BRANCASTER : DISCUSSION - Additional paragraph on animal bones/economy

The interpretative limitations presented by the eroded nature of the archaeology of the excavated area extend to consideration of the site economy as evidenced by the animal bones . More specifically one cannot establish the functional relationship between the settlement area examined and the fort area and hence it is not possible to gauge the extent to which the animal bone assemblage from the excavation reflects the particular demands of the military garrison .

It is clear from the animal bone evidence that complete animals were being butchered on site . The predominance of mature animals in the cattle and sheep assemblages indicates that these animals were not being exploited solely for meat and hide but that the cattle were being utilised as draught animals and/or for milk and the sheep for wool . To what extent these primary uses are related to the fort and settlement at Brancaster it is beyond the limits of the evidence to say. The comparatively small quantities of horse bones would seem to indicate either that the disposal of cavalry animals did not involve slaughter on site or that the cavalry did not form a significant part of the garrison before the settlement area examined was largely abandoned in the fouth century A.D. It is interesting to note in this context that the horse bones recovered were those of small sturdy animals . Otherwise the economy of the site clearly involved some small-scale pig-rearing and the keeping of domestic fowl , supplemented by wildfowling and the exploitation of the site's coastal position as evidenced by the molluscan remains and the fragments of whalebone .

Author's Preface

The excavations at Brancaster in 1974 and 1977 generated a considerable volume of data and material. For this reason the production of the report and archive has been a long process and involved the work of many people, as is evidenced by the list of contributors. I am grateful for the forebearance of those specialist contributors whose work was submitted some considerable time prior to the appearance of this volume. The authors of the pottery and animal bone reports have asked me to point out that these reports were completed in substance before 1981 and hence do not take account of information which has become available since that time.

Since the commencement of the programme of work leading to the production of this report there have been further shifts in attitude to the publication of the results of archaeological excavations, most recently expressed in the report of the Joint Working Party of the CBA and DoE 'The Publication of Archaeological Excavations' (1983). I am grateful to the Editorial Committee for their recognition that although this report does not conform in a number of aspects to 1984 requirements it has been impractical for a number of reasons to attempt a major revision of its structure.

John Hinchliffe

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THE ANIMAL BONES

By S M Wall, P Langley and R T Jones

INTRODUCTION

The animal bones from the excavations at Brancaster by the Department of the Environment's Central Excavation Unit in 1977 came from an even distribution throughout the excavated area to the west of the fort. Chronologically, the site spans a period of approximately four millennia from Neolithic to post-Roman times. This has been divided into seven groups for assessment of the bone remains, corresponding to the phases in which the archaeological evidence has been studied. These are Neolithic, Beaker, Bronze Age, Iron Age, earlier Roman (phases 4-9) later Roman (phases 10-11) and post Roman. Of these, all except the Neolithic group contained some bone, and the earlier Roman comprised by far the largest collection.

In 1974, an area to the west of the CEU site was excavated by C Green and comparison with G Jones' report (p. 000) on the faunal remains from these excavations has been made, though the quantity of bone recovered there was much smaller. Davies (1971, 123-124) considers that the primary food source to the army would have been locally derived produce, and hence the Roman military diet would probably not have differed significantly from that of contemporary civilians. Our results have therefore been compared with other Roman sites in Britain: both military and civilian.

METHOD

The animal bone was recovered by hand-picking. Some trial sieving was also carried out at an early stage, in the hope that remains of the smaller vertebrates might be recovered, but as these trials did not yield any bones, no large-scale on-site sieving policy was adopted. Bulk-soil samples for sieving were only taken after 'small bones' had been noticed during excavation. Ultimately, this method was only used twice for deposits relating to the earlier Roman period.

Bones recovered during sieving are treated in a separate section, and have not been included in the main tables. The bones were examined at the Ancient Monuments Laboratory, identifications being carried out by comparisons with the reference osteological collection housed there.

For the method of recording see Jones (1978) which describes the semi-automatic recording device used. The standardized method involves recording a number of attributes for each bone including species, anatomy, measurements, fragment size, gnawing, butchery, pathology and ageing information. Data recorded on punched paper tape was processed by computer using the Honeywell Timesharing Service (now Geisco), and archival catalogues of detailed non-metrical and metrical listings, including primary statistics were compiled. Catalogues for the entire site (see archive), and for sub-divisions by archaeological phase have bee produced, (stored at the Ancient Monuments Laboratory). Further analysis of this sub divided data was aided by computer tabulation programmes (Jones, 1978), which produced tables of various aspects of the non-metrical data. The metrical information was displayed graphically using a micro-computer (Research Machines 380Z) to aid analysis.

The basic unit used for comparisons is the number of fragments. Bone weights and minimum numbers of individuals (MNI) have not been calculated.

RESULTS

The subsoil of the site was on the whole sandy, well drained and somewhat acidic, but in spite of the acidity, preservation of the bone was good, though brittle. Many bones had a black, mottled surface and erosion or pitting, which may have obscured surface details, was not uncommon. Despite the large sample recovered, comparatively few measurements could be recorded due to the fragmentary nature of the material.

Only a single identifiable fish bone was recovered, from one of the sieved samples. This general lack of fish bones may be due to their fragility and poor survival. One might have expected fish to constitute an important part of the diet on this coastal site, and use of marine resources is evidenced by the study of the molluscs (Bond, *see archive*). The bird bones are considered in a separate section at the end of the main bone report. Apart from a few amphibian bones, the rest of the bones were mammalian, and came from the following species.

The domestic animals were cattle (Bos sp., domestic), sheep (Ovis sp., domestic), goat (Capra sp., domestic), pig (Sus sp., domestic), horse (Equus sp., domestic) and dog (Canis sp. domestic). The wild species found were shrew (Sorex sp) red deer (Cervus elaphus), roe deer (Capreolus capreolus), rabbit (Oryctolagus cuniculus), hare (Lepus sp.,) , rat (Rattus sp), mouse and whale.

The numbers of each element of the anatomy in each species are shown for mammals from the whole site in Table 1. Of the 9 837 bones recovered from the site 9 767 (99.3%) were mammalian, of which 2 735 (27.8%) were identified to species. Not all elements identified osteologically could be unequivocally assigned to species. The problems inherent in distinguishing between sheep and goat bones are well known (Boessneck 1970). These two species were originally recorded as 'ovicaprid' unless definitely identifiable as goat. Only one goat bone was found, and in view of this, all further analyses consider this group as if it were entirely composed of sheep bones. However, it should be borne in mind that a small quantity of goat may be present, especially among the smaller fragments, where the necessary features for sheep/goat distinctions might have been absent. Identifications of small bone fragments may be equivocal, and two categories have been created to deal with these: 'cattle-sized' and 'sheep-sized'. The highly fragmented nature of the Brancaster bone assemblage has necessitated frequent use of these terms, the inclusion of which increases the number of identified bones to 5 697 (58%). As the total number of horse bones is small, in comparison with cattle, it seems reasonable to assume that most of the 'cattle-sized' bones would indeed have come from cattle. Similarly most of the 'sheep-sized' bones are assumed to have come from sheep, as other likely candidates (goat, roe deer, pig and dog) occur in much smaller quantities. These groups (cattle with 'cattle-sized' and sheep with 'sheep-sized') have therefore been combined for certain analyses.

A comparison of the total number of bones recovered from each phase is shown in Figure 1. A brief consideration of the bone assemblages from the different archaeological periods of the site is given below, but as the bulk of the material came from the Roman period, the rest of the report will be concerned mainly with this, unless otherwise stated.

Neolithic

No bone was recovered from this phase.

Beaker

The number of skeletal elements for each species is shown in the archive. Only eleven bones were recovered from the Beaker phase (0.1% of the total bone recovered from the site), of which nine could be identified. As well as cattle and sheep, there is evidence for the presence of dog on the site at this time, as four bones (of both cattle and sheep) showed signs of canid gnawing. Four bones (a radius and a rib of both cattle and sheep) also showed signs of butchery in the form of knife-cuts and chop-marks, suggesting that the bone remains were food refuse.

Bronze Age

The number of skeletal elements for each species is shown in the archive. Of the 155 bones recovered (1.5% of the total bone recovered from the site) fifty-seven (36.7%) were identified. As well as cattle and sheep, pig and horse were recovered from this phase. Though no dog bones were found, its presence was suggested by canid gnaw marks on five bones, all of cattle. Signs of butchery were present in the form of chop marks (on eleven limb bones of cattle and sheep) and knife marks (on six bones: cattle vertebrae and sheep limb bones).

Iron Age

The number of skeletal elements for each species is shown in the archive. Of the seventy-one bones recovered (0.7% of the total bone recovered from the site) forty-one (37.8%) were identified. Four species were represented: cattle, sheep, horse and dog. Evidence for dog was also present in the form of three gnawed bones (one each of cattle, sheep and horse). Butchery marks were recorded: chop marks on four cattle and two sheep bones, and knife cuts on two cattle bones). No significance can be attached to the absence of pig due to the small sample size.

Roman

The Roman period of the site was divided into two periods of occupation. The number of skeletal elements from the different species for the earlier Roman period is shown in Table 2. Of the 8 041 bones recovered (81.6% of the total bone recovered from the site) 4 544, (56.5%) were identified.

The number of skeletal elements for the different species recovered from the later Roman period is shown in Table 3. Of the 630 bones (6.4% of the total bone recovered from the site), 374 (59.4%) were identifiable.

In order to decide whether these two groups could be amalgamated for analysis, the two periods were compared statistically by means of contingency tables. Three criteria were used to test for differences between the two periods, these were: number of bones from each species, fragmentation, and butchery, (see archive for statistics). Though the data are crude and ignore such factors as sampling bias and differential bone deposition and preservation, it seems fair to infer that there was no significant difference in butchery and fragmentation of both cattle and sheep from the earlier and later periods. (Significance was assumed when a particular value of chi-squared (X^2) compared to a probability of 0.5 or less). Thus these topics are considered for the Roman phase as a whole.

On the other hand the species composition showed highly significant differences between the two periods. A drop in the number of cattle bones occurred with an accompanying rise in sheep and pig numbers from the earlier to the later Roman periods. The significance of this will be discussed in a later section.

Post-Roman

The number of each skeletal element from the different species is shown in the archive. Of the 865 bones recovered (88% of the total bone recovered from the site), 455 (52.6%) were identifiable. This bone assemblage represents a heterogenous collection from a large time span including mixing from other phases, largely Roman, and no firm conclusions can be drawn.

FRAGMENTATION, BUTCHERY AND CARCASS UTILIZATION

The bone fragmentation pattern that we see in an excavated archaeological bone assemblage is the result of a complex interaction of processes. The main components are butchery practices, which are considered here under three categories. These are 'primary butchery': the slaughter and initial carcass preparation of the animal for distribution and transport; 'secondary butchery': further butchery involved with preparation of meat for cooking and eating ie mainly carving, and 'tertiary butchery': other practices such as splitting the long bones for marrow.

Further processes occur which are concerned with carcass uses other than food production, but nevertheless affecting the bones, and not always easily distinguishable from butchery, eg marks from skinning, horn removal and glue making. These could be included in the 'tertiary butchery' category, though some (skin and horn removal) might more logically be included in the first category, as they would have been made at an early stage in the carcass preparation.

Gnawing animals (mainly dogs on this site) and burning may further affect the bones. Certain bones may be used as the raw material for making objects such as pins and combs. The final fragmentation pattern will be influenced by the method of disposal. The bones may also have been crushed and spread on the fields as fertilizer a practice possibly in use by the Romans, who may well have been aware of the value of calcium and other nutrients in bones. Refuse may have been thrown into pits or ditches - recent work suggests that these have differing preservation properties, the nature of which will depend upon the type of site (Griffith 1978). The bones may be broken to a greater or lesser extent before being swept up or alternatively, a new earth floor laid. Subsequent occupation may further disturb the rubbish. Penultimately, edaphic factors will affect bone preservation, the manner of which will also depend partly on the bone matrix condition eg whether or not the bone had been cooked. This is a subject which has not yet received much attention; though Coy (1975) has put forward a hypothesis to explain the variety of bone textures found in archaeological assemblages in terms of cooking techniques.

Finally, excavation and transport to the laboratory for study will inevitably take its toll, to an extent dependant on the bone condition.

In order to interpret the bone assemblage, we must separate the affects of these various factors. To attempt this, a number of attributes for each bone fragment have been recorded. These are: skeletal element, part of bone (proximal, midshaft or distal), size of fragment, position and type of butchery marks, and gnawing (severity and causal species). It was hoped to determine from this how the carcass was butchered and its subsequent utilization: for this purpose a number of aspects of the data were analysed. These were:-

1. The relative proportions of the different skeletal elements. From this it was hoped to show whether there was any selection of particular parts of the anatomy which might indicate whether animals were butchered on site, or transported there as dressed carcasses, and whether any selection was occurring for specialised industry (eg horn or bone working, tanning).
2. Analysis of overall fragmentation pattern. The range in fragment size of each bone is displayed graphically. Pie diagrams show the proportions of bones from the different fragment-size categories, as well as the part of the bone present (ie proximal, midshaft or distal).

3. The overall butchery pattern was displayed graphically to show the percentage of chop and knife marks respectively on proximal, midshaft and distal parts of each bone.

4. A detailed analysis of the position and type of butchery mark made on individual bones was described and illustrated by diagrams. The interpretation of this shows how the carcass was dismembered. This is compared with modern practice (Rixson 1976(a) and (b) and MLC 1977) and with other Roman sites where a similarly detailed analysis has been carried out (Grant 1975, and Maltby 1979).

5. An indication of the contribution of butchery to overall fragmentation at Brancaster was gained by comparing fragmentation of cattle, sheep and pig with horse and dog. We consider that the latter two animals have not been butchered or eaten at this site.

The method of derivation of figures for constructing the diagrams is given below, with definitions of the butchery descriptions used. These may seem obvious, but the distinction between natural fractures and butchery marks is not always clear cut. Data for the diagrams are given in the archive. The analysis is mainly confined to cattle and sheep, as there is insufficient pig bone for a detailed study. As mentioned above, bone from earlier and later Roman periods was combined for this analysis, as statistical tests showed no significant difference in the attributes considered. A brief comparison is then made with the other occupation periods of the site.

Terminology. The type, position and direction of any butchery marks on the bone were located relative to the bones' position in a live standing animal. The terms chopped, knife-cut and sawn are based on experimentally produced marks and are defined as follows:-

Chopped is the mark resulting from a heavy sharp implement slicing through the bone, similar to the mark left by a modern cleaver.

Knife-cut is the mark resulting from a light, sharp, thin-bladed instrument. The mark has a distinct 'V-shaped' cross section and does not usually penetrate the bone cortex. A similar mark can be made with a modern hand-held knife.

Sawn is the mark which exhibits parallel ridges on the cut surface of the bone. A modern equivalent can be produced by cutting into a bone with a saw. (Seven sawn bones were recorded, all from the earlier Roman period, but these are not considered further, as it has not been possible to ascertain whether they were the result of butchery or bone-working).

Split is used to describe bones which may have been split open, perhaps for marrow extraction. The term is imprecise, as a certain degree of splitting always occurs with chopping and there is no definite way of telling it from naturally broken bone. This can be a rather subjective description: we have used it to describe fractures that seem to us to be the result of artificial processes but where no unequivocal butchery marks can be found.

Methodology and interpretation

1. The relative proportions of skeletal elements for cattle, sheep and pig are shown in Figure 2 as number of fragments against skeletal element. Numbers for cattle and sheep include 'cow-sized' and 'sheep-sized' fragments respectively - but vertebrae and ribs are not included.

This shows up a number of similarities and differences between the three species. The quantity of pig bone is too small for any firm conclusions to be drawn from the data. For cattle, sheep and pig, all body parts are represented, this suggests that for all three species, on-site butchery was occurring, with no significant removal of parts after carcass preparation. Paucity of representation of certain bones may be due to their small size, and hence reduced recovery and survival (eg phalanges, calcaneus and astragalus). Over representation of other parts, such as the skull and os coxae of cattle may be attributed to their much fragmented state, together with comparative ease of recognition of even small fragments of these bones compared with small fragments of limb bone shafts, which may be very difficult to assign to a particular bone.

