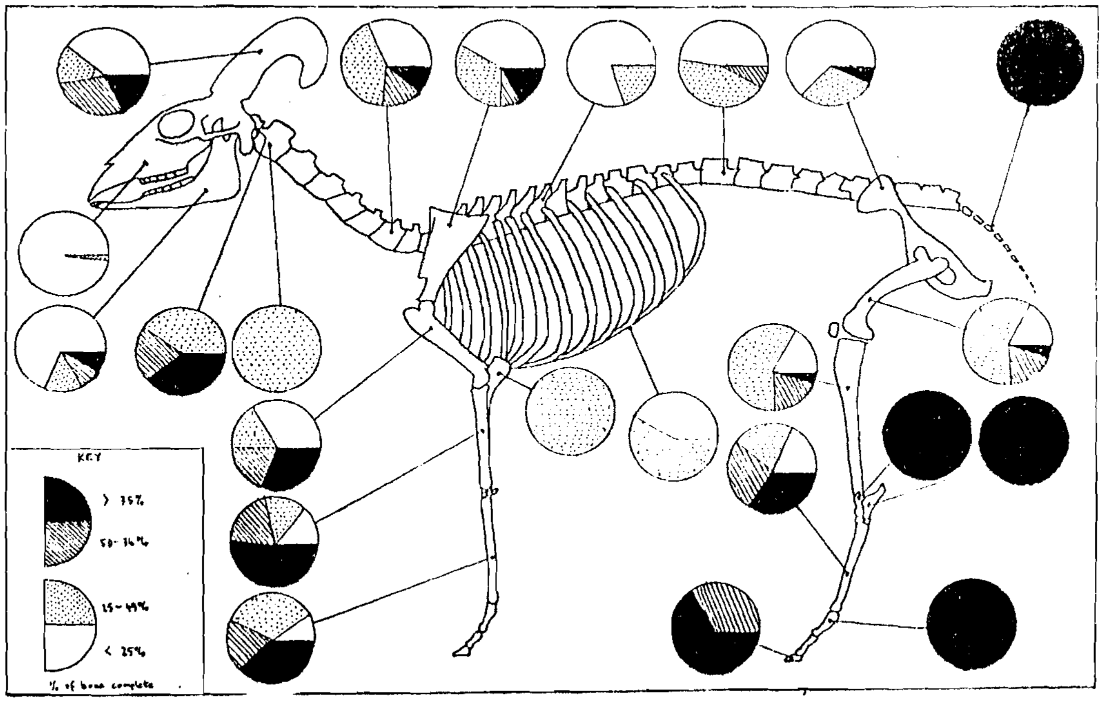


Figure 31. Fragment [illegible] rns in sheep-goat bones, 15th Century

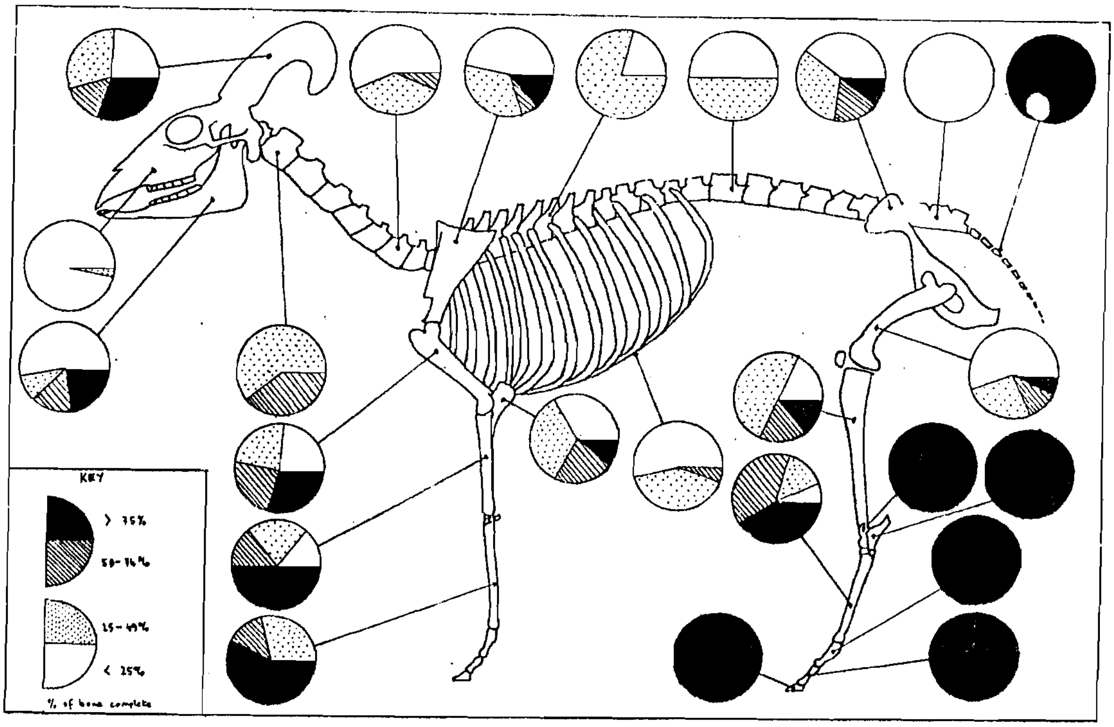


Figure 32. Fragmentation patterns in sheep-goat bones, Post-medieval

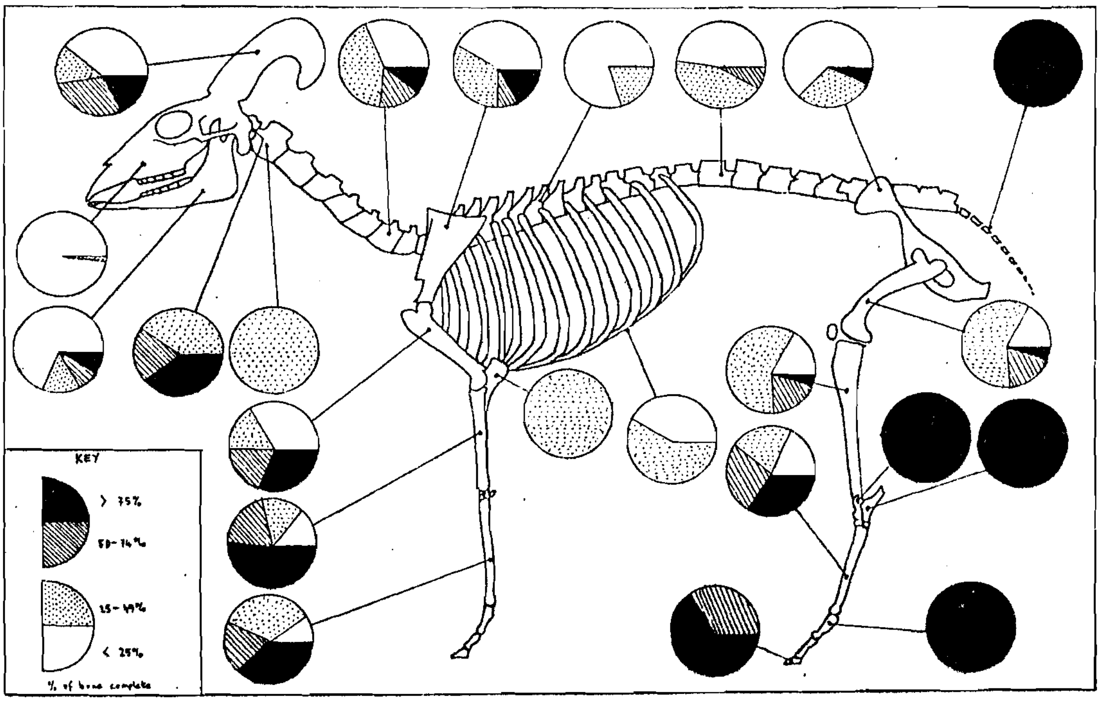


Figure 31. Fragmentation patterns in sheep-goat bones, 15th Century

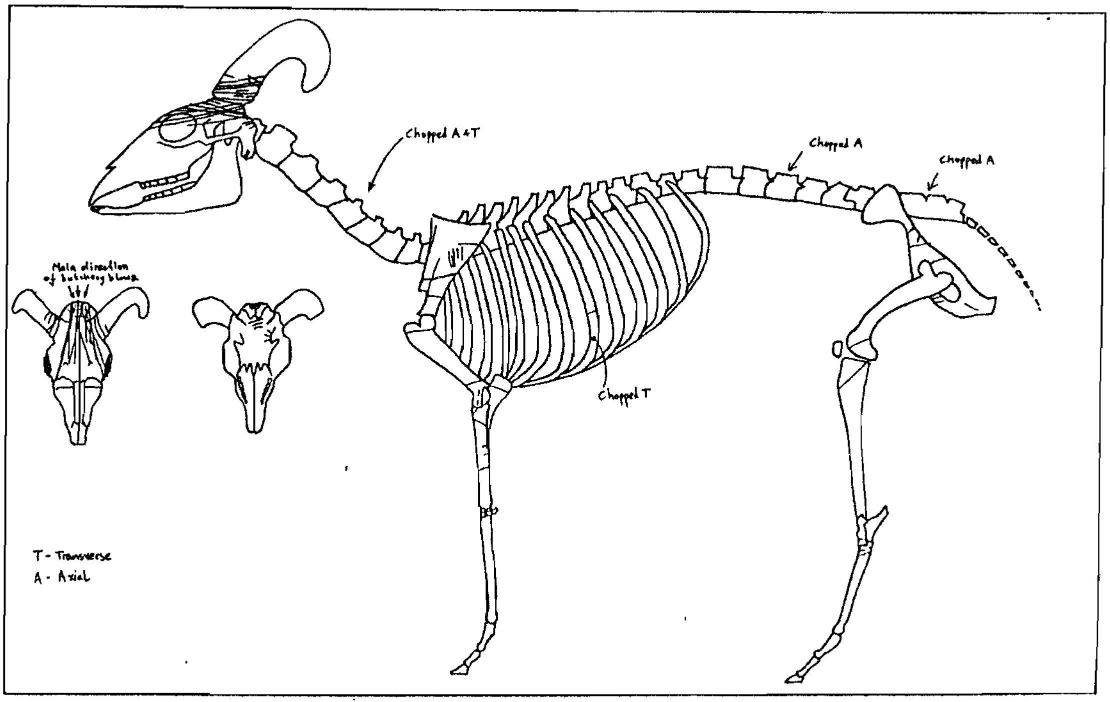