2. Overall fragmentation pattern. For the diagrams, cattle and 'cattle-sized' fragments are combined, as are sheep, goat and 'sheep-sized' fragments. The number of bones in each of the six fragment size categories (viz <25%, 25%, 50%, 75% and 100%) was counted. For the first diagram <25% is combined with 25%, and >75% with 100%, thus giving four size-categories viz 25% and less, 50%, 75%, and more than 75%. For each skeletal element, the number of fragments in the different size categories is expressed as a proportion of the total number of fragments for that bone, and this figure is converted into degrees for the pie charts. A similar procedure is carried out for the different sized fragments coming from different areas of the bone ie proximal, midshaft and distal, but this time any whole bones are obviously excluded, and so the size categories are as follows: 25% and less, 50%, and more than 75% but less than 100%. A final diagram is constructed using figures for fragments which are proximal, midshaft, distal or whole. In figure 3, we see that the skull and ribs of cow and sheep are represented almost entirely by very small fragments. In the vertebrae of cattle, there does not appear to be a significant difference in treatment over the different parts of the spine, whereas in sheep, there are more large portions of cervical than of lumbar and thoracic vertebrae. The vertebrae of sheep seem to have been more fragmented than those of cattle. Although the skulls of both are very fragmented, the mandibles of both species have a greater proportion of larger fragments. Looking at the forelimb, sheep scapulae seem to be more fragmented than those of cattle. The humerus, radius and ulna are all more fragmentary in cattle than sheep, and the metacarpal is markedly more so, whereas the phalanges exhibit a similar pattern, being nearly all whole bones in both cases. (Fore and hind limb phalanges are treated together, and for sheep, first, second and third phalanges are treated as one group, because of the small numbers involved). Now looking at the hind limb,

the os coxae of both species are mainly in small fragments, though there are more sheep bones in the 50% size fragment size category than there are of cattle. The femur and tibia again show a similar pattern, but there is a slightly higher proportion of larger fragments in the smaller animal. The calcaneus and astragalus show the most marked differences, both of which are nearly always recovered whole in sheep, but are fragmented to various degrees in cattle. The metatarsals also show a differing pattern similar to that described above for the metacarpal. Thus, within a species, there seem to be certain similarities between the fore and hind limbs. In both sheep and cattle, the scapula and os coxae and humerus and femur are somewhat different, whereas the radius and tibia, and metacarpal and metatarsal patterns are remarkably similar. Similarities and difference also occur between the two species. Similar fragmentation patterns are seen in the skull, mandible and rib, and to a lesser extent in the major limb bones, and in the phalanges. Differences are apparent mainly in the calcaneus and astragalus and metapodials (metacarpals and metatarsals). It is probable that the similarities between the two species are due to certain common practices in butchery, together with survival abilities common to certain bone structures regardless of size. The differences might be explained by there being a slight variation in the loci and type of 'primary' butchery between the two species, as well as differences in 'tertiary' practice eg bones that are entirely waste in sheep may have been utilised from cattle. This is discussed more fully in conjunction with the butchery.

Figures 4, 5 and 6 show the relative proportion of bones in the different size categories for proximal, midshaft and distal fragments respectively. Vertebrae are only considered from the midshaft category. In all three diagrams, much greater differences than those exhibited in figure 3 are apparent between the fore and hind limb of the same animal, and between the two species. In figure 4, we see that for both species, where the proximal epiphysis of humerus, femur, and tibia occurred, these were small sized fragments, and they rarely had much shaft attached. Proximal parts of calcaneus and metapodials of sheep often had much of the rest of the bone attached, whereas the same bones of cattle could come from a variety of fragment-size categories. A similar picture emerges from an examination of midshaft and distal fragments. These three diagrams need to be interpreted with greater caution than figure 3, because of the obvious reduction in sample size necessitated by this further subdivision. This could exaggerate differences especially in a bone like the scapula, where estimation of size category may be complicated by the irregular shape of the bone.

Figure 7 shows the proportion of bones which come from proximal, midshaft and distal areas of the bone. It is apparent that the majority of fragments recovered came from the midshaft region of the bone, with the exception of the smaller bones, many of which were found intact (eg sheep calcaneus, astragalus and phalanges, cattle astragalus and phalanges). The proportions of proximal and distal fragments vary from bone to bone, but, for each bone element, are similar between the two species.

3. Overall butchery pattern. As for the previous diagrams, cattle and 'cattle-sized' and sheep and 'sheep-sized' are considered together. The number of whole bones was added to each of the numbers for proximal midshaft and distal fragments respectively (ie whole bones are counted three times). The numbers of chop and knife marks found on proximal, midshaft and distal parts of each bone are expressed as a percentage of the total number of fragments from that part of the bone. Certain parts of certain bones have been combined for ease of presentation on the diagrams. These are:- radius and ulna, distal calcaneus and astragalus. With the exception of the first two cervical vertebrae (atlas and axis). the vertebrae are treated in their anatomical groups viz all other cervical, thoracic and lumbar, and they are not divided into proximal, midshaft

and distal. Each bone on the diagrams has been arbitrarily divided into proximal, midshaft and distal portions, and then shaded according to the percentage of butchered bones occurring, but the proximal and distal butchery will include a large amount on the actual joint articulations, which cannot be shown on the diagrams. Figures 8 and 9 give an overall view of the butchery practice for cattle and sheep respectively. Chop marks are, on the whole, more common than knife marks, and cattle show a higher general incidence of butchery than sheep. The chop marks represent major dismembering points, but knife marks are more likely the result of severing ligaments, meat removal or skinning. The cattle skull and first cervical vertebra are chopped - presumably to remove the head, whereas on sheep, this is done with a knife. The cattle mandible is chopped and knife-cut, while the sheep mandible is virtually free from butchery. The thoracic vertebrae of cattle are often chopped, whereas those of sheep are occasionally knife-cut. The ribs of both species are butchered in the midshaft region suggesting they were removed whilst still attached to the vertebrae as 'chops'. Considering the forelimb, major severence points in cattle occur at the distal scapula and distal humerus, whereas in sheep the midshaft scapula and midshaft radius are the most heavily chopped areas. The midshaft metacarpal is often chopped and knife-cut in cattle, whereas in sheep, this bone has proximal knife cuts only. On the hind limb, it would appear that the femur was separated from the pelvic girdle by chopping - in cattle nearer the proximal end of this long bone than in sheep. The calcaneus and astragalus are chopped in cattle but knife-cut in sheep, and in each animal, the metatarsal is butchered in a similar fashion to the metacarpal. It would seem that a large cleaver was used to dismember cattle, whereas sheep joints were more often separated with a knife, and though cattle metatarsals were often butchered in the midshaft region, possibly for marrow extraction, the sheep skeleton was not utilised below the metapodials. This study is meant to complement the detailed analysis of butchery, (see below) which in itself gives a qualitative account of how the carcass was utilised. The diagrams give a quantitative overall picture, and it is hoped to use this method comparatively with other sites in the future.

4. Detailed butchery analysis. Composite diagrams to illustrate the major butchery practice for cattle and sheep are given in figures 10(a) and (b) respectively. The interpretation of these is given below.

Cattle

All the skulls were very fragmentary, and so it was not possible to determine whether pole-axing was used as a method of killing the animals. However, on the most complete skull, the frontal bones were intact (Plates 1 and 2). The fragments most frequently recovered were from the occipital and frontal regions, which are the most robust parts of the skull. The horn cores have been removed from the skull by chopping, usually, with part of the frontal bone attached. Knife-cuts occurred on the maxilla above the second molar, and also on the frontal bone (Plates 1 and 2). These could have been made in removing the skin from the skull prior to removal of the horns. It appears at Brancaster that the skin was removed from the head, and above the phalanges, though not all of this need necessarily have been used. The occipital condyles have been chopped through, as have the cranial articular processes of the atlas vertebra. It seems that the head was severed from the body between the skull and atlas vertebra. In a few cases, the skull might have been split along the sagittal plane, in a similar manner to the sheep skulls (see below). There are knife-cuts on the basilar part of the occipital bones in a mediolateral plane. The stylohyoid bones also have knife-cuts on both sides. These could both have resulted from removing the tongue.

There are knife and chop marks on the buccal surfaces of the mandible, which has usually been fragmented so as to remove the condylar and coronoid processes above the mandibular foramen from the rest of the mandibular ramus viz: the tooth bearing portion: this would have separated the mandible from the skull, leaving the upper part with the articulation in situ. This was probably done in order to remove the cheek meat, and possibly also the tongue. Where the anterior end of the mandible has survived, this has been cut or chopped in the region of the diastema. On one skull, a possibly corresponding chop mark on the dorsal surface of the incisive bone was noted. Both of these could have been to separate the mandibles from each other and again, to remove the skin and/or meat.

That the occipital condyles of the atlas vertebra were invariably chopped through has already been mentioned. One axis vertebra and another cervical vertebra have been chopped through along the sagittal plane, though the majority have remained whole. The thoracic vertebrae were not split in this way, but often the neural spine had been chopped through where it joins the neural arch. Occasionally, the body of the vertebra was chopped through transversely, and one or other transverse process chopped off. The ribs were often cut or chopped from both dorsal and ventral aspects, but not particularly at the articulation. The lumbar vertebrae were occasionally split sagittally. and the transverse processes chopped off. Others were chopped through the centrum from the ventral surface and the spines cut from the ventral and dorsal surface parallel to the spinal column.

The proximal end of the scapula was rarely preserved. One bone, on the medial aspect, had knife-cuts near the proximal end, possibly incurred in removing this fore limb from the body. On the lateral side, the acromion process of the scapula spine had often been cut through in a manner suggesting meat being sliced off from the blade. It is conjectured that this might have occurred after cooking as found at Portchester (Grant 1975, 392). The distal joint surface (glenoid cavity) invariably displayed chop marks. Sometimes the coronoid process had been chopped through on either side of, and parallel to, the blade of the scapula.

The proximal humerus rarely survives (for reasons mentioned elsewhere, see p 24), and so butchery corresponding to that of the distal scapula has not been recorded. The distal humerus, however, was invariably butchered. The distal condyles of the trochlea and capitulum had been chopped through and/or there were knife-cuts on the distal diaphysis mediolaterally on the anterior surface, either side of the radial fossa.

The proximal radius and ulna possess chop marks in varying places, which might correspond to those on the humerus. Sometimes the olecranon process of the ulna has been chopped off, whilst on other individuals the anterior proximal radius and the trochlear notch of the ulna have been chopped. In others the radius and ulna are chopped or split in the midshaft region. It is thought that this might be a secondary butchery process. The distal radius is often chopped through.

One metacarpal was chopped in the midshaft region. Another was cut across the distal condyles on the anterior surface in a position consistent with that of marks on the phalanges. The first phalanx invariably had knife-cuts on all surfaces, presumably a result of separating the metapodials from the phalanges, and possibly in skinning the animal. (Fore and hind phalanges were not studied separately).

The os coxae was chopped through the acetabulum or through the adjacent shaft of the ilium. The head of the femur has been chopped through in most cases, consistent with butchery on the os coxae. The distal femur and proximal tibia rarely survived and when they did, were in a very fragmentary state. The midshaft of the tibia was chopped through and the distal epiphysis has usually survived intact.

The calcaneus was chopped posteriorly above the groove for the Achilles (calcaneal) tendon. Sometimes, the distal articulation was chopped through. The astragalus was often chopped through in various positions, and had medio-lateral knife-cuts across the anterior aspect. Centroquartals were usually found whole. The metatarsals were sometimes chopped proximally or through the midshaft and one was split longitudinally similar to the method used in Saxon times presumed to be for marrow removal (Grant 1976, 272-273). One was sawn just below the proximal articulation probably to use the midshaft section for bone working.

Sheep

The skulls have been split along the sagittal plane. The parietal and frontal bones were the most commonly surviving fragments. The animals had their horn cores removed, or in a few cases were naturally polled. Knife-cuts were observed on the basilar part of the occipital bone in a mediolateral direction similar to those described for cattle. Possibly, the occipital condyles were chopped through, but the only surviving fragments from this skull region were much eroded, and it was not possible to be definite about interpretation. Mandibles were cut near the diastema. The atlas vertebra was split sagittally and had knife-cuts dorsally on the caudal articulatory process, possibly due to removing the atlas from the skull. On the cervical vertebrae the transverse processes were chopped through. The body of one was also chopped.

The neural spines of the thoracic vertebrae were chopped. The ribs had chop marks and knife-cuts, usually on the internal surface.

On the distal end of the scapula, there were knife-cuts on the lateral aspect of the glenoid cavity. There are also holes through the distal scapula (cf tibia, see below) whose purpose is unclear.

As for cattle, the proximal humerus was rarely recovered. However, butchery was noted on the distal humerus where either the lateral midshaft was chopped or the distal articulation chopped through medio-laterally from the posterior surface.

The proximal articulation of the radius was chopped off, or there were mid-shaft chops on the medio-posterior surface.

On the os coxae the acetabulum was chopped through. Holes were also observed on some specimens. Chop marks were seen on the caudal ischium, possibly the result of separating the two halves of the pelvic girdle, working from the ventral side of the animal. No butchery was noted on the femur. The proximal tibia rarely survived but lateral chop marks were found on the midshaft. A hole through the distal end of the shaft was frequently observed, and similar holes have been noted elsewhere by the authors in deposits from various periods and on a Roman sheep at Staines (Chapman, in press). It is possible that this might have been used for hanging the joint. However, legs of lamb may be seen in butchers' shops today hanging from the Achilles' tendon, which suggests that it is unnecessary to put a hook through the bone for this purpose, and so these holes in the archaeological specimens may have had some other function.

The distal articulation of the calcaneus was chopped through, and knife-cuts on the astragalus laterally and dorsally were observed, similar to those described for cattle. Knife-cuts occurred on the proximal metapodials which may be from skinning.

Pig

Very little butchery was recorded from pig. Of particular note, the spine of the scapula was sliced through in a similar manner to cattle (see above). This did not however occur on sheep. The spine of the pig scapula bends back on itself in such a manner that it might impair easy removal of the meat without cutting the bone, as can be done on sheep, where the spine is virtually at right angles to the blade. The scapula also had distal knife-cuts similar to those described for sheep. The distal articulation of the humerus was chopped through as was the midshaft tibia.

Comparisons with other sites

Butchery at Brancaster was compared with that at Exeter (Maltby 1979) where bones from a number of sites within the city have been studied including both military and residential areas and covering a time span from 50 AD to the early 5th century and Portchester Castle (Grant 1976) a military fort. Similar butchery implements were in use at all three sites.

Cattle

At Portchester, evidence for pole-axing of cattle was found, but the skull material from Exeter, like that at Brancaster, was very fragmentary, which Maltby (1979, 38) interprets as deliberate smashing for removal of the brain. At all three sites, the horn cores had generally been removed with a portion of skull attached. This could have prevented damage to the horn sheath and allowed the entire horn to be utilised. Marks on the mandible and skull are again similar, indicating removal of the jaw and possibly also the tongue. At Brancaster, as at Portchester, the head was removed from the body between the skull and the occipital condyles. At Exeter, vertebrae from the earlier Roman deposits were not split, whereas at Portchester they were split sometimes sagittally, sometimes at right angles to the spinal column and sometimes along both planes. Grant (1975, 392) suggests that this might be due to a difference in butchery technique between animals for immediate consumption and those for storage or transport. At Brancaster, the majority of the vertebrae were entire, but occasional sagittal or transverse splits did occur, and on the thoracic vertebrae, 'chops' seem to have been cut through the distal ribs and the articulatory processes for the ribs on the vertebrae. Marks on the ribs also occur at Portchester and Exeter. At both these sites, the authors consider the fore-limb to have been removed from the body between the distal scapula and proximal humerus. At Portchester, the glenoid cavity itself is butchered, as at Brancaster, whereas at Exeter, it is more often broken at the point where the spine begins. This is also an area of heavy butchery on the Brancaster bones, but it is quite possible that the limb would have been separated between the proximal scapula and the body, by cutting through the musculature, as this is the easiest way to remove a fore-limb. In modern practice, the carcass is first quartered, and then the limb removed between the humerus, and the radius and ulna, after which, the humerus and scapula are removed from the trunk of the carcass before they themselves are separated.

From all three sites, cuts at the elbow joint - notably on the distal humerus - are probably the result of removing meat rather than severing the joint, and the distal radius is often chopped through; this could be for the removal of marrow (Maltby 1979, 39) or for separating the metacarpal from the radius.

The hind limb, seems to have been severed from the body at the hip joint, as evidenced by marks on the proximal femur corresponding with those on the acetabulum from all three sites. The tibiae from Brancaster and those from Exeter were always very fragmentary. There is evidence from all three sites that the legs were severed again above the metapodials, and that the latter were often broken in the midshaft region presumably for marrow extraction. Knife-cuts on phalanges occur at Brancaster and Portchester, and seem to result from severing the foot from the rest of the limb, or skinning, but these marks are rare at Exeter.

Sheep

Sheep skulls were chopped through along the sagittal plane at all three sites, presumably in order to remove the brain. But apart from this, not enough information was available to build up a picture of butchery practice at Portchester (Grant 1975, 392) - At Exeter Maltby (1979, 53) suggests that the scapula and humerus comprised a single joint, as the distal humerus was a common severance point. The meat from the radius may have formed a separate joint, or have been used in stews, and the distal radius was a common butchery point, where the feet of the animal were severed from the rest of the carcass. The midshaft tibia was commonly chopped, and today many leg joints of lamb are broken off at roughly the same point. These observations seem to hold true for the Brancaster sheep carcasses also.

Comparison with modern butchery practice

It is difficult to determine exact butchery technique from bone remains. Present day butchery practice for cattle is to hang up the carcass, split it down the body's axis, then quarter it. Each quarter is then further butchered on a table, by removing the limb in sections, working from the distal end of that limb. However, it seems that this was not so in Roman times. When dealing with an entire carcass, as was probably the case with this archaeological material, it is more likely that the whole limbs were removed from the complete carcass, perhaps while it was on the ground, and then each limb further butchered, possibly on a table, as this would be a more manageable way of handling the carcass. The limbless carcass would then be further butchered, as has been recorded for Roman material in London (Armitage 1979) by chopping off the ribs through the transverse processes of the thoracic vertebrae. This could be done either on the ground or on a table. The vertebrae could then be separated into sections, either by chopping, or by separating the ligaments between a pair of vertebrae with a knife. It seems unlikely that the present day practice of boning a joint occurred in Roman times. However, the occasional finds of entire bones could be attributed either to such a butchery technique, or to the bones in question having came from a carcass which was not eaten for some reason.

5. Statistical Analysis of Fragmentation

A series of X^2 contingency tests was done in order to determine whether there were differences in the overall fragmentation patterns of different species (cattle, sheep, horse, pig and dog). Comparisons were made of all possible pairs of species for the distribution of bones amongst the six fragment size categories previously mentioned. The results are set out in Table 4 in rank order: The level of significance was taken at the 0.5% probability level.

From this it can be seen that those groups which were not significantly different at a probability level of 0.5% are sheep and pig (similarly sized food animals) and horse and dog (non-food animals dissimilar in size). All other combinations of species showed significant differences at a probability level of 0.5%. From this we conclude that the main cause of the differences in fragmentation pattern between species is due to butchery. However, butchered animals also differ significantly, depending on the size of animal involved. This was exemplified by X^2 contingency tests on sheep, cow and pig to elucidate butchery differences. The different combinations of pairs of species were compared for a. knife and chop marks b. per cent of knife marks c. per cent of chop marks. The results of these show that overall butchery patterns differ between cow and sheep as do the chop-marks, but there is no significant difference in the percentage of bones with knife marks. The results from tests between sheep and pig, and cow and pig must be treated with caution as the total number of pig bones is so low. No significant differences were detected in the latter tests. Nevertheless, from looking at the rank order (see archive) it appears that sheep and pig are more similar than cow and pig, as might be expected from their similarity in size.

These tests show the effect of differential survival: though dog and sheep are similarly sized animals, they are fragmented in significantly differing manners because sheep are butchered and dogs are not. A similar comparison may be made between cow and horse. Despite their size differences, horse and dog do not differ significantly in their fragmentation pattern. A major factor in this difference is the presence or absence of butchery. However, this is not necessarily the only factor: differential preservation of the bones within a species has been studied by Brain (see Grant 1976, 384) the maturity of the individual animal will also affect bone preservation. For example, the epiphyses of dogs fuse relatively early in life. (See Silver 1970, for a comparison of age of fusion data in the domestic animals). Thus one might expect differential survival between this and an animal with later-fusing epiphyses, as for example, there might be more uniform preservation of bone which is fully adult. Late-fusing epiphyses such as the proximal humerus, are less likely to survive. This is compounded by these same bone parts often being of a more porous nature than other, early fusing, epiphyses. Similarly, animals kept for reasons other than food production are likely to be kept to a greater age, and thus horses might generally be older than cattle, and a similar argument to the above apply. Also the ages at which food animals reach optimum meat yields vary. One might expect wild food animals to show a different pattern again; a group for hunted animals might have a different age structure, and a wild animal carcass might not have been utilised in quite the same way as a domestic animal of a similar size. For example, a red deer caught on a hunting expedition might be preliminarily butchered for transport and only the more valuable parts bought back to the site. However the latter instance is entirely conjectural for this site, as there was too little deer bone for any comparison to be made with the other mammals.

To test some of the above hypotheses, X^2 tests were done on the distribution of fragments between proximal, midshaft and distal fragments, and whole bones, for all possible combinations of the five species under consideration. Significant differences occurred between all combinations of species except sheep and pig (see archive).

Finally, the pie diagrams in figure 11 illustrate the overall similarities and differences: note the similarities between all the food animals, especially sheep and pig when compared with horse and dog. The latter two animals were not eaten at this site, as has already been stated, but this is not invariably the case. Cramm considered horses to have been eaten at the Roman site of Hockwold, and indeed, to have been third in importance to cattle and sheep, being a more important food source than pigs. He infers this from the fact that horse bones are indiscriminately mixed with the bones of the usual food animals (see Salway, 1970, 14). The authors have observed butchery marks on other Roman material: on dogs from Dorchester and horses from Penrith (in preparation). The former seemed to be marks from skinning, while the latter were consistent with meat-eating. Harcourt (1974, 171) states that there is much evidence and informed opinion to support the use of the dog as a food animal. Literary evidence suggests that horse would only have been eaten in dire circumstances. Tacitus writes that the troops of Germanicus, shipwrecked on inhospitable shores in AD16, ate horsemeat because there was no other supply of food (Davies 1971, 139).

A similar observation on differential fragmentation between species has been made by Griffith (1978) who looked at the range of average fragment sizes and noted that the more heavily utilised species are more uniform in their fragmentation than the less heavily, more randomly fragmented species. This he attributes to post-butchery carcass utilisation eg processes such as boiling of smashed bones for stock or marrow extraction.

Discussion

In summary, considering the food animals, the larger meat-bearing bones are more fragmented than the smaller, non-meat bearing bones. This distribution pattern can probably be largely attributed to butchery practices, which may also account for the differences apparent between cow and sheep: as the cow is a larger animal, bones would have to be cut up into smaller pieces for easy handling during transport and for cooking. The sheep carcass, on the other hand, is small and manageable, and so the bones are more likely to survive whole. Take, for example, the calcaneus and astragalus: these were nearly all whole bones from sheep, whereas in cattle less than half the calcanei and less than one quarter of the astragali were whole. These bones in cattle were also heavily butchered, presumably in jointing the carcass. Other bones are more likely to be fragmented due to their fragility - possible examples are the ribs and skull, although the skulls may have been smashed to extract the brain. Interpretation of fragmentation patterns is thus complicated by the presence of butchery, and fragmentation due to other causes. The latter, such as bone condition, disturbance etc might better be examined by reference to faunal remains of non-food animals such as dog and horse. A useful comparison can be made between these two non-food domestic animals and food animals of a similar size with the caveat that differences may also reflect factors other than butchery, though not unrelated to food production, for example, population age structure.

AGE AT DEATH

There are two methods by which the age of an animal at death can be determined. These are firstly, the state of epiphyseal fusion of the long bones and secondly, tooth eruption and wear of the mandibles. The first method exploits the fact that the epiphyses of all the different long bones of a mammal fuse at different periods in its life, and these are constant within a prescribed range, for different species. The actual fusion dates are, however, dependant on various environmental factors such as plane of nutrition, and breed. For this reason, actual data derived from modern animals (Silver 1969) are not quoted as they are misleading. Nevertheless, it is assumed that the order of fusion will not have changed and so, instead of assigning actual ages to the animals, they are grouped into age classes (Chaplin 1971, 128-130) in Table 10. The results are expressed as a percentage of unfused bones to the total number of bones for each age class. This has been done for cattle and sheep, but there was not sufficient data for pig. Recently, aspersions have been cast on this method by Watson (1978) who states that data derived in this way are misleading for a number of reasons. The fusion dates are not fixed points but ranges. For simplicity these ranges are not usually taken into account, and by amalgamating bones into age groups it is hoped that any discrepancies will be eliminated - but they may equally well be exaggerated. As we have not used the MNI method, but number of fragments only, these have been used directly in the ageing data.

For the purpose of age estimation we make the assumption that more bone is destroyed in antiquity than is recovered during excavation and so each bone probably represents the remains of a single individual. A bias might have been operating among certain bones to select either mature or immature bones. For example, recovery of immature metapodials might be favoured if the mature bones were preferentially used for bone working; and immature bones are probably less often recovered because the texture of growing bone is more porous than that of mature bone, and is consequently more rapidly destroyed, though the extent to which this occurs remains unknown. Other important points to bear in mind are that the sexes may mature at different times, and castrates will further confuse the issue. This means that in considering ovicaprid material, where sheep and goat have not been separated, there is the possibility that we are dealing with up to six groups with slightly different, probably overlapping, ages and so any interpretation must of necessity be tentative.

In the second method, use is made of the assumption that the order of tooth eruption within a species is constant, and the degree of attrition increases the longer a tooth has been erupted. Again, the actual ages of tooth eruption will be dependant on several factors and the degree of attrition will be influenced both directly and indirectly by various environmental parameters. For example, the quantity of sand in the soil will directly affect attrition rate by its abrasive action on the occlusal surfaces of the teeth, and lack of calcium in the diet may cause the teeth to be softer than normal, and hence to wear down faster. For these reasons, development stages are again used rather than actual ages. These are shown in Table 5.

Data relating to teeth are complex and can be displayed in several ways, either considering individual teeth or whole mandibles. Maxillae are not used as insufficient comparative work has been carried out on them and this would, in any case, merely duplicate data derived from the mandibles. Table 6 shows the various wear stages for all the teeth (excluding incisors) in the mandible for cattle and sheep. The results for ages derived by both methods are displayed graphically in Figure 12 for cow and sheep. Watson (1978) stresses the importance of abandoning bar charts and histograms as a means of comparison for this type of data, and proposes that any comparisons with other sites should be made using statistical tests such as Yates X^2 test or Fisher's exact probability test on each element in turn. We have not done this here, but the necessary data are given in the archive. The good correlation between the histograms for ages derived from bone and tooth data for both cattle and sheep may be fortuitous, but we suggest that it offers hope for the relatively simple age determination methods used.

The overall picture seems to show that for both sheep and cattle, the majority of animals killed were mature, or sub-adult. A histogram of deaths in a 'natural' population might be the opposite to that seen here. The evidence can be interpreted in a number of ways but the decision as to which is the correct one must await further discoveries. The absence of younger animals could be because the majority of meat was imported from elsewhere - perhaps by sea, as salted carcasses, but more likely 'on the hoof', as the fragmentation analysis indicates that whole animals were butchered on the site (see p 9). Alternatively, the remains of meat eaten on the site, may represent only a selective portion of the slaughtered animal stock, and the younger, perhaps choicer, carcasses, may have been consumed elsewhere - perhaps within the fort at Brancaster.

Uerpmann (1973, 316) considers that, in prehistoric times, the optimal slaughter ages for animals reared for their meat would have been approximately: pig 1½ years, cattle 2½-3½ years and small ruminants 1-2 years. The Brancaster data give the ages at which the maximum numbers are slaughtered as, at least 3 years (age class 4) for sheep and at least 2½-4 years (age classes 3 and 4) for cattle, from the limb bones, and at least 2 years (age class 4) and at least

2½-3 years (age classes 3 and 4) respectively, from the teeth. This suggests that the primary purpose for which both species was kept was something other than meat production. These could be milk or draught for cattle, and milk or wool for sheep. One should bear in mind that earlier cultures would have made maximum use of their stock. Sheep destined for the meat market would most likely have been kept until at least one fleece had been obtained from them. Cows would be used for draught purposes, as well as oxen, and Columella recommends that they are allowed to calf only every other year, so as not to weaken them unduly (White 1970, 277-278). The paucity of pig remains does not permit a similarly detailed analysis, but as might be expected, the majority of pig bones came from immature animals.

METRICAL ANALYSIS

Where possible, measurements were taken on all identified mature bones. The points of measurement followed those of Jones (1978) and where comparable, the ones corresponding with those given by von den Driesch (1976) are indicated The standard number of measurements per bone ranges from one to twenty, depending on the complexity of the bone element. These same measurements are made on all bones recorded at the Ancient Monuments Laboratory, and in the near future, computer analyses will facilitate comparison of sets of bone measurements from various sites and periods throughout the country. Unfortunately, the previously mentioned fragmentary nature of the Brancaster bone assemblage did not allow many measurements to be taken. At least one measurement could be taken on 47% of the fully identified bones.

Measurements of bones can give us information on a variety of topics. Firstly, they can give us an indication of the size of the animals. Where complete long bones survive, an estimate of the beast's withers height can be estimated. Multiplication factors used here are those of Fock (1966) and Matolcsi (1970) for cattle, and Teichert (1974) for sheep. Estimates were only possible in a few cases, as not many bones survived entire. These are given in Table 7.

Secondly, they allow an easy means of inter-site comparison, and comparison with modern breeds. Some measurements of cattle bones were compared directly with those from other Roman sites (see Table 8). These indicate that the cattle from Brancaster were within the size range already established for cattle of the Roman period in Britain. However, there are not any individuals as small as the lower size range as seen at Exeter, or as large as those in the upper size range as at Portchester. The cattle at Exeter seem to be exceptionally small, whereas at Portchester, the large sample might mean that the extremes of the range are represented, which may not always be found on smaller excavations such as that at Brancaster, simply because they would have been rarer, and their chances of survival and recovery concomitantly smaller due to the laws of chance.

The sheep are compared with those excavated by Pitt-Rivers (1888) from Woodcuts and Rotherley and also with the measurements of some modern breeds which he gives. They are rather longer limbed than the Soay ram which he measured, but not usually as big as the Hampshire Down ewe and they have the generally slender build and slim shafts of the Soay and Highland sheep breeds of the late nineteenth century (see Table 9).

Thirdly, it is hoped that any polymorphism will become apparent when measurements are displayed graphically as scatter diagrams or histograms. This, if present, could be attributable to the presence of different sexes if the degree of sexual dimorphism is sufficiently large and/or the presence of different 'breeds'. An analysis of various cattle metapodial measurements gives an indication of two, possibly more, peaks - though these are by no means definitive, and no attempt was made to validify them statistically. Even if these are real peaks, they do not tell us much. Interpretation of such data must remain tentative as there is as yet no definitive way of ascertaining whether sex or 'breed' is the main governing factor in any particular case. If it seems likely that the metrical separation represents the two sexes (and possibly also castrates), the ratio between them may tell us something about husbandry practises and indicate what was the main animal product. For example, where sheep are kept for wool, castrated males (wethers) may well predominate, but a higher proportion of females would suggest that milk was the primary product.

Meat yields have been estimated by two methods. Firstly we can work out from the proportions of species represented the amount of meat which each would have contributed to the diet, by adjustment with factors to allow for the size discrepancies between the species. We have multiplied the number of fragments by the factors given in Grant (1975, 383) in Table 10. From this, it is obvious that cattle contributed the largest proportion of meat, followed by sheep, and then pig. Secondly, a more detailed method has been devised by Noddle (1973) for cattle. She has estimated from modern data, the weight of meat that an animal could have yielded. A revised version of this method by Noddle et al (in preparation) has been used to give estimates for the dressed carcass weights of the Brancaster cattle. These are compared with those from two other Romano-British sites in Southern England given by Noddle (1973, 386) in Table 11.

PATHOLOGY

We will probably never have a complete picture of the state of health of ancient domestic stock. Some information can be gleaned from ancient texts, and in his summary of Roman veterinary medicine, Walker (1970) describes diseases which can be recognised as having modern counterparts. This is complemented by the study of any signs of disease, injury and anomaly amongst the animal bone assemblages from archaeological sites. Of course, only a limited spectrum of diseases will affect the bone, and then often at a late stage in their progression. It is probable that sick animals would often have been killed before they were so ill that their nutritional state was adversely affected, once it was clear that they were not likely to recover. Columella recommends that sick goats be slaughtered and the flesh salted. This habit must have been an important factor in exposing the populace to serious disease from infected meat (Walker 1970, 329).

Any pathological changes in the bones from Brancaster were examined in detail with the aid of radiographs.

Dental diseases and anomalies were the most commonly observed pathological changes. Several examples of malocclusion of teeth were noted, the most common being of the cattle permanent fourth premolar. Calculus was also quite common in both sheep and cattle maxillae and mandibles. The formation of calculus may enhance the development and progress of periodontal disease, as food particles can more easily lodge between the teeth and gums and hence infection set in. Examples of periodontal disease were most common in sheep mandibles, and these are still common today.

A recent study of dental abnormality and changes in skeletal structure of 481 adult culled ewes (Richardson et al 1979, 521) showed only two with normal buccal morphology. The remainder showed a range of abnormalities, but body condition did not appear to be adversely affected by dental disease, a point worth bearing in mind when considering the supposed effects of disease on the general health of animals from archaeological sites.

Three examples of dental abnormalities in sheep mandibles from the Brancaster remains are described below:-

One jaw (Plates 3a and 4a) shows a recession of the bone around the second and third molars on the buccal side. At its deepest point, this is 12 mms below the bone on the lingual side, reaching almost to the roots of the third molar. Radiography demonstrates that the bone in this region is structurally different from the surrounding bone. The surface of cortical bone of the ramus directly below this 'resorbtion' shows a small degree of minor pitting. This may once have been more severe.