Figure 34. Diagrammatic summary of butchery marks on sheep-goat bones, 13th century

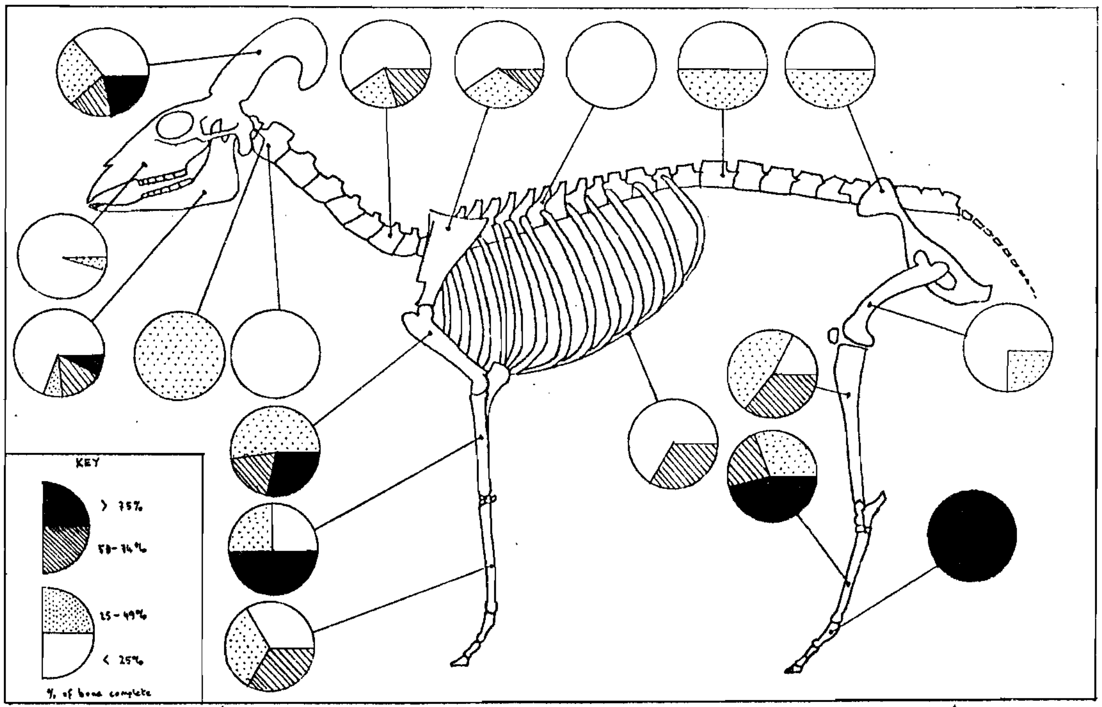


Figure 33. Fragmentation patterns in Sheep-goat bones, Recent.

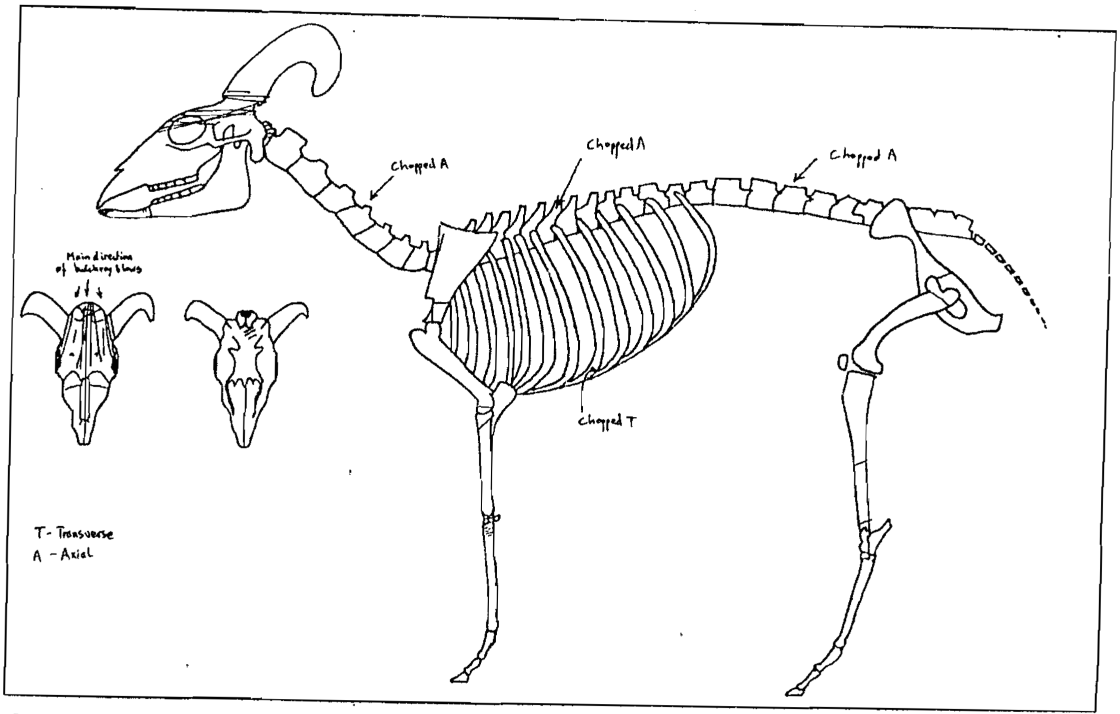


Figure 35. Diagrammatic summary of butchery marks on sheep-goat bones, 14th Century

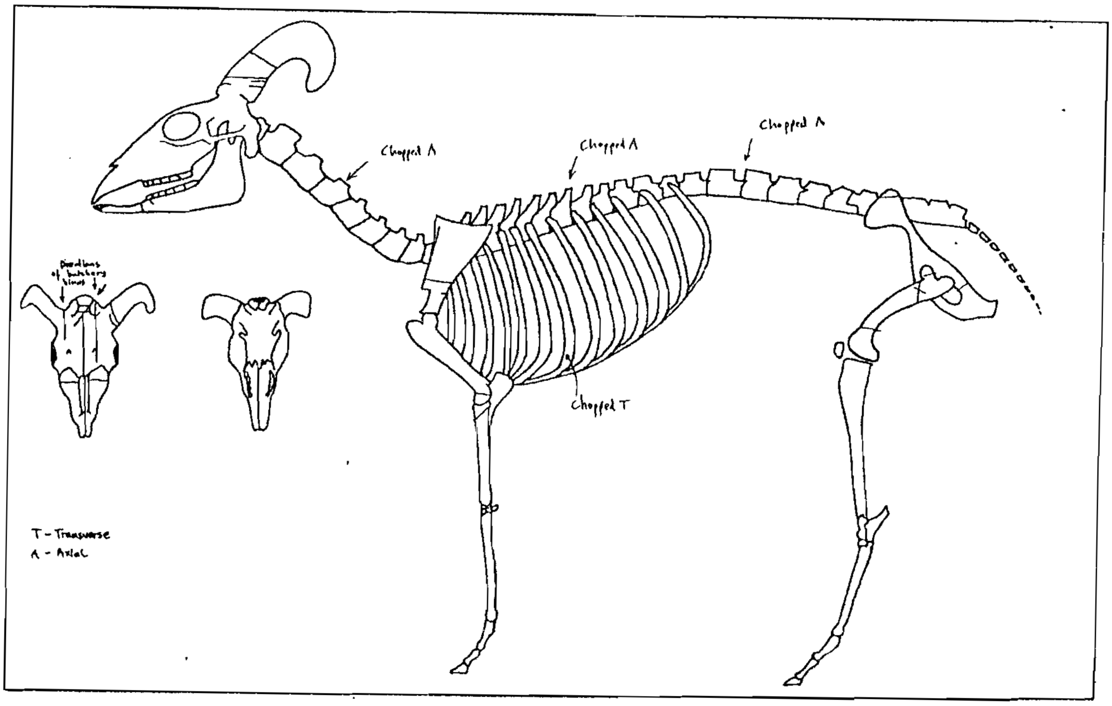


Figure 36. Diagrammatic summary of butchery marks on sheep-goat bones, 15th Century