The second mandible (Plates 3b and 4b) shows pathological bone changes in the alveolus of the third molar and on the lateral and medial external cortical surfaces of the ramus. The changes exhibited are more severe on the medial surface. The alveolus of the third molar is greatly enlarged possibly as a result of ulceration of the roots of the third molar. The changes noted in the bone on the lateral aspect of the ramus are along the dorsal margin and appear as a slight porosity and increase in thickness of the cortex. This change is local to the third molar. On the medial aspect of the ramus the changes are similar though more massive, covering a larger area, from the dorsal margin almost to the ventral margin. The thickness of this lesion is also greater than that on the lateral side.

The condition of the alveolus together with the condition of the ramus are conducive to there having been an ulcer in this area and the infection of the medial surface and tooth root would probably have been more severe. There is also slight crowding of molars one and two with consequent malocclusion.

A third mandible (Plate 5) showed pathological changes very similar to those first described, but the lesion is associated with the fourth premolar. The medial and lateral surfaces of the ramus are affected to the same degree. The second premolar is missing, though from radiographic analysis it is not possible to say whether this is congenital absence or antemortem loss. In modern bovids, it has been noted that when the permanent second premolar is absent, the deciduous tooth has often been present, but lost antemortem (Andrews and Noddle 1975, 142).

A dog jaw (Plate 6) showed antemortem loss of all three incisors and the canine. The alveolar cavities had been infilled with cancellous bone.

The next common group of conditions was of arthritis and similar complaints. A cattle metatarsal (Plate 7) shows pathological changes on two areas of the bone and possibly also a third. Firstly, a moderate degree of exostosis on the proximal anterior, proximal lateral and proximal medial aspects. The degree of bone growth in these areas has been sufficient to join the fused second and third tarsal bones and the centroquartal (now broken off) to the proximal articular surface of the metatarsal. Radiography demonstrates that both the fused second and third tarsal have become attached by extra bony growth only at their periphery. As a modern comparison, a similar condition is produced by an inflammation (arthritis) of the tarsometatarsal joint known as tarsitis (Greenough et al 1972, 289). The Brancaster animal would probably have shown some degree of lameness and the joint would probably have been enlarged. A similar instance has occurred at the Iron Age site of Winklebury Camp (Jones 1977, 66) and also at the Roman site of Portchester (Grant 1975, 403).

The second bone change occurs on the diaphysis towards its distal end, wholly on the lateral and partly extending to the anterior aspect covering an area measuring 68 mms by 27 mms and 6 mm high. Radiography demonstrates that this bony addition is superior to the outer surface of the cortex. This change is probably periosteal in origin and is possibly the result of some form of trauma.

The third area of pathological change is also on the diaphysis at the proximal end on the dorsal surface lying to either side of the vascular groove. The changes are exactly similar to those described at the distal diaphysis, though the size of the lesion is smaller measuring 30 mms long, 20 mms across and 2 mms high. Alteration to the course of the vascular groove has been caused by this, and the last described pathological change.

The three changes occurring on this bone may all have been caused by some form of trauma, though the fusion of the tarsal bones to the proximal metatarsal may have been caused by many factors, including infection.

A cattle second phalanx. (Plate 8), displays a massive lesion on the proximal articular surface of sufficient proportions to destroy the articulation. At the centre of the affected area there is a circular depression approximately 20 mms in diameter. On the medial side of the lesion the newly formed bone is eburnated indicating firstly that there was some movement of the joint and secondly that the orientation of the foot had been altered so that the affected digit would have been rotated medially and posteriorly. The accompanying digit may also have been involved.

The lesion at the proximal articulation may be considered as consisting of two parts, the outer area extending around the perimeter of the articular surface and partly down the diaphysis and a second depressed area in the centre of the joint, containing many perforations into the medullary bone.

Another specimen of this bone (Plate 9) displays a wide fissure measuring 10 mms by 3 mms in the centre of the lateral proximal articular surface. It is unlikely that this would have caused any disability.

On a dog femur, a slight lip of extra bone has formed around the anterior surface of the head. Eburnation is frequently observed in specimens of this kind but none is apparent here. It is unlikely that this small amount of lipping could have produced lameness.

A final group is of injuries due to fracture or trauma. Only one notable instance occurred. This was a pig skull. (Plates 10 and 11).

There is extensive fracturing to the left squamous part of the occipital bone, the parietal bone and the squamous part of the temporal bone. The fractures are centred around two loci, one between the occipital, parietal and temporal bone, and the other between the parietal and temporal bones immediately caudal of the zygomatic process of the frontal bone. All of the fractures are well healed. Clearly, the animal survived these injuries and there are knife marks on both frontal bones so the animal's carcass was utilised. Resulting from these injuries the left wing of the nuchal crest (viewed posteriorly) has been depressed ventrally by 20 mms and medially by approximately 4 mms. The zygomatic arch and opening of the auditory meatus have moved rostrally approximately 5 mms compared with the position of those on the right side. There is no damage to the bone immediately surrounding the cranial cavity and therefore the brain cannot have been lacerated by broken edges of bone from this fracture. That is not to say, however, that the brain did not suffer damage in other ways. The damage to the caudal frontal sinus of the left side is severe. The maxillary sinus entering the zygomatic process of the temporal bone is badly distorted.

The second locus, caudal to the zygomatic process of the frontal bone shows four radiating fractures at right angles to each other. The surface of the cranial cavity in this area shows four pits. In this area the thickness of bone is much less than it is more caudally, and there seems to have been some penetration into the cranial cavity. It is possible that at this point the brain may have been damaged at an area close to the sylvian fissure in the lateral side of the left cerebral hemisphere.

Damage to the soft tissues in this area would have occurred and hearing on the left side may have been affected as the bone in the area of the cochlear is badly distended. It is likely that these injuries would have affected the external appearance and possibly also the behaviour of this animal when alive. This condition has often been observed in pig skulls from archaeological sites and it is usually attributed to fighting between boars that have perhaps been closely penned (von den Driesch 1975, 421-423).

SIEVED SAMPLES

Only two samples yielded small animal bones. Both came from earlier Roman deposits. The first was from a ditch and only contained several frog bones. Frogs are not scarce in Britain today, and are quite common in certain archaeological deposits such as waterlogged fills of wells and ditches (Evans 1978, 45). The Romans probably used various portions of this animal's 'interior' for remedies and charms (Toynbee 1973, 216).

The second sample was from a pit which may have functioned as a cess-pit. The only fish bones from the site came from this sample: an eel (Anguilla anguilla) vertebra and ten fin-rays (indeterminate species). As well as some indeterminable fragments, two species of small mammal were found. Shrew was represented by a humerus and an ulna. This animal is common over much of England. One immature tibia from a mouse was also found.

BIRD BONE

The excavations at Brancaster yielded a comparatively small sample of bird bones. Eight species were recognised, including both domestic and wild representatives, and these are listed below, in taxonomic order.

Species List

Black-throated diver (*Gavia arctica*)

Domestic goose (*Anser anser*)

Domestic duck/mallard (*Anas platyrhynchos*)

Buzzard (*Buteo buteo*)

Domestic fowl (*Gallus* sp)

Woodcock (*Scolopax rusticola*)

Rock dove/feral pigeon (*Columba livia*)

Raven (*Corvus corax*)

Of the seventy bones present, sixty-one (87%) could be fully identified. No bird bones were recovered from the Beaker, Bronze Age or Iron Age periods of the site. The majority of the bones (64) came from the earlier Roman period, the remainder coming from the later and post Roman periods (two and three bones, respectively). The number of each skeletal element from the different species present is shown in Table 12, for the whole site, and Table 2, for the earlier Roman period. The high percentage of identifiable bird bone in comparison with that of mammals indicates that, although a much smaller quantity, it was in better condition than the mammal bone assemblage. This could be attributed to a number of causes such as differential deposition, recovery and survival.

Considering first the domestic animals, Zeuner (1963, 451) considers that the British fowl had not had a long history before it was encountered by the Romans, and Caesar in his Gallic Wars, writes that the Britons would not eat this bird (Caesar, 135). It would seem that this was soon changed, however, as chicken remains have invariably been found wherever bird bones have been studied from Roman military sites in the provinces of Britain and Germany (Davies 1971, 130) As well as being eaten, poultry would have been kept for their eggs. Zeuner (1963, 448) considers that this would have been the primary reason for their initial domestication, and egg shells have been found at Hoffheim and Vindonissa (Davies 1971, 131). It was not possible to take many measurements on the fowl bones, but those taken have been compared with those for Roman fowl from several sites given in Macready (1976) whose ranges they fall within. As only one tarsometatarsus, was recovered (a male), the sex ratio could not be determined. According to Columella, this would have been between 1:3 and 1:5 cock:hen, depending on the breed (see White 1970, 328). Evidence of butchery occurred on three bones which had knife cuts on the diaphysis. Macready also found three bones with knife cuts (all humeri) in her study of the Roman fowl from Wicken Bonhunt. She contrasts this situation with that of Fishbourne, where Eastham (1971, 391) records that many bones show signs of having been cut at the joints as in carving, and Macready (1976) suggests that the inhabitants of the Villa at Fishbourne were, perhaps, more fastidious.

Caesar writes that geese, also, were not eaten by Britons before the Roman Conquest, up until which they were either considered sacred or kept as pets (Toynbee 1973, 263). It is generally considered that the species which has been domesticated is the grey-lag, our only indigenous goose. It is easily tamed and readily adapts itself to captivity. Geese have often been recorded from Roman sites (Davies 1971, 130), representing as much as a quarter of the birds eaten at one German site, Valkenburg. One bone of grey lag goose (the only bird bone) was also found at excavations in Brancaster directed by Green (Jones, in press). Columella (see White 1970, 327) says that geese can be reared with very little trouble and are worth keeping for their goslings and feathers, but they need plenty of water and grass. These requirements would have been amply satisfied by a salt-marsh habitat. The one measurable specimen was slightly smaller than specimens from Wicken Bonhunt.

Ducks were eaten in Roman times, but may have been considered as low-class food as is the opinion expressed by Trimalchio in the Satyricon by Petronius. (see Toynbee 1973, 273). They are quite commonly represented on archaeological sites of the Roman period. The duck bones found were similar to those of mallard - the most numerous and widely distributed of our resident waterfowl - and those measurements which it was possible to take, fell within the range of archaeological specimens from Wicken Bonhunt. Delacour (see Eastham 1971, 391) noted that though it is known that the Romans built large aviaries where mallard were bred and fattened, the earliest literary reference to a distinct breed of duck is in the twelfth century. The Fishbourne bones have a larger size range than the mallard, suggesting domestication was taking or had taken, place. Dr Bramwell has also noted that ducks from the Roman period are similar to, but larger than the mallard. He thinks they may have taken wild duck eggs and hatched them under fowls (1971).

Rock dove and feral pigeon today constitute a single species. Semi-domesticated dove-cote pigeons, which were free to find their own food, would have played an important part in rural economies. From the eariest times, there must have been contact between dove-cote birds and wild rock doves, leading to inter-breeding and assimilation of populations. Rock dove/feral pigeon have been found on other Roman sites eg Waddon Hill (see Davies 1971, 130). Silchester and Caerwent (see Fisher 1966, 38). No matter what the status of this species it is certain that it would have been eaten.

The woodcock would also have been caught as food. The typical habitat of this bird is deciduous woodland, with a combination of dry ground for nesting, wet areas for feeding and open spaces. This area might once have provided such a habitat for this forest wader, though it no longer breeds there today.

The remaining birds are less likely to have been food remains. The raven is now rare in Britain, though it was widespread up until the early nineteenth century. Thus, in Roman times, it would have been much more common, and has, indeed, been found invariably on Roman sites (see Fisher 1966, 38 and Davies 1971, 130). There are many references in the literature including Pliny's Natural Histories, to ravens having been tamed and taught to talk by the Romans (see Toynbee 1973, 273-275) so it is possible that these birds were kept as pets. Bramwell, noting the abundance of ravens amongst Roman poultry considers that they may have been killed as marauders of poultry (1975, 208). Elsewhere, (Bramwell 1971) he suggests that they were kept as a deterrent to hawks which must have been a constant threat. Indeed, Columella advocates that birds of dark plumage be kept, one of the reasons for this being that the more conspicuous white birds make them easy prey for hawks and eagles (see White 1970, 323). Ravens from Portchester Castle were found as skeletons in pits and Eastham (1975, 414) considers the possible interpretation that they were kept as pets or mascots. Four of the Brancaster bones may also have come from a single skeleton. There is evidence that some, at least, of the individuals had been utilised by man, for meat or feathers, as there was a chop mark on one ulna. Measurements taken were compared with archaeological specimens from Wicken Bonhunt as no modern reference material was available. They were of a similar size.

The densest concentrations of buzzards are where the habitat is diverse. Maps of past breeding distributions show that as late as 1800, the buzzard bred throughout the British Isles (Sharrock 1976, 455) though they no longer occur in the Brancaster area. Other Roman sites on which buzzards have been found include Colchester, Haddington in Scotland and possibly the Villa at Folkestone's East Cliff in Kent (Fisher 1966, 37) and Exeter (Maltby 1979, 73).

The seventeen bones of the black-throated diver all come from the same context and almost certainly represent a single individual. This is now one of our rarest birds. It breeds in summer freshwater haunts in north-west Scotland, and overwinters at sea or in estuaries, or sometimes on lakes or in man-made waters near the coast. Thus Brancaster is within its present winter range and this bird would probably have died in winter or during a spring or autumn migration. It is recorded from Baynard's Castle (Bramwell 1973) and Exeter (Maltby 1979, 73) but otherwise, is rare or unknown in archaeological bone assemblages. Other divers have occasionally been recorded eg the great northern diver (Gavia immer) from Roman Portchester, and Broch of Ayre in Orkney and the red-throated diver (Gavia stellata) from a Fife cave (Eastham 1975, 412). The Portchester Castle bird is also an almost complete skeleton, and Eastham suggests that it was accidentally bagged on a wild fowling trip, and thrown straight into a rubbish pit, as the flesh of the diver is reputed to be extremely unpalatable. That divers found on archaeological sites of various periods were probably not eaten is also the view held by Fisher (1966, 38) who vouches for their unpalatability from personal experience. However, a butchered bone of a great northern diver was recovered from Saxon Southampton (Bourdillon and Coy 1979, 46). Arthur Cleveland Bent, writing in the early part of this century in America, says of the great northern diver "There is no good excuse, however, for shooting them as they are practically never used for food. They are exceedingly hard to kill, and it is well-nigh useless to chase a wounded loon.

On the coast of Labrador, loons are shot for food, and I can testify from experience that they are not bad eating, though I should not consider them to be in the game bird class". (Bent 1919, 58). It would seem that the Romans must have been good marksmen! But it is still a matter for speculation whether this diver was caught deliberately for food or not, and whether, if acquired accidentally, it was eaten anyway.

Possibly an indication of a bird's status (eg food, sport, pet) may be gained from careful examination of its archaeological context, for instance whether single scattered bones or a partial or complete skeleton, in a pit or an occupation layer. The skeletons of birds in rubbish pits probably indicates that they were not eaten eg the ravens and diver at Portchester Castle. This might also apply to the finds of a partial skeleton of raven, and a diver at Brancaster.

In conclusion the bird bone evidence indicates that several domesticated species were kept for food, and these were supplemented to a greater or lesser extent by wildfowl taken in the vicinity. Certain other species recovered may be incidental from the food point of view, but represent the habitat of this area in Roman times, which included species once more widespread than they are today.

GENERAL DISCUSSION AND CONCLUSIONS

The faunal evidence is first considered systematically, before drawing some general conclusions about the site economy.

Cattle

Though there is much information in the ancient literature on Roman husbandry practice in Italy, this should not be applied without reservations to the interpretation of Romano-British material. Environmental conditions and native techniques established before the Roman invasion will have influenced husbandry practices here. White (1970; 276-277) considers that the main purpose for keeping cattle was for draught - meat would have been a secondary product, and cow's milk was rarely drunk in Italy. The temperate climate of Britain might have allowed cattle to be kept as dairy animals, and meat, largely beef and veal, would have been a regular constituent of military rations (Davies 1971, 126).

Most individuals recovered from Brancaster were horned, but hornless cattle were also present. Jewell (1962) describes two types of cattle from the Roman period in Britain: the small "Celtic ox" which played a dominant role in the early Iron Age, and a larger type, possibly imported, though both are slender-boned beasts. These may both be represented at Brancaster as indicated by the measurements (see p 32).

The majority of the animals were mature, with a smaller percentage of very young animals than was found for sheep. This suggests that the primary purpose of cattle was for draught or milk; rather than meat production; but which of these was the more important cannot be determined, as it was not possible to separate the sexes.