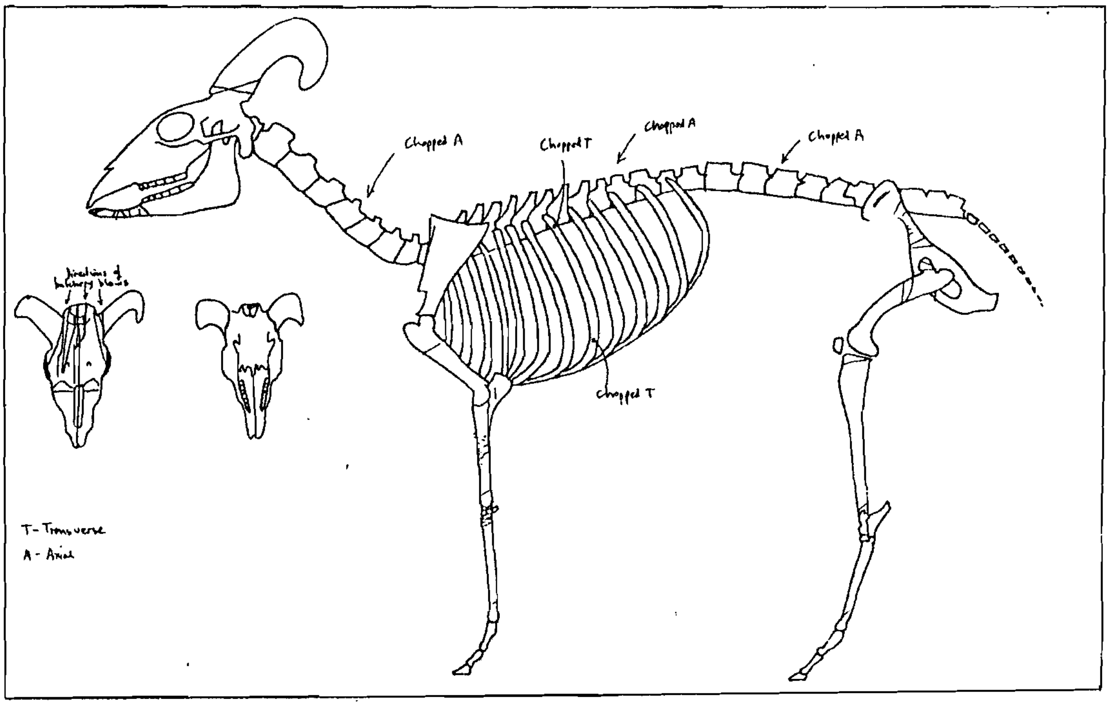


Figure 37. Diagrammatic summary of butchery marks on sheep-goat bones, post medieval

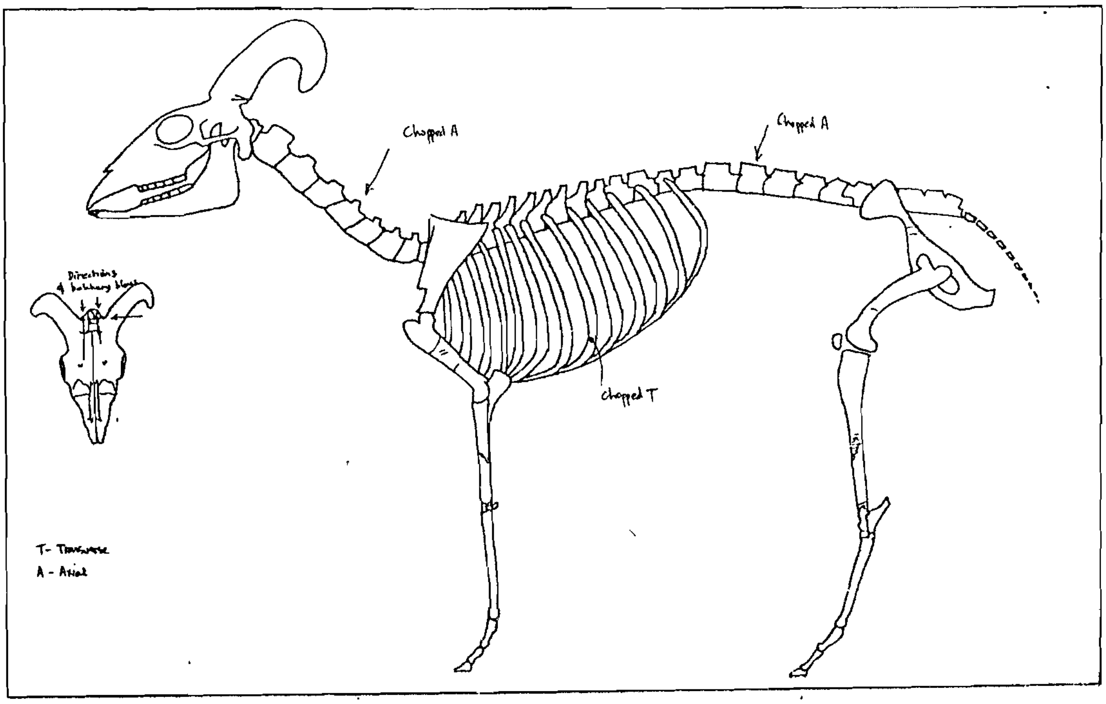


Figure 38 Diagrammatic summary of butchery marks on sheep-goat bones, recent.

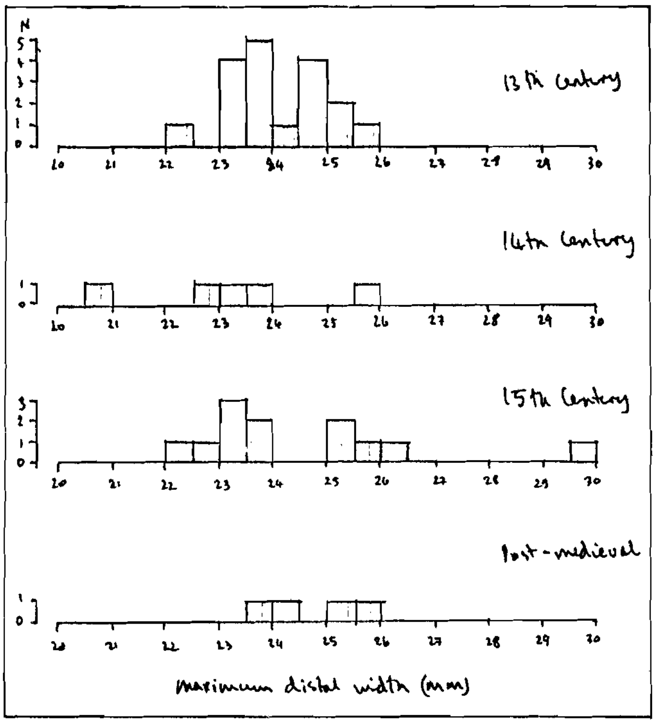


Figure 27 Maximum distal width in sheep/goat tibiae

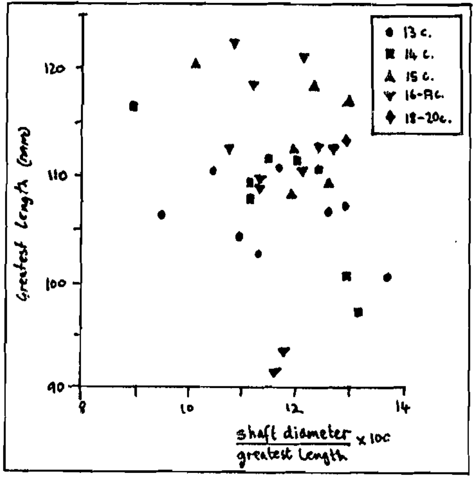


Figure 28 Length-breadth ratios in sheep metacarpals.

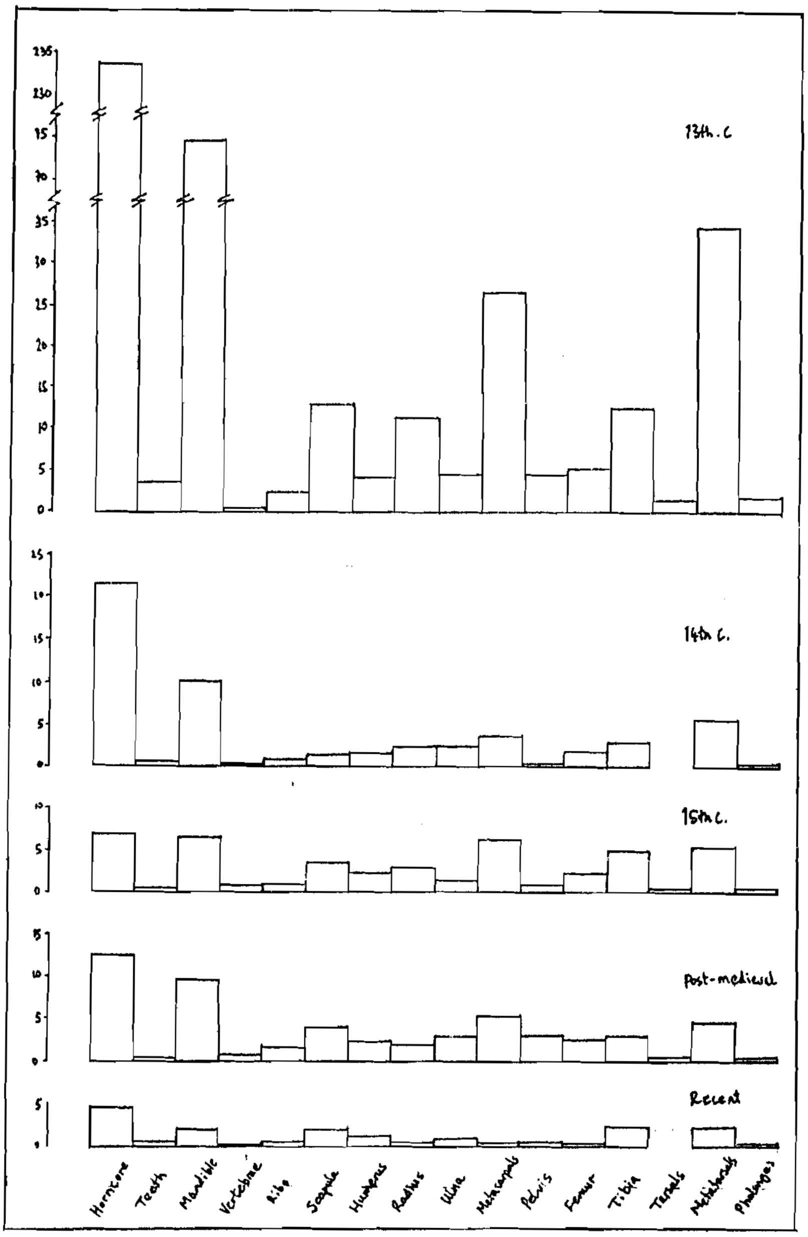


Figure 39. Anatomical distribution of sheep-goat elements. Vertical scale $\frac{n}{N}$

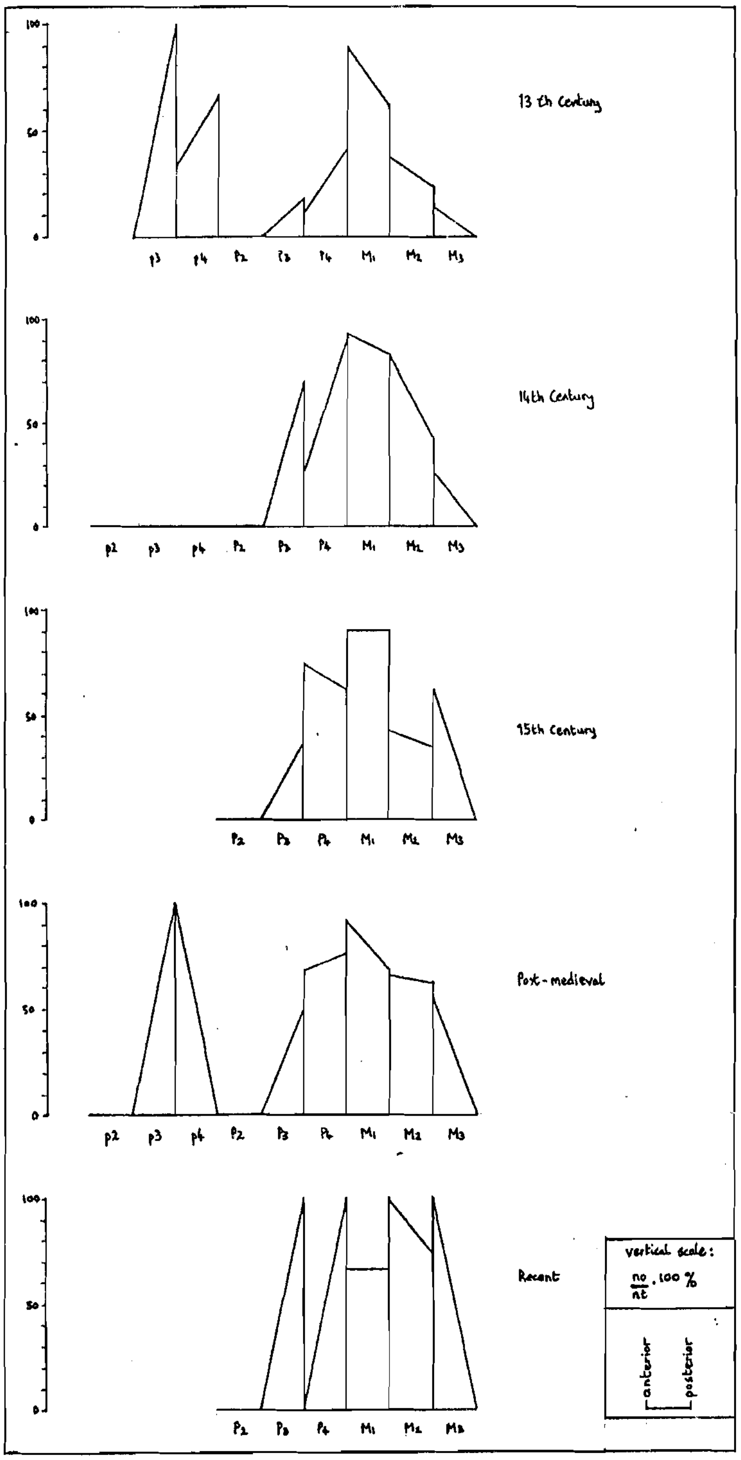
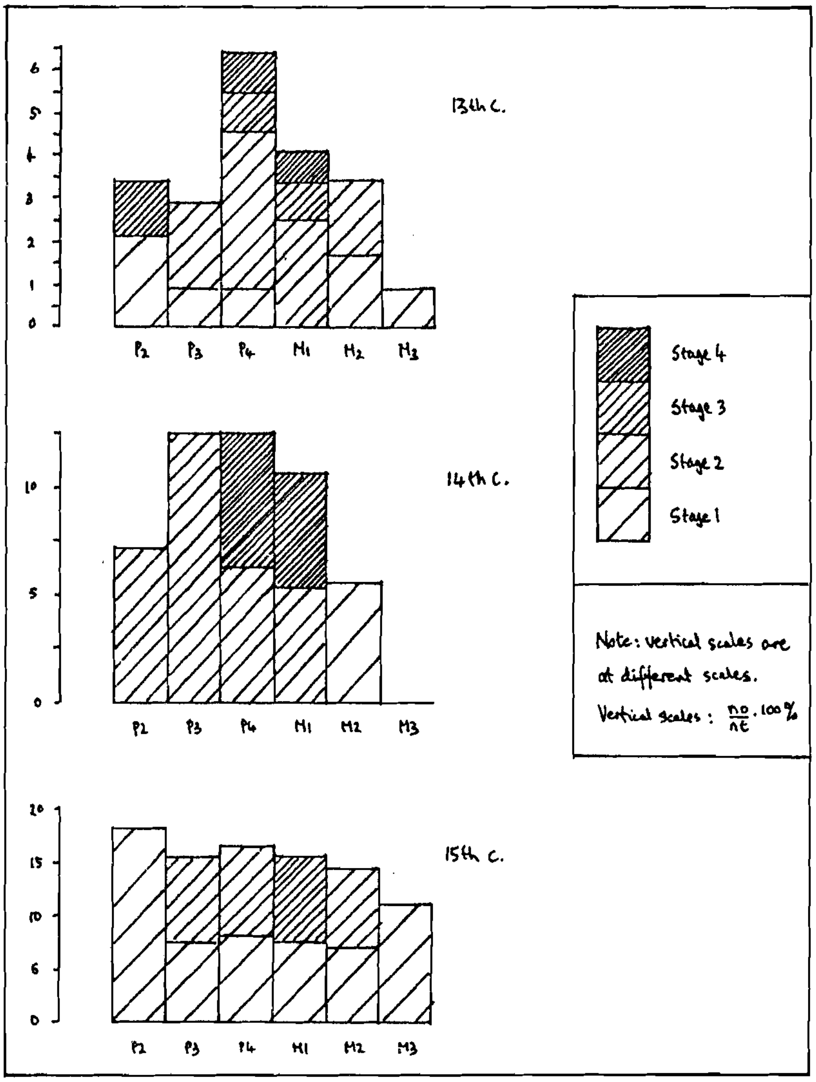