<u>Sheep</u>

The sheep are of the gracile type commonly found on Romano-British sites, somewhat similar in build to the present day Soay breed. Though generally horned (Plate 13), a few polled individuals occurred; these were of two types: those with a smooth flat frontal bone, and those with a rudimentary horn bud (Plate 14). It is open to conjecture which of the following three possibilities these animals represent: a different breed, the females of a single breed where the males alone bear horns, or an occasional individual in a population where both sexes are normally horned. A hornless sheep skull fragment is also noted by Jones (p. 000). The majority of sheep were killed when sub-adult or mature, but with a small percentage of deaths in the very young age group. This suggests that the primary purpose for which they were kept was something other than meat production ie, wool or milk. White (1970, 301) considers that the primary product of sheep in the Roman period would have been wool, followed by cheese and milk though the meat would, of course, have been eaten, perhaps especially from surplus young animals. Columella suggests that they should be sent to the butcher "before they have begun to graze, since it costs very little to send them to town, and when they have been disposed of, a substantial profit is made out of the milk from their mothers" (White 1970, 303). However, it is most likely that there is a bias against the survival of bones of such young animals due to their fragility and porous texture.

Goat

Only one definite goat bone, a horn core, was recovered. Although, because the bone assemblage was highly fragmented, it is possible that any smaller fragments of goat have not been distinguished from the remains of sheep (see p 4), the paucity of remains suggest that this animal cannot have contributed greatly to the site economy.

Pig

Very few of the bones recovered were from mature animals, which severely limited any metrical analysis. It is likely that the majority of the bones were of domestic pig, although occasional wild boar might be present. These were larger animals than the domestic pig at that time. One metatarsal compares favourably in size with that of a zoo-bred wild boar in the reference collection (Plate 15). Davies (1971, 128) states that wild boar was frequently taken - (it was found at fourteen of the thirty-three Roman sites he reviewed) - and he considers that it may have been hunted as much for sport as for food; for example, an altar to Silvanus was set up in Weardale "In fulfilment of his vow for capturing a boar of outstanding fineness, which many of his predecessors had been unable to bag". As the pig is a single purpose animal, with the only useful products being meat and lard and possibly hide, it can be culled at the economic optimum kill-age for meat yield ie when sub-adult, at the point when the maximum food-input/growth ratio has been reached in contrast to the multipurpose animals such as cattle and sheep where slaughter patterns are necessarily more complex. The pig is a prolific breeder and so only a few adults need be kept to ensure a steady population replacement. Pig meat was popular with the Romans, as evidenced by the space devoted to pork recipes in Apicius (see King 1978, 225). Though there is no archaeological evidence to support this, pigs may have been castrated to make them more manageable and as the meat of uncastrated males is reputed to have a poor flavour (Uerpmann 1973, 316).

Horse

The horse bones found were generally less fragmentary than those from most of the other domestic animals on the site. Data from modern animals given by Silver (1969) was used for assigning ages to the bones. The ages given below are modern age equivalents: actual ages of ancient stock are not known. The majority of the bones were from mature animals; of the forty-seven bones on which ageing information was recordable, only three were immature. The latter were from animals under 3-3½ years of age. Of the remainder, two were about 5 years and four were over 5 years, the rest being at least 9 months-3½ years, depending on the bone. Ageing information also came from the state of eruption and wear of the teeth in mandibles and maxillae. Only six individuals retained sufficient teeth *in situ* for age assessment. These give the following ages: two are older than 2½ years, one is 4-5 years of age and the remaining three are at least 3½-4 years. The size of the animals have been compared with examples of modern breeds given by Pitt-Rivers (1888), as well as with those of horses from other Roman sites. Wither's heights were estimated using Kieswalter's method (1888). These are given in Table 14. No large horses are represented and the bones are generally about the size of, or smaller than, an Exmoor Pony (11½ hands) though some were and no bigger than a New Forest Pony (12 hands), and possibly a slightly larger form is also represented. The same range of horses occurred at Corstopitum (Meek and Gray 1910, 84) but at Pitt-Rivers' excavations at Rotherley and Woodcuts, all the horses were of the small type of the Exmoor pony (Pitt-Rivers 1882, 217), as were those in the Brancaster bones studied by Jones (p. ooo). The Roman horses from Exeter were larger - probably from animals of 13-14 hands (Maltby 1979, 62) as were those at Hemel Hempstead (Harcourt 1974, 259). A third metatarsal from a post Roman context had been sawn through the shaft just below the proximal epiphysis (Plate 16) in a similar manner to the specimen described by Maltby (1979, 362). This was undoubtedly a preliminary to working the bone. Cannon bones of sheep and cattle are often used for making bone objects, as was the case at Brancaster, and these two examples provide evidence for such a process on horse bones.

The absence of butchery marks on the Brancaster horse bones suggests that they were not eaten, nor their bone marrow extracted though, as at Exeter, their use as an occasional food source cannot be discounted. This is not invariably the case, and Pitt-Rivers (1888, 217) concluded that the horses at Rotherley and Woodcuts had been used for food, because many of the bones had been split longitudinally as if to obtain the marrow, and at these sites horse was the third most common animal. On sites where horse does not appear to have been eaten, it is not usually found in such large quantities.

The Romans are known to have had large horses for military use (Bökönyi 1974, 262-263) but none fitting this description was found at Brancaster. As well as cavalry, horses were used for breeding mules and sometimes for traction and working corn-mills. Though horse meat was not eaten, other products from the dead animal were used, eg the skins and tails were used for leather and decoration (Toynbee 1973, 185).

The ageing data, with very few immature animals, support the view that the horse was kept primarily as a working animal.

Dog

A total of thirty-seven dog bones was recovered, the majority of which came from the earlier Roman period, but with three from late and four from post Roman contexts respectively, and a single bone from the Iron Age. Measurements of the bones have, where possible, been compared with those of modern breeds in the reference collection. The dogs seem to have been of at least three types. One was rather smaller than a miniature poodle, but slightly larger than a toy poodle, another is tenatively judged to be about the size of a border collie, though no complete long bones have survived and there is a possible third intermediately sized animal. Height calculations were only possible on two bones, a radius and a humerus. These gave withers height estimates of 29.1 cms and 27.9 cms respectively. These are near to the lower size limits of dogs from Roman sites given by Harcourt (1974, 166). Though the quantity of dog bones recovered from Brancaster was not great, they give an indication of the variability which is typical of dogs in the Romano-British period. Dogs in Roman times would have had a variety of uses. Possibly their skin and meat was utilised, but there is no evidence for this at Brancaster. Hunting dogs were used, and certain British breeds were prized in Rome. Sheep dogs were also known, as were house dogs, and there is some evidence for the occasional use of dogs for draught purposes and in performing acts (Toynbee 1973, 102-122). Pet dogs or lap dogs were kept, and it is likely that the smaller dogs found at Brancaster fit this category. One radius and humerus were very short and bowed; similar specimens from Corstopitum were likened to the modern Dachshund (Meek and Gray 1910, 122). Small dogs should not be automatically considered of no use as working animals. The Welsh Corgi, for example, was used by the cattle drovers, as it could snap at the beasts' heels, and be quick enough to avoid being kicked (Godwin and Toulson 1977, 10).

Cat

Though no bones of this animal were found, a cat had left its paw impression on one of the tiles found at the site (see p000). Domestic cats, though not common, have been recovered from Roman sites in this country eg from Lullingstone and Wroxeter (Toynbee 1973, 90), Exeter (Maltby 1979, 64) and Silchester (Jones 1892, 288) and they have been recorded as early as the Iron Age (Harcourt 1979, 154).

Deer

Two species of deer were found: red and roe. Both species are indigenous, and quite common in suitable woodland habitats, and also moorland in the case of red deer. All the deer bones came from the earlier Roman contexts, and these animals were presumably hunted for food. Davies (1971, 128) says that venison was clearly a common delicacy, the former has been recorded from thirty-one and the latter from seventeen of the Roman military sites reviewed by him. The antlers were also used, for making objects: an iron awl found on the site had its handle fashioned from an antler tine, probably of red deer, another worked fragment of red deer antler was found, and a third was sawn off at the base, ready for working.

Rabbit

A single rabbit mandible was found in an earlier Roman ditch deposit, but the possibility that it arrived there by burrowing cannot be discounted. It was once thought that when Caesar referred to hares in Britain, it may actually have been rabbits which he saw; however it is now generally agreed that this animal was introduced by the Normans (Sheail 1971, 17). Rabbit bones occasionally turn up on Roman sites, but in all cases they have been discounted as intrusive. While it is unlikely that they were widespread at that time, confirmation of the presence of rabbit in pre-Norman Britain may yet come from the meticulous examination of the archaeological contexts yielding small mammal bones, in the same way that the existence of black rat in Roman York has been established by Rackham (1979). This has also been done for the small mammal bones at Saxon Southampton, where only a single rabbit bone (a butchered scapula) was found to be non-intrusive (Bourdillon and Coy 1979, 44).

Hare

Only one bone was recovered, a calcaneus, and it was not possible to ascertain whether the species represented was Lepus capensis (brown hare) or Lepus timidus (mountain hare). A single bone seems slim evidence from which to infer the practice of hunting. However, as remains of the smaller animals on the site were scant, this bone might represent only a relatively small proportion of the individuals present. Hare bones have been found on several Roman sites (Davies 1971, 128) and doubtless they also supplemented the diet at Brancaster. Davies (1971, 128) considers that the hare may have been hunted for sport rather than food, though in times of shortage it would have been a welcome supplement to army rations. For example, Vegetius mentions this species in his description of the siege diet in Britain. "The soldiers were worn out by ...the unaccustomed food of the country. They ....fed on wheat and barley and large quantities of meat and hare boiled without salt which upset their digestion". At Brancaster, however, salt shortage should not have been a problem, as the salt marshes would ensure a supply of this important commodity.

Rat

One humerus of an immature rat (Rattus sp) was found in the floor of an early Roman ditch. It is not possible to distinguish the post-cranial elements of the black and brown rats (R. rattus and R. norvegicus, respectively), but the brown rat was not introduced into this country until the early eighteenth century (Barrett-Hamilton and Hinton 1904.). The archaeological context from which the Brancaster rat bone came was well sealed and stratified, and it can be safely assumed that the animal did not enter by burrowing.

Though the brown rat is known to burrow extensively, this is not an attribute of the black rat. The latter, together with the early date of the deposit, suggest this animal is, in fact, a black rat. Until recently, the black rat was thought to have been introduced into Britain in the Norman Period, but Rackham (1979) has produced evidence for its introduction in Roman times, from excavations at York. This could prove of considerable importance, especially in view of recent discussions on plague and the end of Roman Britain and subsequent plagues of the Anglo Saxon period (Rackham op cit). A rat bone has also been found in an early tenth century deposit in London, and though assumed to be from the black rat this, like the Brancaster bone, was of an immature post-cranial element (Armitage 1979b).

Whale

Six fragments of vertebral centra from a whale were recovered from the earlier Roman period, but it was not possible to determine from which species these came. Chop marks were present on three of the fragments (Plate 17), which we consider to be the result of butchery, and conclude that the whale meat was eaten. Whale bones have occasionally been recovered from Roman sites: at Valkenburg, an auxiliary fort near the mouth of the Rhine (Davies 1971, 129-130) and at Bishopstone, where it was suggested that the proximity of the site to the sea makes it likely that a whale was stranded on the shore, and part of the carcass taken up to the site (Gebbels 1977, 279). The same explanation is likely to apply to the Brancaster whale. Deliberate, often mass, strandings of whales are well documented for which various explanations have been hypothesised, including an ear infection having affected the sonar system (Harrison Matthews 1978, 178-182). Of course, the animal could have been washed up dead, in which case the flesh would probably have been putrid: the butchery suggests that the whale meat was utilised so a stranded live animal seems the preferable interpretation. In contrast to this, a whale vertebra of the Little Piked Whale

(Balaenoptera acutorostrata) found at Saxon Southampton which had been used as a chopping block (deduced from the numerous incisions on the flat facets of the vertebra) was probably washed ashore as a carcass, or even as a bone as there is no evidence for the flesh having being eaten (Holdsworth 1976, 45).

Occasional records of whale occur in the Roman literature and Porcupius relates how a whale stranded near the city of Constantinople was dragged to shore and killed by the local people (see Toynbee 1973, 208).

Conclusion

The major contribution to the Brancaster bone assemblage came from food remains of the domestic animals. The excavated bone assemblage shows us the pattern of slaughter, from which certain attributes of stock-breeding practice can cautiously be hypothesized. However, many unknown variables will have influenced the pattern we see, such as possible import of animals to the site, or export of animals from the site for consumption elsewhere. This problem is discussed more fully by Uerpmann (1973).

If we look at the relative proportions of species found from the different phases throughout the time span of site occupation (Table 13), we see that there is a very slight increase in the proportions of pig and also of sheep from the earlier to later Roman phase, with a concomitant decrease in the proportion of cattle. The numbers of horse and dog remain at the same low level throughout. The increase of horse in the post-Roman bone assemblage is probably not significant because of the mixed nature of that bone group. King (1978), in his comparative survey of all the major bone assemblages from Roman sites in Britain, has observed and interpreted the changes and trends in their species composition. These are firstly, a decrease in the number of sheep bones in late Roman times which he attributes to an increasing number of 'Romanized' deposits, viz villas, towns and forts. He suggests that sites on which sheep are favoured are continuing the Iron Age farming pattern, or are on lowland dry light soils.

In support of this, Applebaum (see Hallam 1970, 64) ascribed Romano-British settlement on the fringe of the Essex and Kent settlements to sheep rearing in the absence of liver fluke. The salt marshes of the Essex coast could support heavy sheep numbers because of the fine, extensive short herbage and the absence from disease given by salt water: the liver fluke does not thrive so freely under these conditions, and foot-rot is somewhat less troublesome in a salt-water than a fresh-water pasture (Trow-Smith 1957, 76). As the settlement at Brancaster was probably considerably 'Romanized' throughout its existence the latter of King's explanations is the most likely.

The second trend which King noticed was an increase in pig in the second to fourth centuries AD which he interprets as perhaps an indication of increased woodland usage or the establishment of orchards, while a more important part might have been played by political and cultural considerations. During the third century, money supply problems caused increases in the taxes levied, which could in turn have led to taxpayers utilizing more, and marginal, land to maintain their living standard. From the fourteenth century, livestock was included in the poll tax, which may have been an incentive to keep larger animals (cows instead of sheep), and pigs could have evaded tax inspectors because they could be unobtrusively kept in woodland. Another factor might be the fact that the Romans regarded pork as a delicacy and perhaps British tastes adjusted accordingly.

The fort at Brancaster started life as an infantry establishment, later becoming one of cavalry but the bones do not reflect this change in use, as there is no change in the percentage of horse bones between the earlier and late occupation phases. This might be because it is generally considered that horses from Roman forts would have been buried well outside the occupied area (Grant 1975, 383).

The animal kill-off patterns of domestic stock, with a paucity of younger animals, suggests that they might have been consumed elsewhere - perhaps shipped salted up to the Northern forts, as probably occurred in the nearby Fens (Salway 1970, 13-14)- with the meat eaten at the site coming from more mature animals which had been raised primarily for other purposes such as milk and wool production. Alternatively, the younger meat may have been consumed elsewhere on the site, for example, within the fort. In the Roman period, vast supplies of hides were needed - for tents, shields, protective clothing and harness. Gut might also have been required by the artillery, and wool was needed in quantity for uniforms. These commodities might also have been transported from this area. In addition, the surrounding salt-marsh habitat would have provided a natural reservoir of fish and fowl, which might free a large proportion of the domestic produce for use elsewhere. Unfortunately, the preservation on the site has provided an unquantifiable bias towards the larger animals, and so we can but guess at the extent of the contribution to the local diet of the commodities mentioned.

On the other hand, no major road led to Roman Brancaster, and though no large ships could have harboured here the possibility that Brancaster itself received supplies by sea can be entertained.

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LIST OF TABLES

TABLE 1

THE MAMMAL SPECIES AND PARTS OF THE SKELETON FROM THE WHOLE SITE

	CATTLE	"CATTLE-SIZED"	SHEEP	GOAT	"SHEEP-SIZED"	PIG	HORSE	DOG	WHALE	RED DEER	ROE DEER	RABBIT	HARE	RAT	INDETERMINATE MAMMAL	TOTAL
SKULL	128	135	29	1	27	18	4	6	–	–	–	–	–	–	133	481
ANTLER	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
MANDIBLE	202	36	112	–	17	24	4	4	–	–	–	1	–	–	10	409
SCAPULA	134	75	41	–	34	11	4	6	–	–	–	–	–	–	7	312
HUMERUS	48	39	39	–	16	11	5	5	–	–	–	–	–	1	1	165
RADIUS	66	19	58	–	32	3	12	7	–	–	–	–	–	–	–	197
ULNA	29	13	12	–	2	3	7	3	–	–	–	–	–	–	–	69
METACARPAL	126	–	50	–	3	2	7	–	–	–	–	–	–	–	–	188
1st PHALANX	126	–	33	–	2	7	10	–	–	1	–	–	–	–	–	179
2nd PHALANX	78	–	6	–	–	–	8	–	–	–	–	–	–	–	–	92
3rd PHALANX	60	–	7	–	–	3	1	–	–	–	–	–	–	–	–	71
OS COXAE	57	144	36	–	21	5	8	–	–	–	–	–	–	–	–	271
FEMUR	51	37	17	–	18	5	9	4	–	–	–	–	–	–	–	141
PATELLA	9	1	–	–	–	–	1	–	–	–	–	–	–	–	–	11
TIBIA	57	24	69	–	26	12	4	1	–	1	2	–	–	–	–	197
FIBULA	–	–	–	–	2	6	–	2	–	–	–	–	–	–	–	10
CALCANEUM	35	3	9	–	2	6	4	–	–	–	–	–	1	–	–	60
ASTRAGALUS	39	3	8	–	–	6	6	–	–	–	–	–	–	–	–	62
METATARSAL	119	1	80	–	7	6	12	–	–	–	–	–	–	–	–	225
ATLAS	21	9	1	–	1	1	3	–	–	–	–	–	–	–	–	36
AXIS	11	8	1	–	2	–	2	–	–	–	–	–	–	–	–	24
CERVICAL VERTEBRAE	19	106	7	–	19	3	1	–	–	–	–	–	–	–	–	155
THORACIC VERTEBRAE	17	182	11	–	25	1	2	–	–	–	–	–	–	–	1	239
LUMBAR VERTEBRAE	17	186	10	–	31	2	–	–	–	–	–	–	–	–	2	248
VERTEBRAE (INDETERMINATE)									6							
SACRAL VERTEBRAE	5	27	1	–	3	–	1	–	–	–	–	–	–	–	–	37
RIBS	131	1,066	139	–	384	16	–	6	–	–	–	–	–	–	7	1,749
INDETERMINATE FRAGMENTS	–	1	–	–	–	–	–	–	–	–	–	–	–	–	4,130	4,137
	1,586	2,115	776	1	674	151	115	44	6	3	2	1	1	1	4,292	9,768

TABLE 2

THE MAMMAL SPECIES AND PARTS OF THE SKELETON
FROM THE EARLIER ROMAN PHASE AT BRANCASTER

	CATTLE	"CATTLE-SIZED"	SHEEP	GOAT	"SHEEP-SIZED"	PIG	HORSE	DOG	WHALE	RED DEER	ROE DEER	HARE	RAT	INDETERMINATE MAMMAL	TOTAL
SKULL	118	115	23	1	18	13	3	4	–	–	–	–	–	114	409
ANTLER	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
MANDIBLE	165	28	88	–	15	19	3	3	–	–	–	–	–	7	328
SCAPULA	117	62	29	–	25	5	3	5	–	–	–	–	–	5	251
HUMERUS	38	34	36	–	14	8	4	4	–	–	–	–	1	1	140
RADIUS	56	18	46	–	28	2	9	7	–	–	–	–	–	–	166
ULNA	24	12	11	–	2	3	5	2	–	–	–	–	–	–	59
METACARPAL	100	–	41	–	2	2	6	–	–	–	–	–	–	–	151
1ST PHALANX	100	–	31	–	2	7	8	–	–	1	–	–	–	–	149
2ND PHALANX	72	–	6	–	–	–	6	–	–	–	–	–	–	–	84
3RD PHALANX	54	–	7	–	–	2	1	–	–	–	–	–	–	–	64
OS COXAE	49	120	31	–	18	5	5	–	–	–	–	–	–	–	22
FEMUR	40	32	12	–	14	5	7	4	–	–	–	–	–	–	114
PATELLA	9	1	–	–	–	–	1	–	–	–	–	–	–	–	11
TIBIA	48	19	53	–	22	–	3	1	–	1	2	–	–	1	157
FIBULA	–	–	–	–	1	–	–	1	–	–	–	–	–	–	8
CALCANEUM	31	2	7	–	2	–	4	–	–	–	–	1	–	–	52
ASTRAGALUS	35	3	7	–	–	–	4	–	–	–	–	–	–	–	51
METATARSAL	105	1	70	–	6	–	9	–	–	–	–	–	–	–	196
ATLAS	18	7	1	–	1	–	3	–	–	–	–	–	–	–	31
AXIS	8	7	–	–	2	–	2	–	–	–	–	–	–	–	19
CERVICAL VERTEBRA	12	87	7	–	14	–	1	–	–	–	–	–	–	–	121
THORACIC VERTEBRA	17	146	11	–	19	–	2	–	–	–	–	–	–	1	196
LUMBAR VERTEBRA	17	159	9	–	24	1	–	–	–	–	–	–	–	1	211
VERTEBRA (INDST)	5								6						6
SACRAL VERTEBRA		25	1	–	2	–	1	–	–	–	–	–	–	–	35
RIB	124	894	115	–	293	5	–	5	–	–	–	–	–	7	1,443
INDETERMINATE FRAGMENT	–	1	–	–	–	–	–	–	–	–	–	–	–	3,360	3,367
TOTAL	1,362	1,773	642	1	524	103	90	36	6	3	2	1	1	3,497	8,041

TABLE 3

THE MAMMAL SPECIES AND PARTS OF THE SKELETON
FROM THE LATER ROMAN PHASE AT BRANCASTER

	CATTLE	"CATTLE-SIZED"	SHEEP	"SHEEP-SIZED"	PIG	HORSE	DOG	INDETERMINATE MAMMAL	TOTAL
SKULL	4	6	2	3	3	–	1	6	25
MANDIBLE	11	3	10	–	3	1	–	1	29
SCAPULA	5	5	5	5	2	–	–	1	23
HUMERUS	2	–	2	–	2	–	–	–	6
RADIUS	–	1	8	–	1	1	–	–	11
ULNA	2	1	–	–	–	1	–	–	4
METACARPAL	7	–	5	–	–	–	–	–	12
1ST PHALANX	5	–	–	–	–	–	–	–	5
2ND PHALANX	1	–	–	–	–	1	–	–	2
3RD PHALANX	1	–	–	–	–	–	–	–	1
OS COXAE	2	8	2	–	–	1	–	–	13
FEMUR	3	2	1	–	–	–	–	–	6
TIBIA	2	1	6	2	4	–	–	–	15
FIBULA	–	–	–	–	–	–	1	–	1
CALCANEUM	1	–	–	–	–	–	–	–	1
ASTRAGALUS	1	–	–	–	1	–	–	–	2
METACARPAL	2	–	6	–	–	1	–	–	9
ATLAS	1	–	–	–	–	–	–	–	1
AXIS	1	–	–	–	–	–	–	–	1
CERVICAL VERTEBRA	1	3	–	3	3	–	–	–	10
THORACIC VERTEBRA	–	13	–	4	1	–	–	–	18
LUMBAR VERTEBRA	–	12	1	4	1	–	–	1	19
SACRAL VERTEBRA	1	–	–	–	–	–	–	–	1
RIB	–	85	18	51	11	–	1	–	166
INDETERMINATE FRAGMENT	–	–	–	–	–	–	–	247	247
TOTAL	53	140	66	72	32	6	3	256	628

TABLE 4: Statistical comparison of overall fragmentation patterns for the five major domestic species found on the site (cattle, sheep, pig, horse and dog).

Species Combination	X^2 value	Significance at 0.5% probability level
Sheep/Pig	8.38	Not Significant
Horse/Dog	9.38	Not Significant
Pig/Dog	17.9	Significant
Cow/Pig	19.53	Significant
Pig/Horse	21.06	Significant
Sheep/Dog	25.06	Significant
Cow/Horse	32.88	Significant
Cow/Dog	58.3	Significant
Sheep/Horse	52.89	Significant
Cow/Sheep	82.68	Significant

TABLE 5

AGE CRITERIA FOR CATTLE AND SHEEP (from bone data)

A CATTLE

AGE CLASS	EQUIVALENT MODERN AGE (YEARS)	BONE AND EPIPHYSIS
1	$1-1\frac{1}{2}$	Humerus distal, radius proximal
2	$22-2\frac{1}{2}$	Metacarpal distal, tibia distal
3	$2\frac{1}{2}$	Metatarsal distal
4	3-4	Femur proximal, calcaneum, humerus proximal, radius distal, femur distal, tibia proximal

B SHEEP

AGE CLASS	EQUIVALENT MODERN AGE (YEARS)	BONE AND EPIPHYSIS
1	10 months	Humerus distal, radius proximal
2	$1\frac{1}{2}-2$	Metacarpal distal, tibia distal
3	$2\frac{1}{2}-3$	Metatarsal distal
4	3	Calcaneum, radius distal, ulna, femur distal, tibia proximal.

TABLE 6

AGE CRITERIA FOR CATTLE AND SHEEP (FROM TOOTH ERUPTION)

AGE CLASS	AGE (YEARS)		TOOTH WEAR STAGE
1	CATTLE	SHEEP	
1	$\frac{3}{4}$	$\frac{1}{2}$	M1 unworn
2	$1\frac{1}{2}$	$\frac{3}{4}$	M2 unworn
3	$2\frac{1}{2}$	$1\frac{1}{2}$	M3 unworn
4	3	2	PM4 unworn

TABLE 7: Withers heights estimates of the domestic mammals from the early Roman occupation phase.

Species	Anatomy	N	Range
Cattle	humerus	1	109.1
	radius	6	108.8-124.3
	metacarpal	11	108.9-123.6
	metatarsal	12	116.1-121.8
Sheep	radius	1	62
	metacarpal	4	59.3-69.2
	calcaneum	4	52.8-60.3
	metatarsal	10	61.8-65.4
Horse	radius	2	124.2-146.5
	metacarpal	2	119.9-135.9
	metatarsal	1	124.4
Dog	humerus	1	27.9
	radius	1	29.1

TABLE 8: Comparison of selected cattle measurements from Brancaster with those from other Roman sites, and with modern breeds.

Site/Breed	Bone	Measurement	N	Range (mms)
Brancaster	Humerus	Distal breadth	12	64.4–90.4
Corstopitum	"	" "	61	47–80*
Exeter	"	" "	6	63.1–74.3**
Chillingham cull	"	" "	1	53*
Chillingham cow	"	" "	1	64*
Shorthorn cow	"	" "	1	76*
Brancaster	Radius	Total length	6	253–289
Exeter	"	" "	5	243–274**
Chillingham bull	"	" "	1	273*
Chillingham cow	"	" "	1	252*
Shorthorn cow	"	" "	1	305*
Kerry cow	"	" "	1	249*
Brancaster	Metacarpal	Total length	11	178–202
Corstopitum	"	" "	87	164–203*
Exeter	"	" "	5	166–194**
Chillingham bull	"	" "	1	202*
Chillingham cow	"	" "	1	179*
Shorthorn cow	"	" "	1	225*
Kerry cow	"	" "	1	183*
Brancaster	Metacarpal	Distal Width	41	49.4–70.8
Corstopitum	"	" "	116	47–73*
Exeter	"	" "	30	44.8–57.3**
Chillingham bull	"	" "	1	44*
Chillingham cow	"	" "	1	54*
Shorthorn cow	"	" "	1	65*
Brancaster	Tibia	Distal Width	20	49–68.6
Corstopitum	"	" "	78	45–68*
Exeter	"	" "	9	49.7–63.3**
Portchester Castle	"	" "	143	50–69**
Gadebridge Park	"	" "	13	44–60**
Chillingham bull	"	" "	1	49*

* After Meek and Gray (1910)

** After Matby (1979)

Site/Breed	Bone	Measurement		N	Range (mms)
Chillingham cow	Tibia	Distal Width		1	50*
Shorthorn cow	"	"	"	1	65*
Brancaster	Metatarsal	Total length		2	213-223.5
Corstopitum	"	"	"	67	181-244*
Exeter	"	"	"	15	190-219**
Portchester Castle	"	"	"	108	183-240**
Gadebridge Park	"	"	"	3	208-254**
Chillingham bull	"	"	"	1	222*
Chillingham cow	"	"	"	1	205*
Shorthorn cow	"	"	"	1	255*
Kerry cow	"	"	"	1	212*

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* After Meek and Gray (1910)

** After Matby (1979)

TABLE 9 : Comparisons of selected **sheep** measurements from Brancaster with those from other Roman sites, and with modern breeds.

Site/Breed	Bone	Measurement		N	Range (mms)
Brancaster	Humerus	Distal breadth		13	25.3–33
Corstopitum	"	"	"	10	22–28
Exeter	"	"	"	23	23.9–30.1
Stanham Aspel	"	"	"	2	29–30
Brancaster	Metacarpal	Total length		4	122.5–143
Corstopitum	"	"	"	11	106–126
Exeter	"	"	"	3	112–127
Cranborne Chase	"	"	"	11	109–137
St Kilda ewe	"	"	"	1	107
White faced heather ewe	"	"	"	1	111
Highland horned ewe	"	"	"	1	113
St Kilda ram	"	"	"	1	112
Hampshire down ewe	"	"	"	1	139
Dorset horned ram	"	"	"	1	136
Brancaster	Tibia	Distal breadth		31	23.2–27.7
Corstopitum	"	"	"	14	15–18
Exeter	"	"	"	51	21.3–29.2
Stanham Aspel	"	"	"	2	26–27
Brancaster	Metatarsal	Total length		10	137–145
Corstopitum	"	"	"	10	108–128
Exeter	"	"	"	3	112–127
Cranborne Chase	"	"	"	5	119–126
St Kilda ewe	"	"	"	1	116
Highland horned ewe	"	"	"	1	128
St Kilda ram	"	"	"	1	124
Dorset horned ram	"	"	"	1	147
Hampshire down ewe	"	"	"	1	150

Table 10: The relative contribution of the major domestic food species to the diet

	No. of fragments	Percentage after figures adjusted for meat yield
Cattle - early Roman	3,132	94.4%
late Roman	193	88 %
Sheep - early Roman	1,169	4.9%
late Roman	138	8.7%
Pig - early Roman	103	0.7%
late Roman	32	3 %

Table 11 : Estimated carcass weights of cattle

	BRANCASTER (Early Roman)			*OTHER ROMANO-BRITISH SITES		
Bone	n	Mean CW (kg)	Range of CW (kg)	n	Mean CW (kg)	Range of CW (kg)
Humerus	12	156.1	144.8-176.8	4	154	146-168
Calcaneus	4	163.24	154.1-182.3	2	155	-
Metatarsal	6	162.94	155.1-173.9	12	167	157-187
Astragalus	15	163.67	160.9-168.2	14	166	-

* data after Noddle (1975)

TABLE 12

THE BIRD SPECIES AND SKELETAL ELEMENTS FROM THE WHOLE SITE

	Domestic Fowl	Domestic Goose	Domestic Duck	Black Throated Diver	[illegible]	Woodcock	Rock dove/feral Pigeon	Raven	Indeterminate Species	TOTAL
SKULL	–	1	–	–	–	–	–	1	–	2
CORACOID	2	–	–	–	–	–	–	–	–	2
FURCULA	1	–	–	–	–	–	–	–	–	1
HUMERUS	2	–	–	–	–	*1	–	2	–	5
RADIUS	*3	–	–	2	–	–	–	–	1	6
ULNA	1	–	–	2	–	1	1	4	1	10
CARPOMETACARPUS	–	–	–	1	–	–	–	3	1	5
OS COXA	–	–	–	–	–	–	–	–	[illegible]	2
FEMUR	*[illegible]	1	2	–	[illegible]	–	–	–	–	6
TIBIOTARSUS	*[illegible]	–	1	[illegible]		–	–	*[illegible]	*	17
FIBULA	[illegible]	–	1	[illegible]	–	–	–	–	–	2
TARSOMETATARSUS	[illegible]	–		[illegible]	–	–	–	1	–	4
PHALANGES	[illegible]	–	–	[illegible]	–	–	–	–	–	6
SYNSACRUM	–	–	–		–	–	–	–	–	2
TOTAL	[illegible]	2	4	17	[illegible]	[illegible]	1	16	[illegible]	[illegible]

* All bones are from the early Roman period, except for one bone in each of the numbers which are asterisked.

Table 13: The relative proportions of the major domestic species

	Cattle		Sheep		Pig		Horse		Dog		Total Identified Bone
Period	No. of fragments	%	No. of fragments	%	No. of fragments	%	No. of fragments	%	No. of fragments	%	No. of fragments
Beaker	6	67	3	33	–	–	–	–	–	–	9
Bronze Age	45	76	8	14	3	5	1	2	–	–	59
Iron Age	18	44	21	5	–	–	1	2	1	2	41
Early Roman	3,132	69	1,169	26	103	2	93	2	36	1	4,533
Late Roman	193	52	138	37	32	9	6	2	3	1	372
Post Roman	304	67	114	25	13	3	17	4	4	1	452
Total	3,698	67	1,453	27	151	3	118	2	44	1	5,464

LIST OF FIGURES

has been arbitrarily divided into three sections, proximal, midshaft and distal. (Figures used are for the earlier Roman phase only, and include 'cattle-sized' fragments).