Figure 40. Frequency of occurrence of intra-dental attrition in sheep-goat mandibles



Note: vertical scales are at different scales.
Vertical scales: $\frac{no}{nt} . 100\%$

Figure 4b Frequency of occurrence of periodontal disease in sheep-goat mandibles

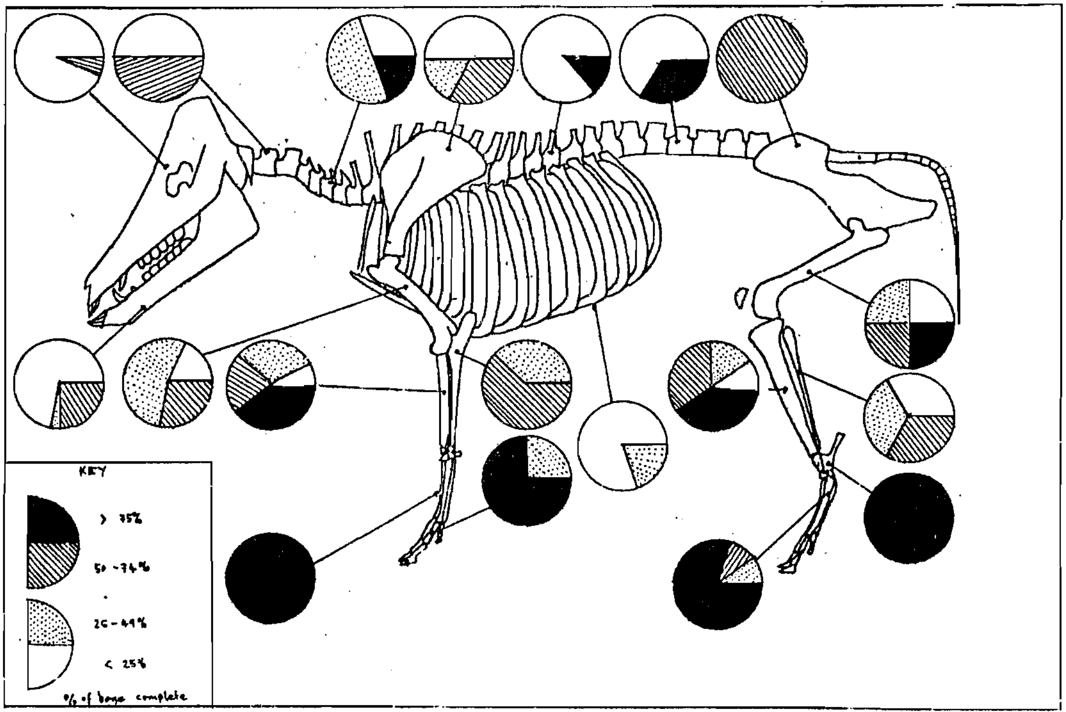


FIGURE: 42 FRAGMENTATION PATTERNS IN PIG BONES 13TH CENTURY.

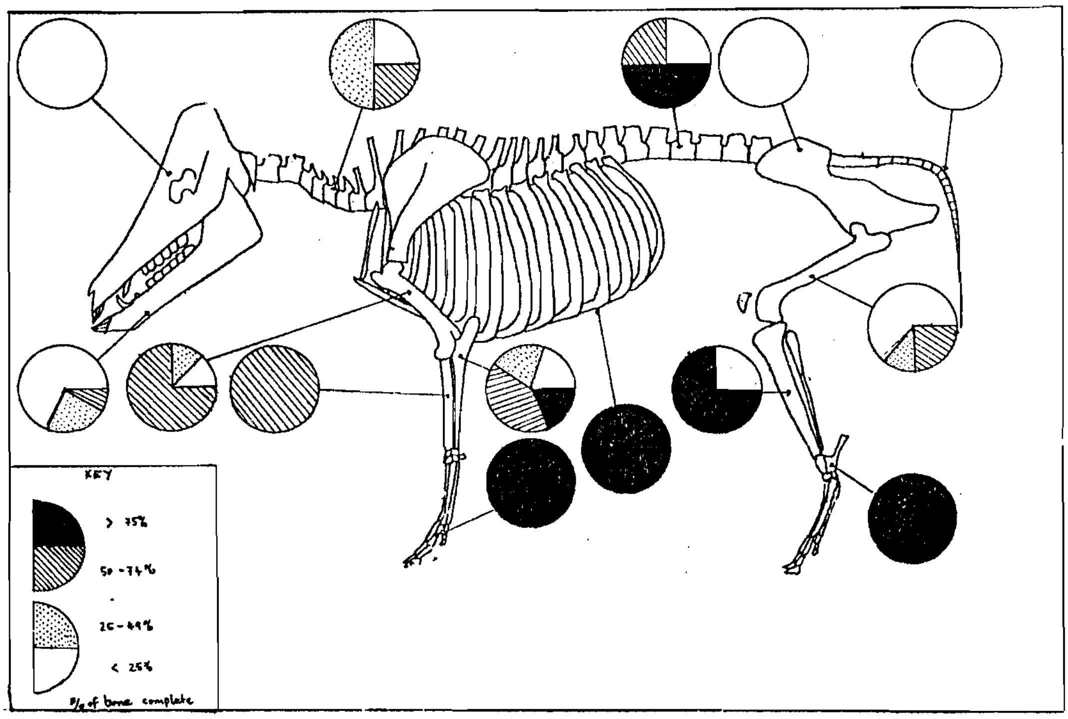


FIGURE: 43 FRAGMENTATION PATTERNS IN PIG BONES 14TH CENTURY.

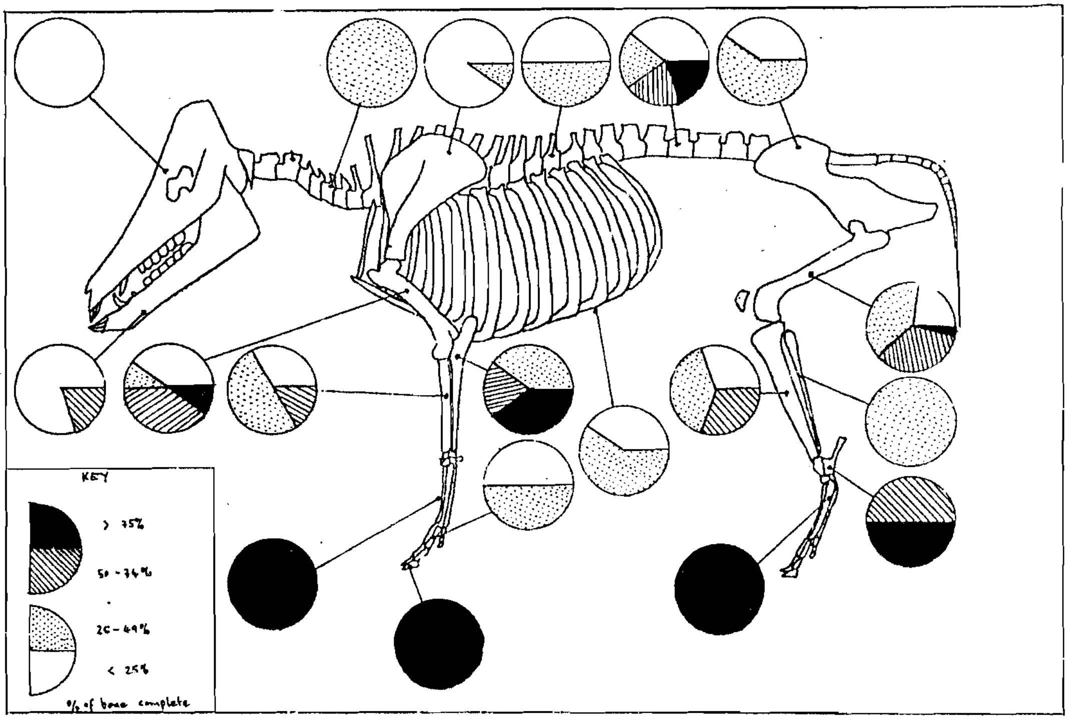


FIGURE: 44 FRAGMENTATION PATTERNS IN PIG BONES 15TH CENTURY.