Figure 9 — Butchery analysis of sheep: a. chop-marks and b. knife-cuts. Occurrence of butchery marks is expressed as percentages of the number of bone fragments present. For this purpose, each bone has been arbitrarily divided into three sections, proximal, midshaft, and distal. (Figures used are for the earl Roman phase only, and include 'cattle-sized' fragments).

Figure 11 — Overall fragmentation patterns of the five major domestic species present on the site (cattle, sheep, pig, horse and dog). Pie diagrams show the percentage of bones of different sized fragments as a fraction of the total for all skeletal elements. (Figures used are for the combined earlier and late Roman phases).

Figure 12 — Histogram of the age at death or slaughter for the populations of cattle and sheep from the earlier and late Roman phases of site occupation.

A. Percentage of cattle dying in each of the four age classes (see text) as calculated from the epiphyseal fusion of the long bones.

B. Percentage of sheep dying in each of the four age classes (see text) as claculated from the epiphyseal fusion of the long bones.

C. Percentage of cattle dying in each of the four age classes (see text) as calculated from the tooth eruption and wear in the mandibles.

D. Percentage of sheep dying in each of the four age classes (see text) as calculated from the tooth eruption and wear in the mandibles.

Figure 10 — Diagrammatic summary of types of butchery mark on:

A. cattle.

B. sheep.

Figure 1

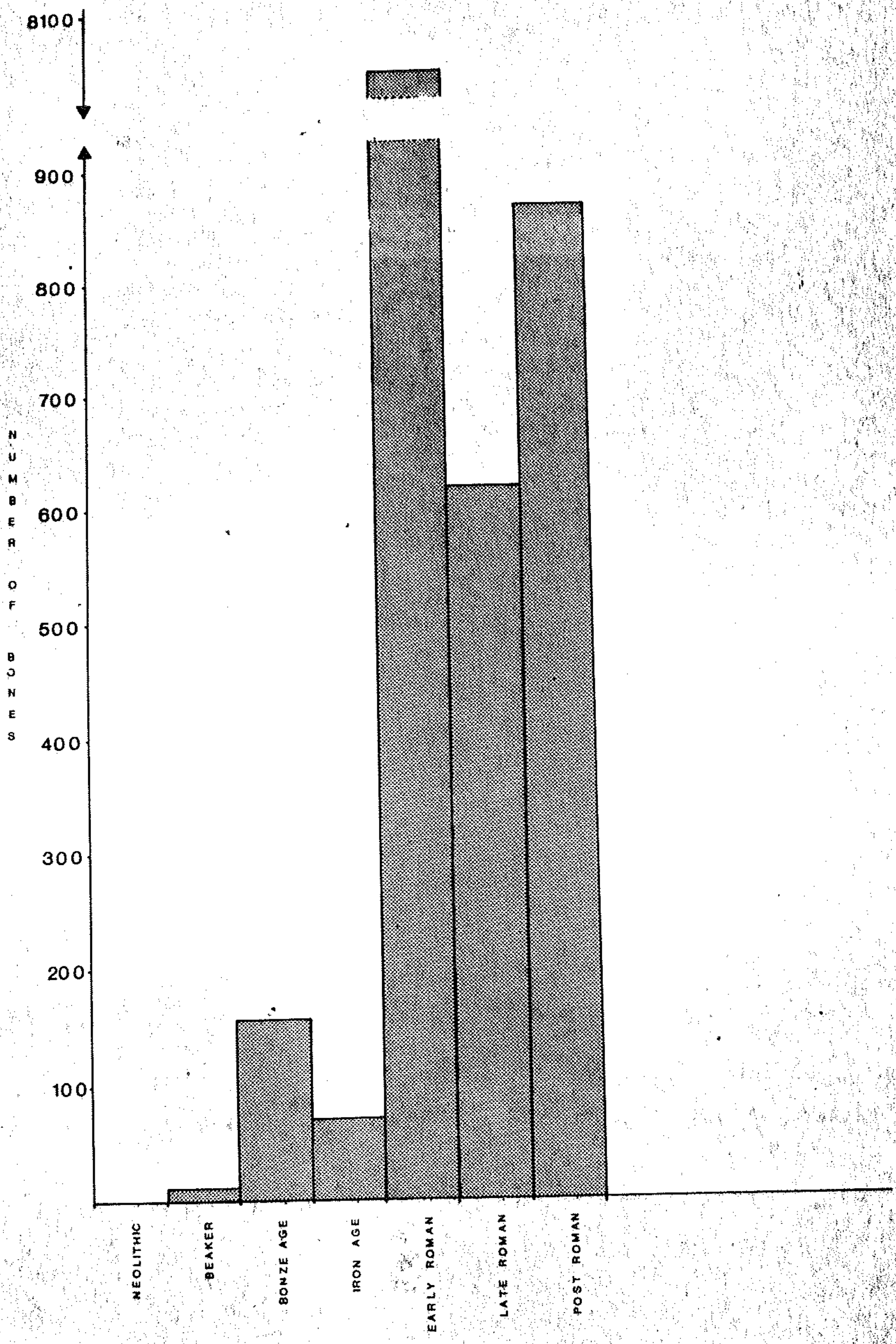

8100
900
800
700
600
500
400
300
200
100
NUMBER OF BONES
NEOLITHIC
BEAKER
BONZE AGE
IRON AGE
EARLY ROMAN
LATE ROMAN
POST ROMAN

Figure 2 : The relative proportions of the various skeletal elements from the three main domestic food species (cattle, sheep and pig) for the earlier Roman period.

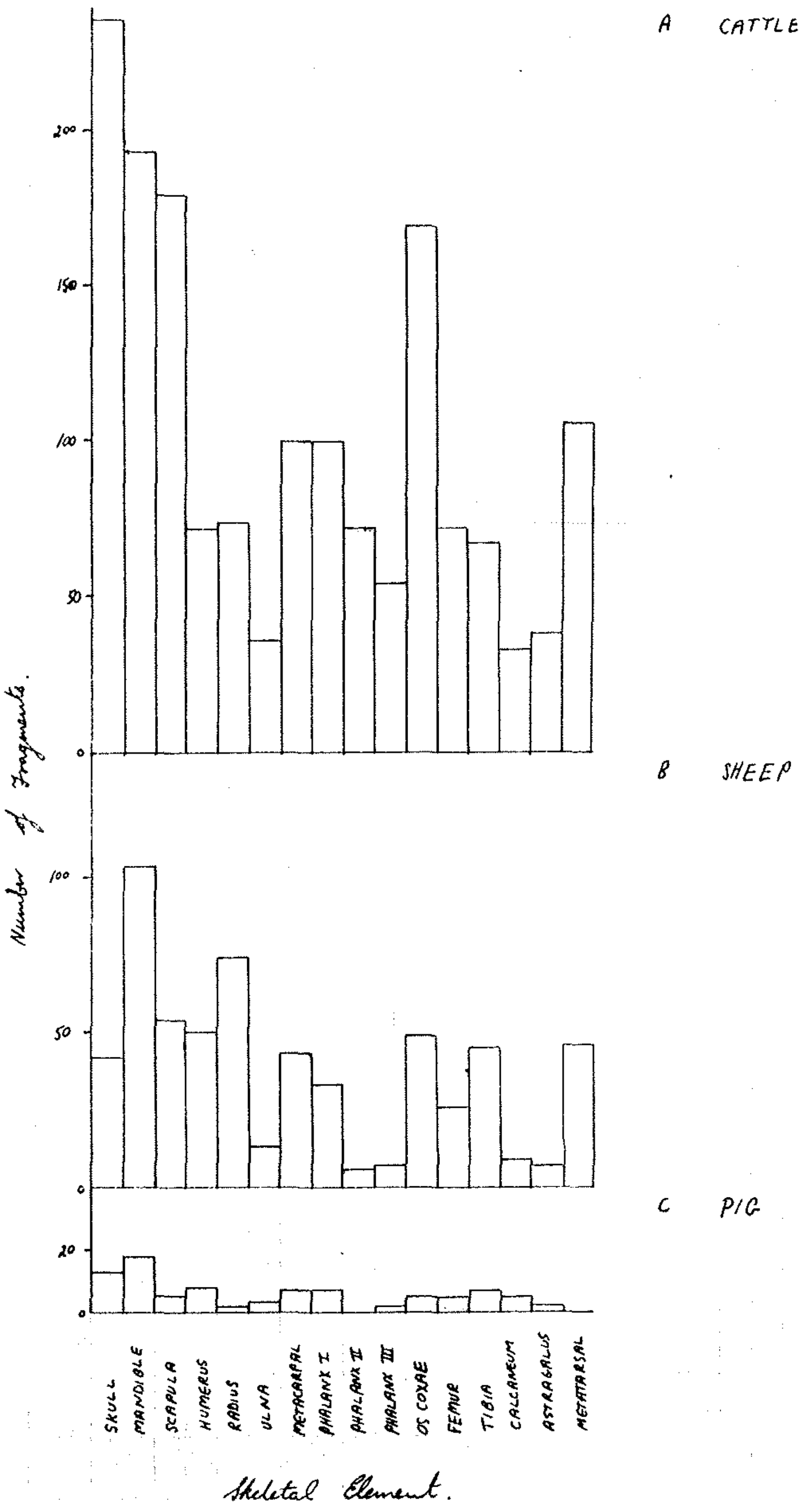
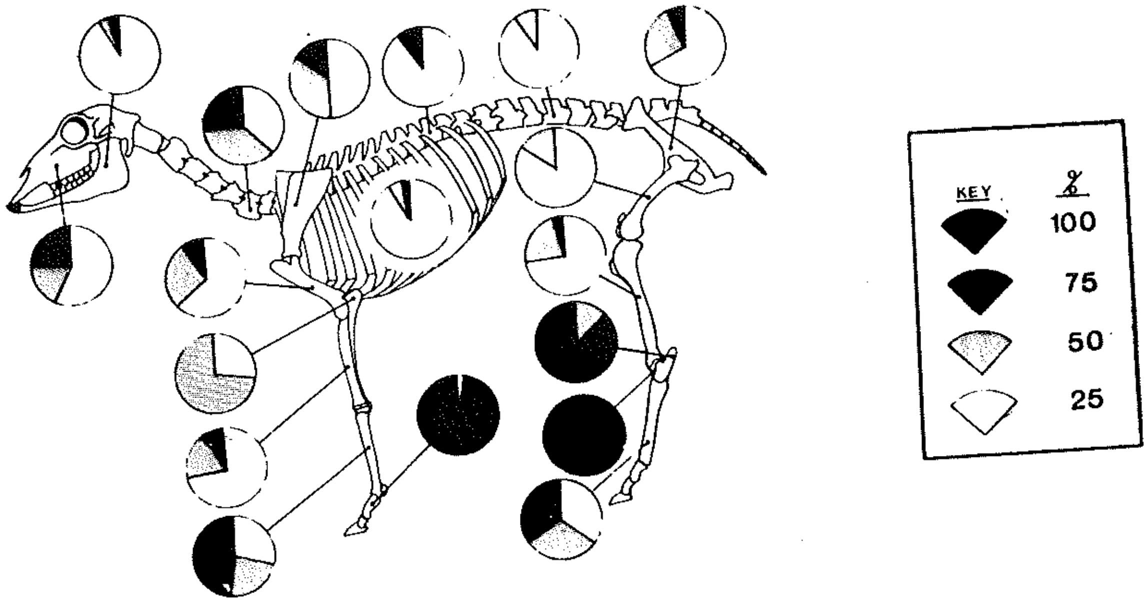
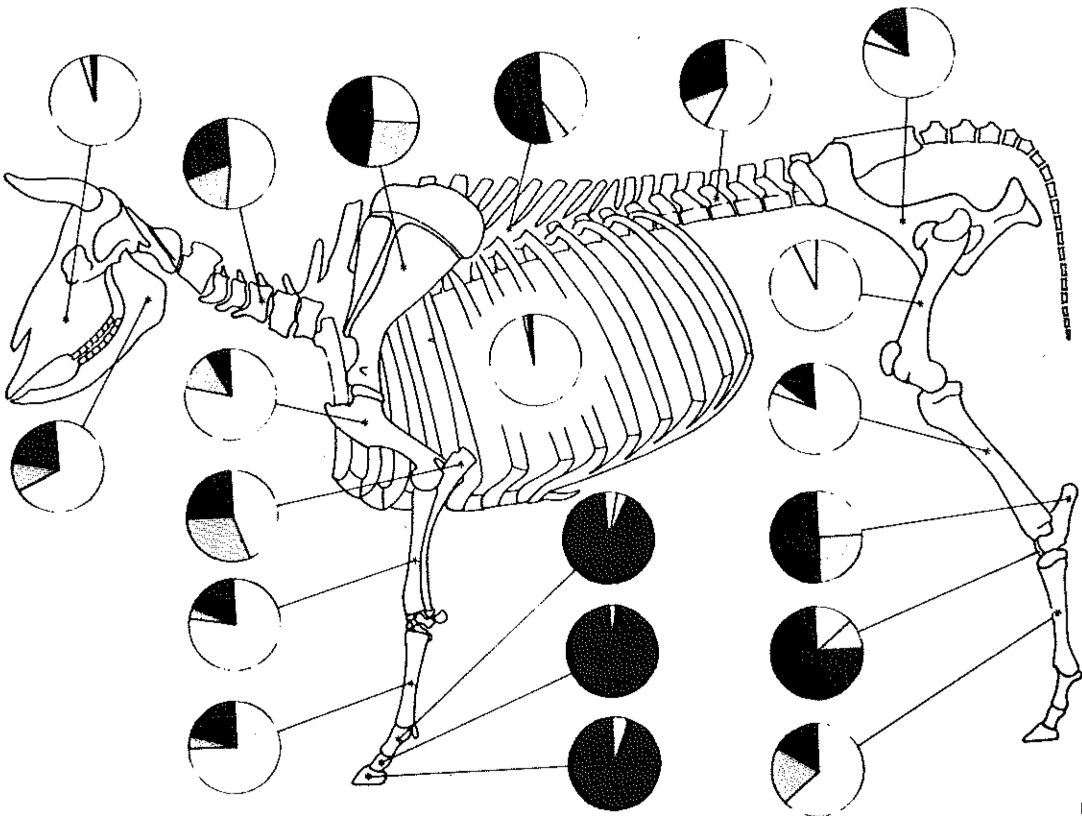