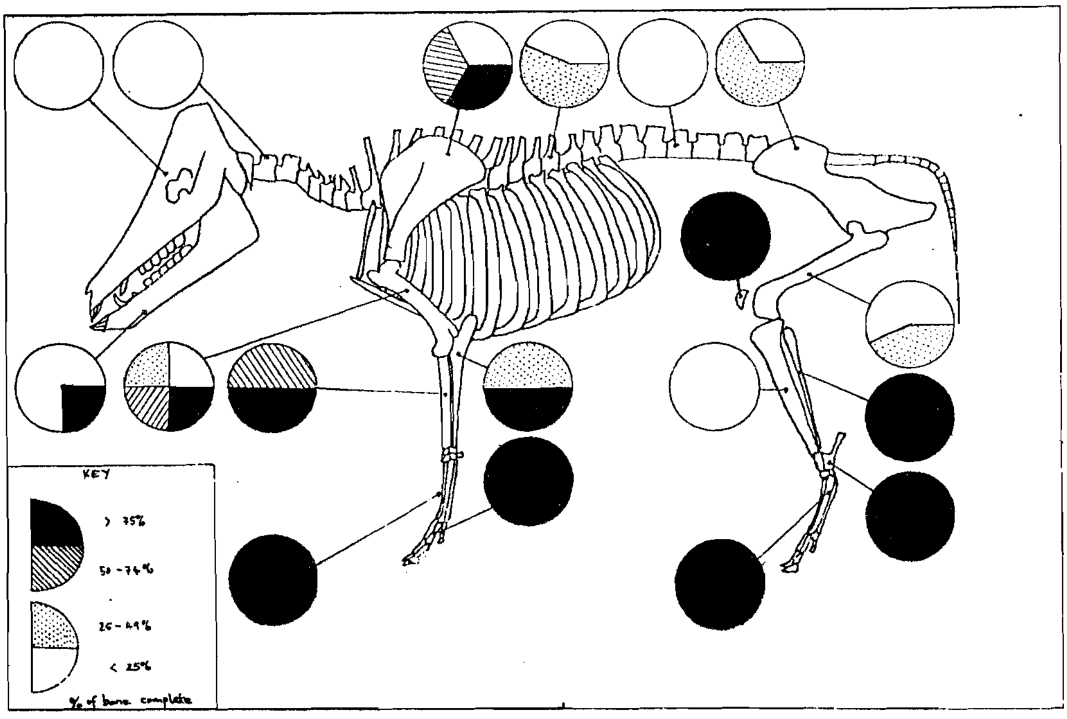


FIGURE: 45 FRAGMENTATION PATTERNS IN PIG BONES POST MEDIEVAL.

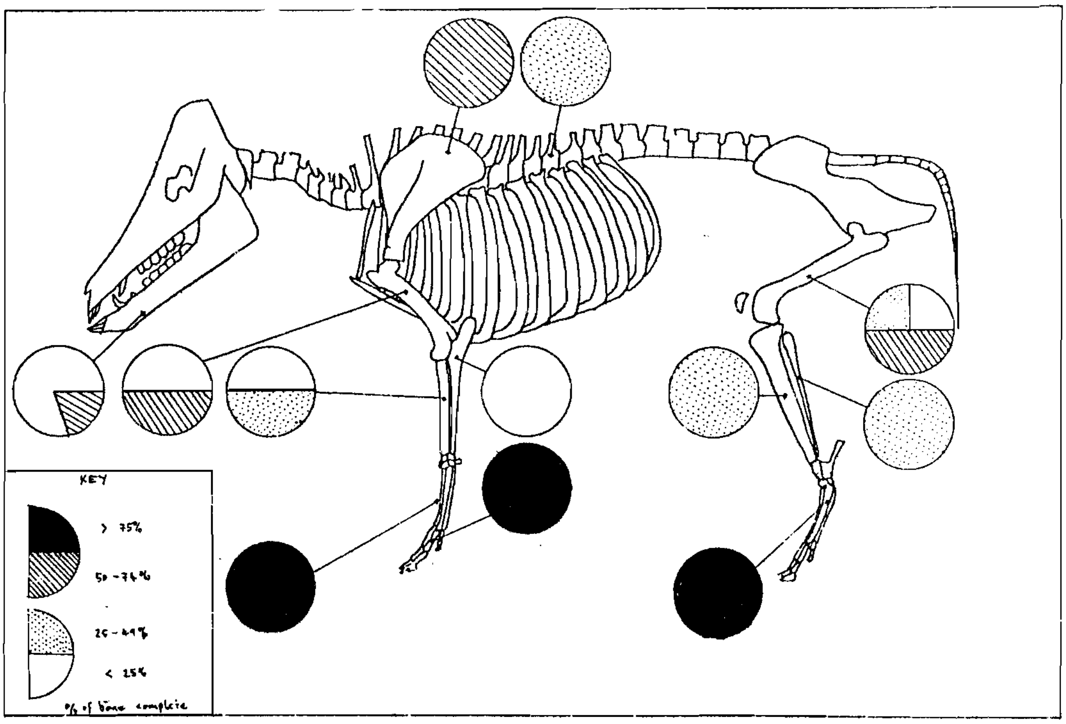


FIGURE 46. FRAGMENTATION PATTERNS IN PIG BONES RECENT.

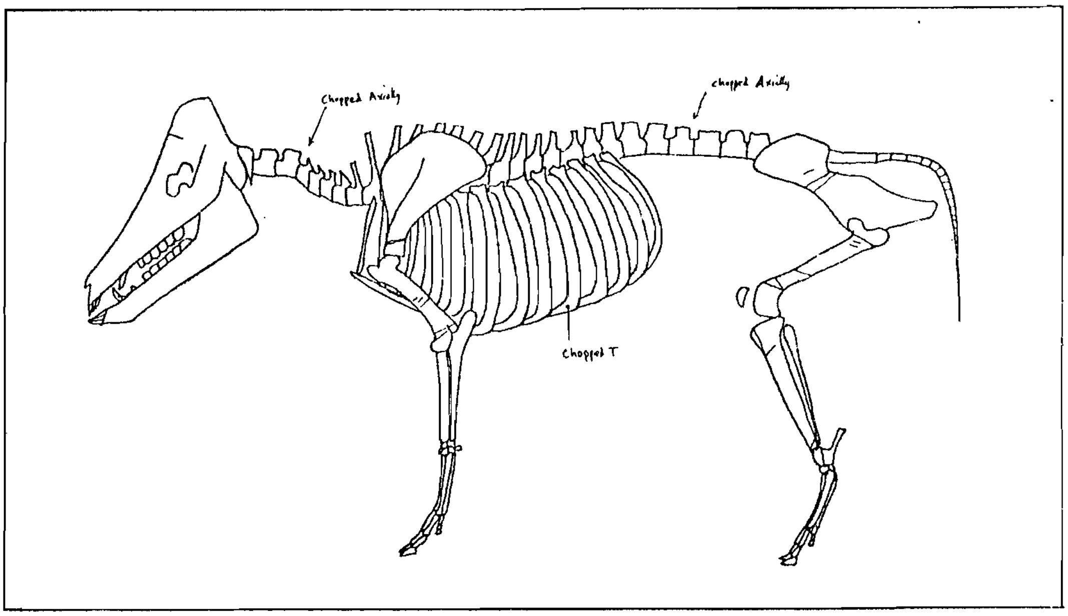


Figure 47. Summary of butchery marks on pig bones, 13th century – post-medieval.

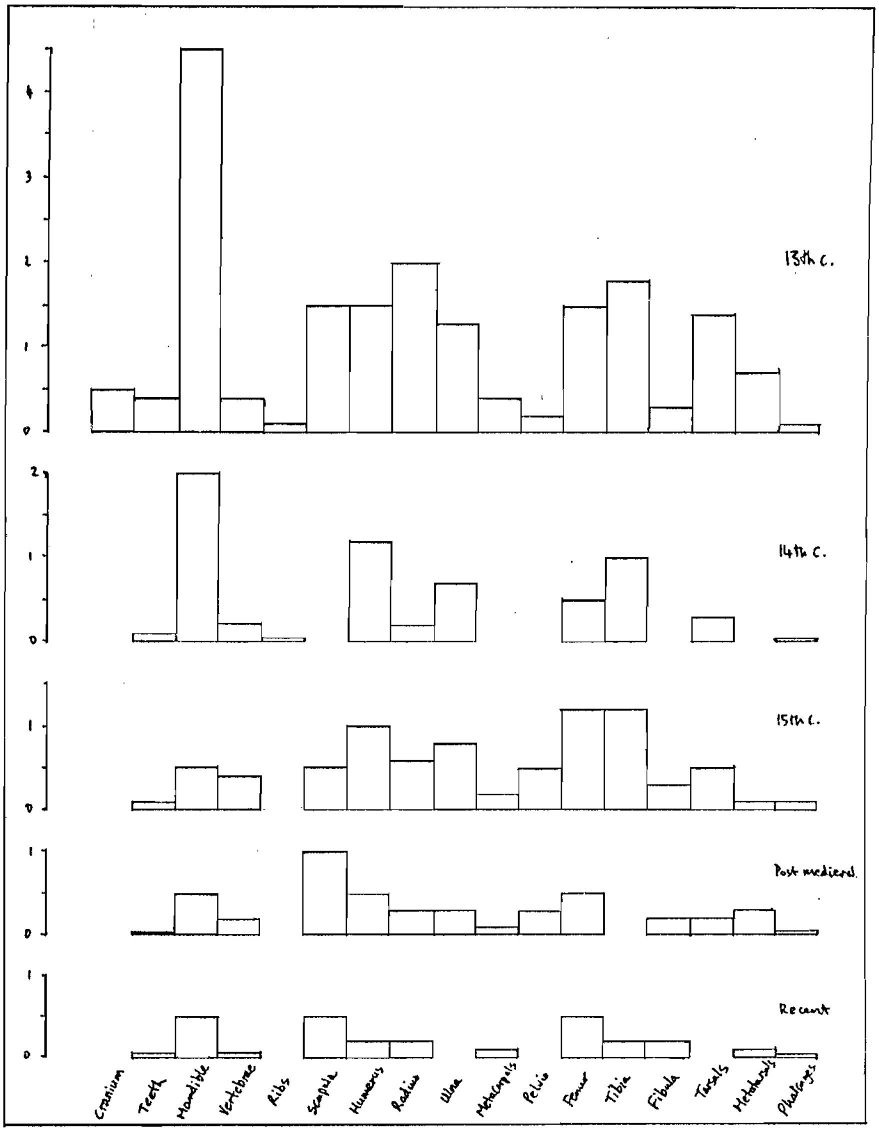


Figure 48 Anatomical distribution of pig bones. Vertical scale $\frac{n}{N}$

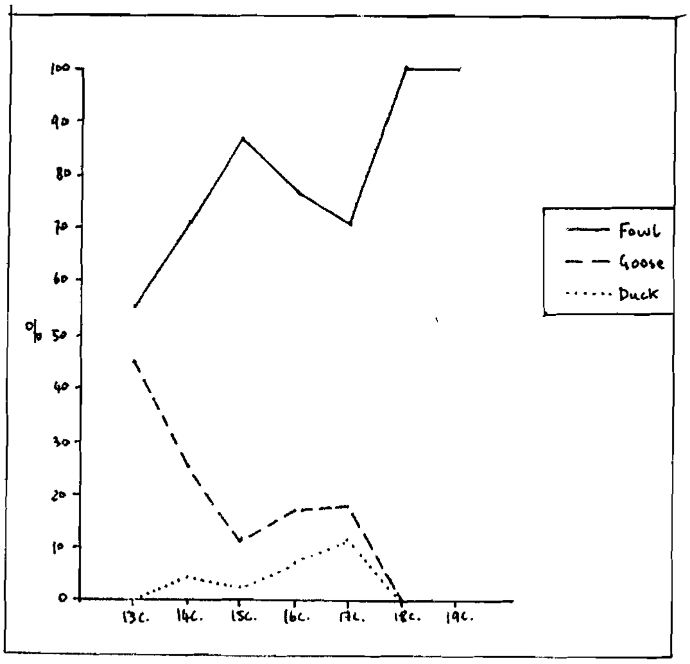


FIGURE 49. Relative abundance of major birds expressed as percentages of fragments. (fowl + goose + duck)

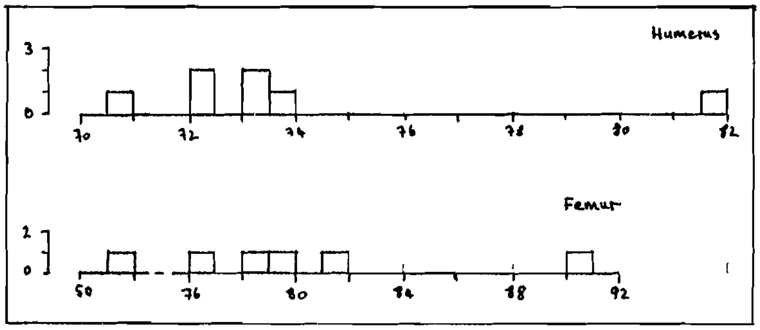


Figure 50. Maximum length measurements in mediaval domestic fowl bones

List of plate captions. Exe Bridge.

Plate 1. Cattle horncores with distorted surfaces.

Plate 2. Cattle skulls with one or multiple holes in the parietal. Holes range in size from 3 to 10mm diameter.

Plate 3. Joint disorders in cattle metapodia:
a) metatarsus with osteo-arthritis - note heavy grooving, eburnation, new bone formation and associated exostoses;
b) metatarsus with extra bone growth/exostosis around proximal joint.

Plate 4. Spondylosis of two cattle lumbar vertebrae - note that they are completely fused dorsally, but only partially ventrally.

Plate 5. Sheep mandible with grossly deformed second molar - the anterior extra column may have ejected the first molar which has been lost ante-mortem.

Plate 6. Sheep mandible with deformed symphysis - the condition has affected the lateral surface also, which is "porous" in appearance.

Plate 7. a) sheep-size rib with simple fracture;
b) sheep thoracic vertebra with simple fracture in the neural spine;
c) goat third phalanx with exostoses which may be a condition such as "ring bone".

Plate 8. One goat (far left) and three sheep horncores with 'thumb-print' depressions - note extremely large depression in specimen on far right. The condition is thought to indicate poor nutrition and/or castration.

Plate 9. Sheep horncores with various forms of distortion. a) and b) may be due to castration or late/mismanaged polling.

Plate 10. Polled goat (left) and sheep skulls. The goat is possibly artificially polled, the sheep appears to be naturally polled.

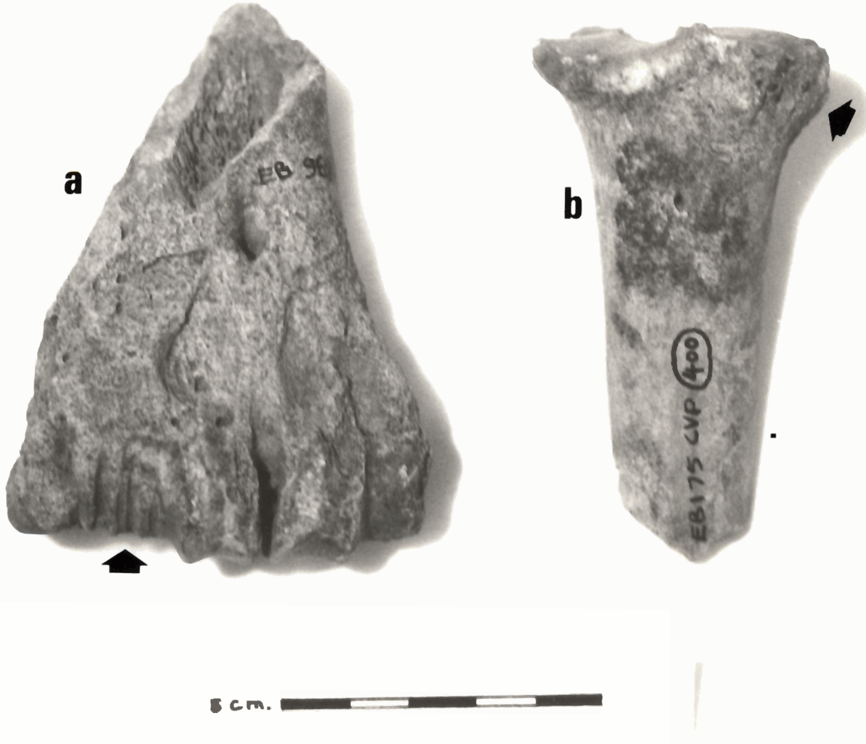
Plate 11. a) pig ulna with "greenstick" fracture close to the articulation surface; b) pig metatarsal IV with exostosis and additional bone growth around proximal epiphysis.

Plate 12. Cat metatarsals with simple fractures (from same individual).

Plate 13. Anomalies of fowl bones:
a) extra bone growth on the medial aspect of the distal end of a tibiotarsus - possibly an ossified ligament;
b) juvenile tibiotarsus with slight deformation of shaft;
c) extra bone growth on proximal epiphysis of spurred (? male) tarsometatarsus;
d) sternum with distorted keel.

PLATE 1.

PLATE 2.



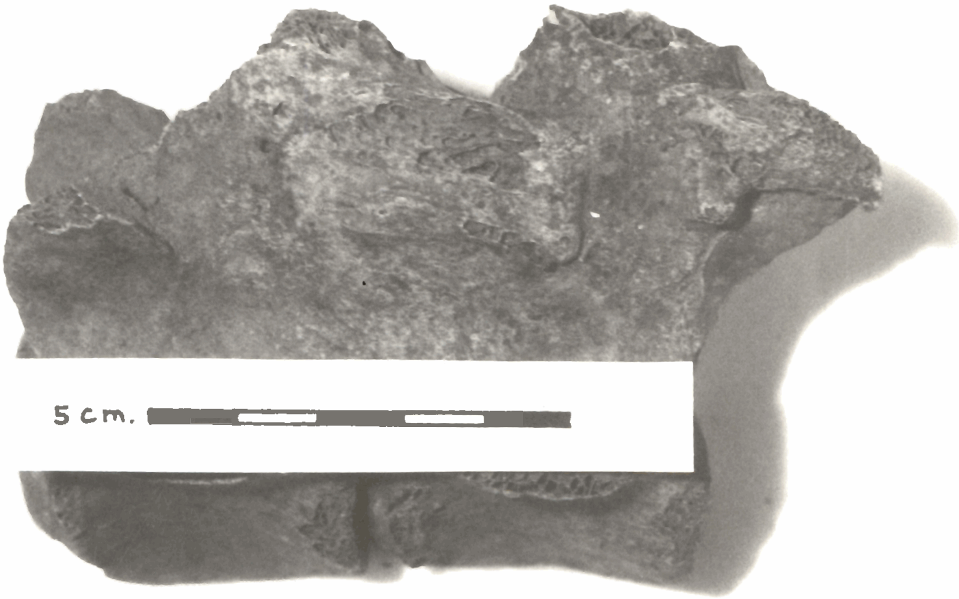


PLATE 4.

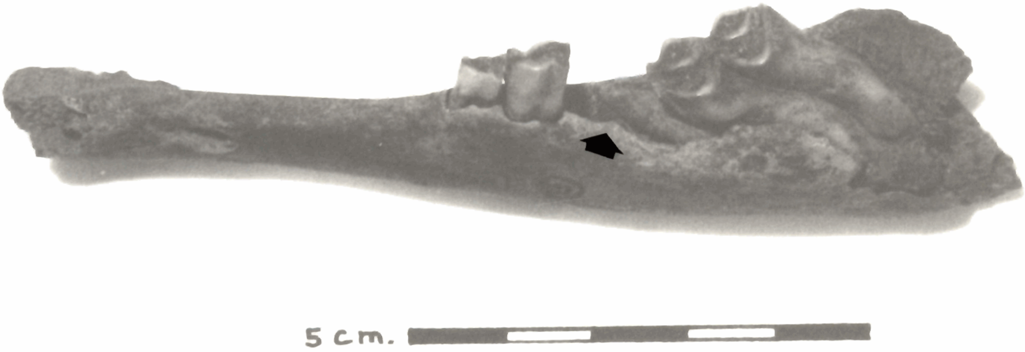


PLATE 5

PLATE 6

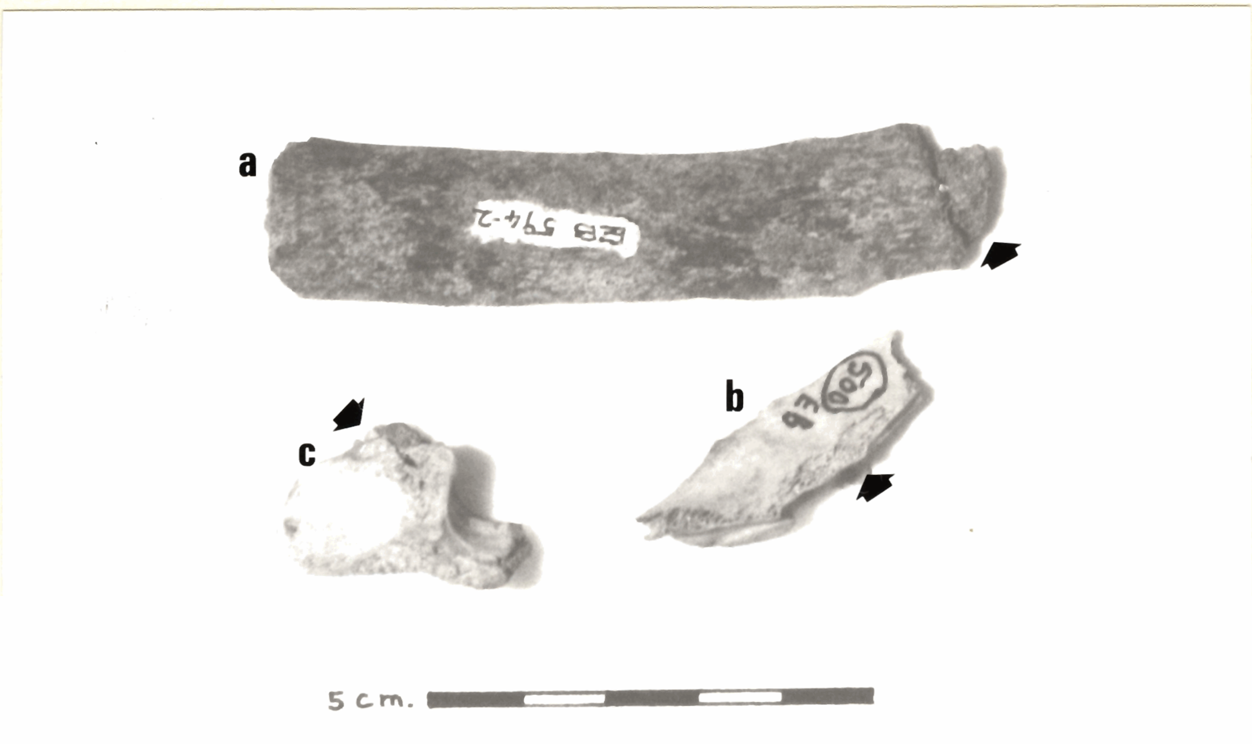


PLATE 7

PLATE 8

PLATE 9

PLATE 10

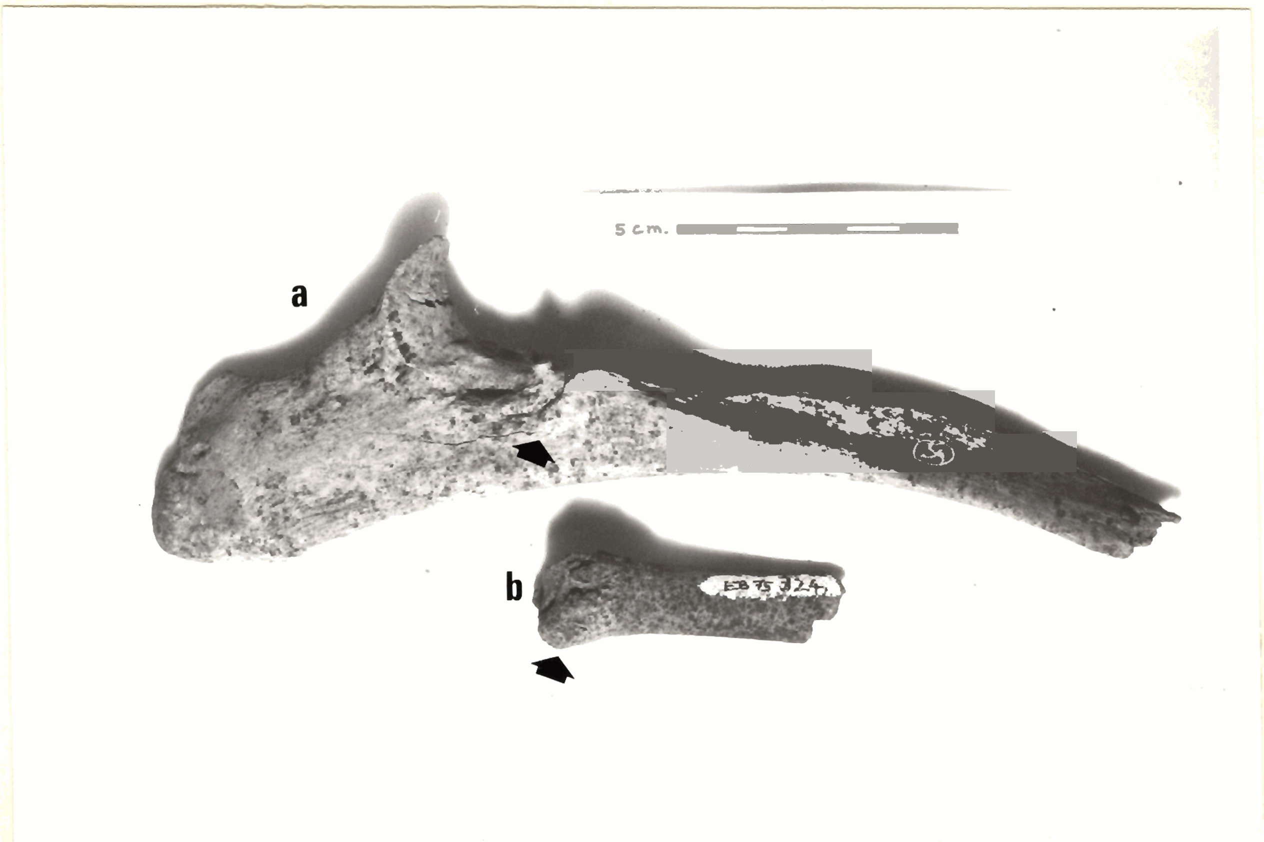


PLATE 11.

PLATE 12

PLATE 13