Figure 3



A



B

Figure 4

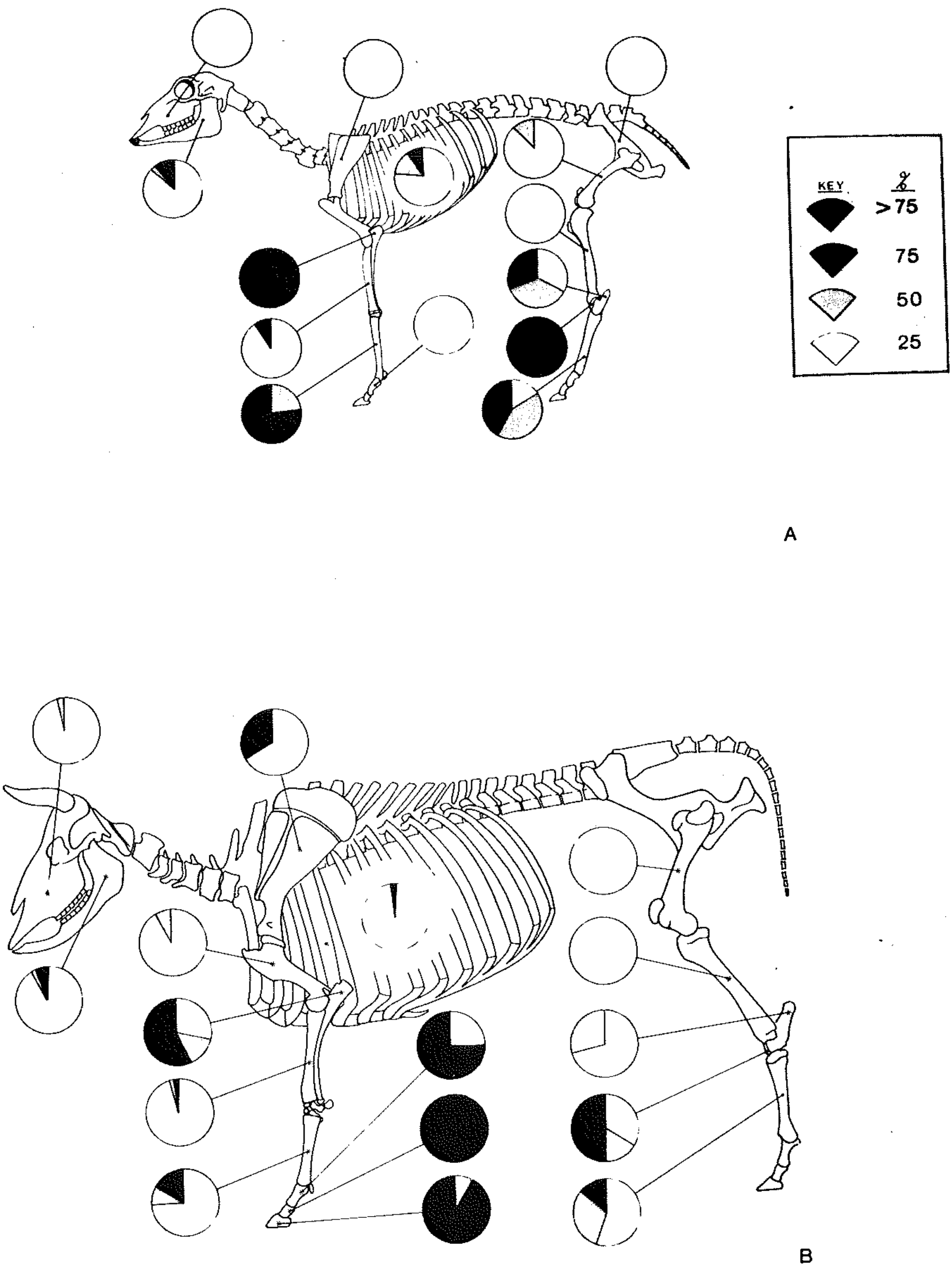
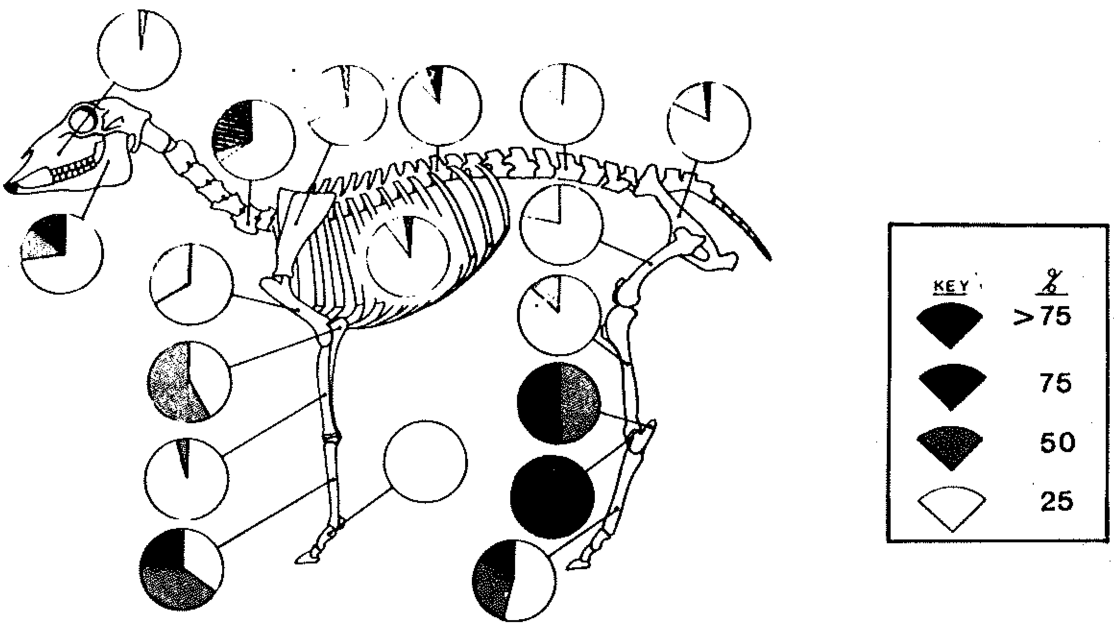
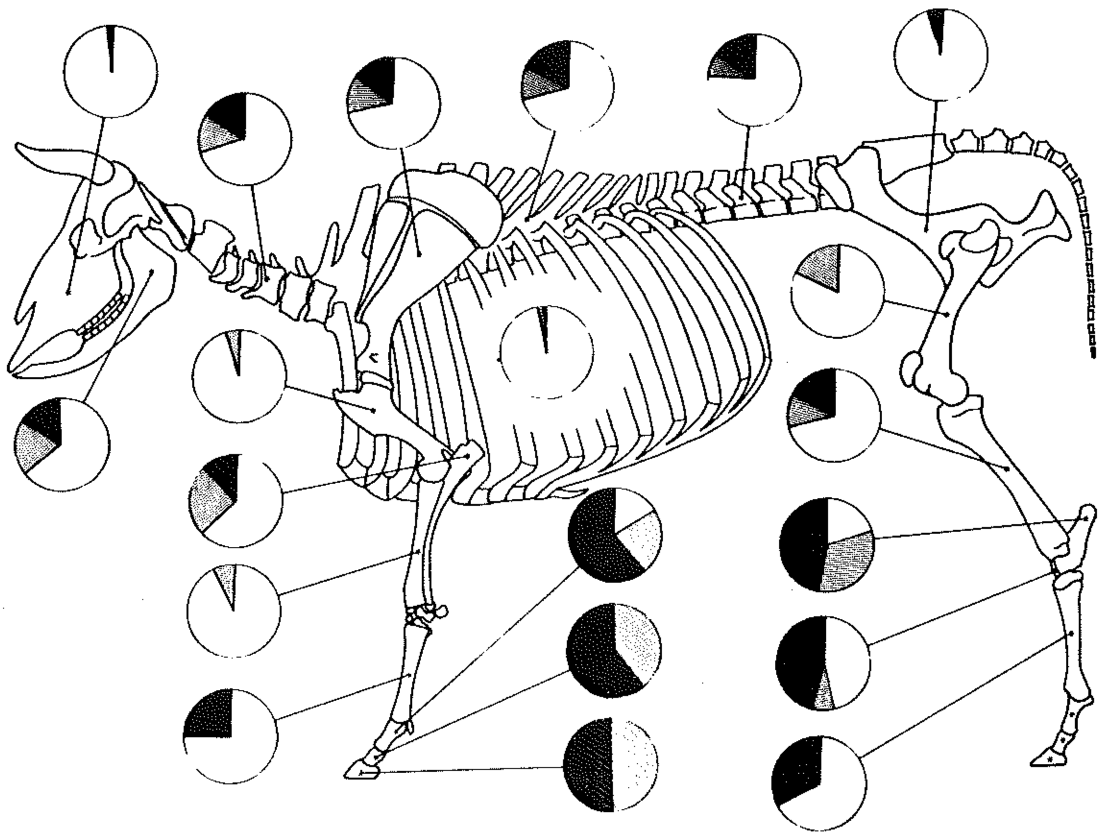


Figure 5

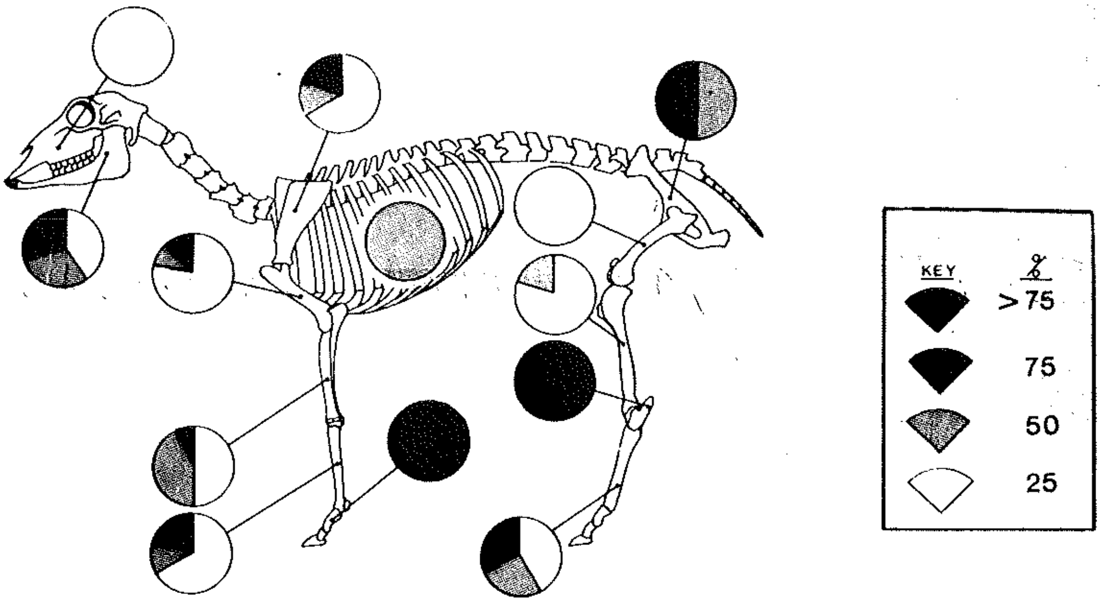


A

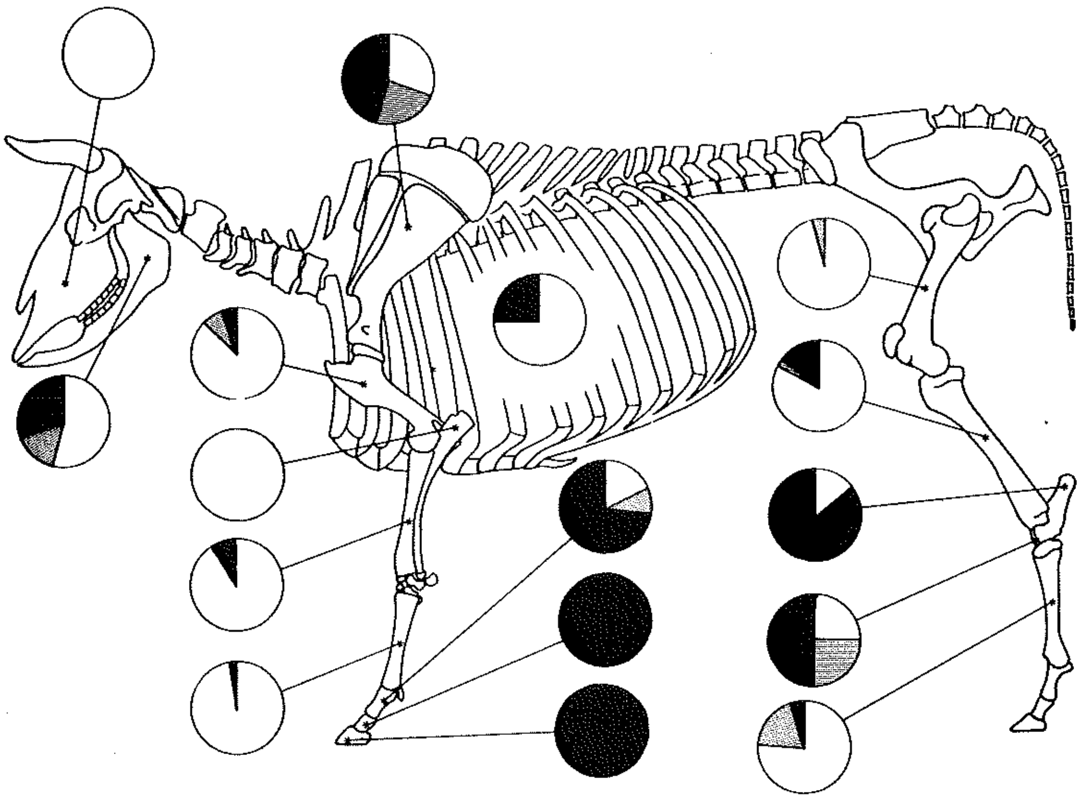


B

Figure 6

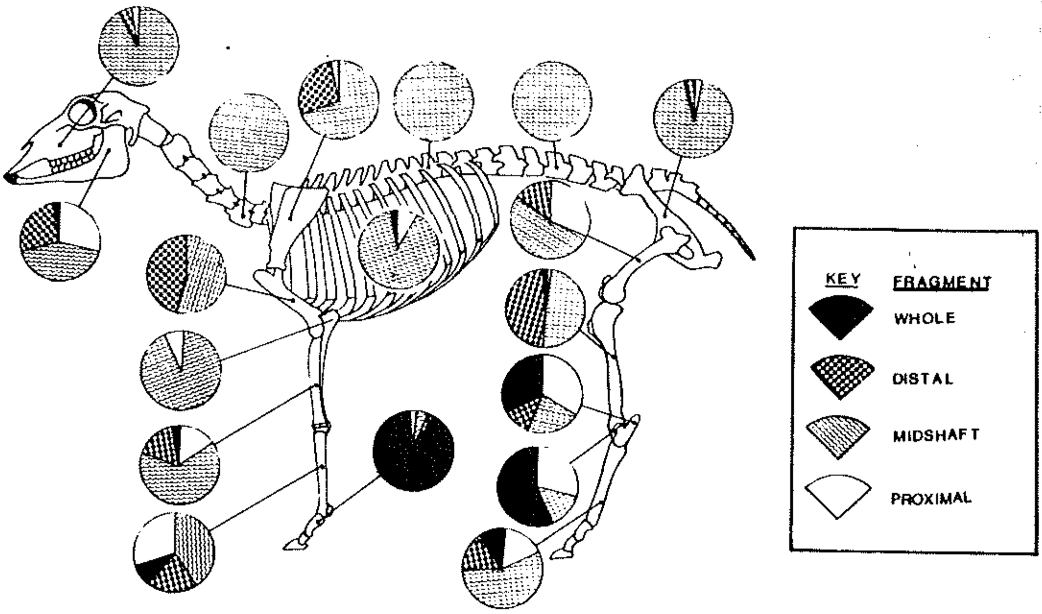


A

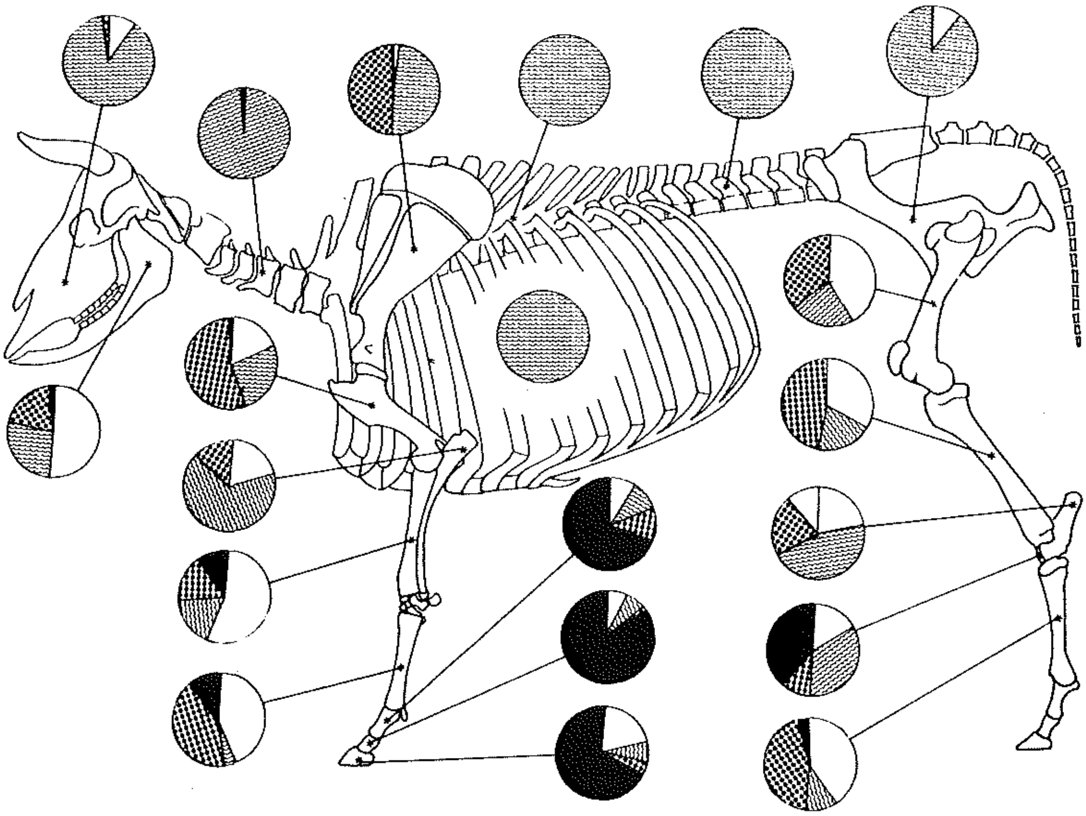


B

Figure 7



A



B

Figure 8

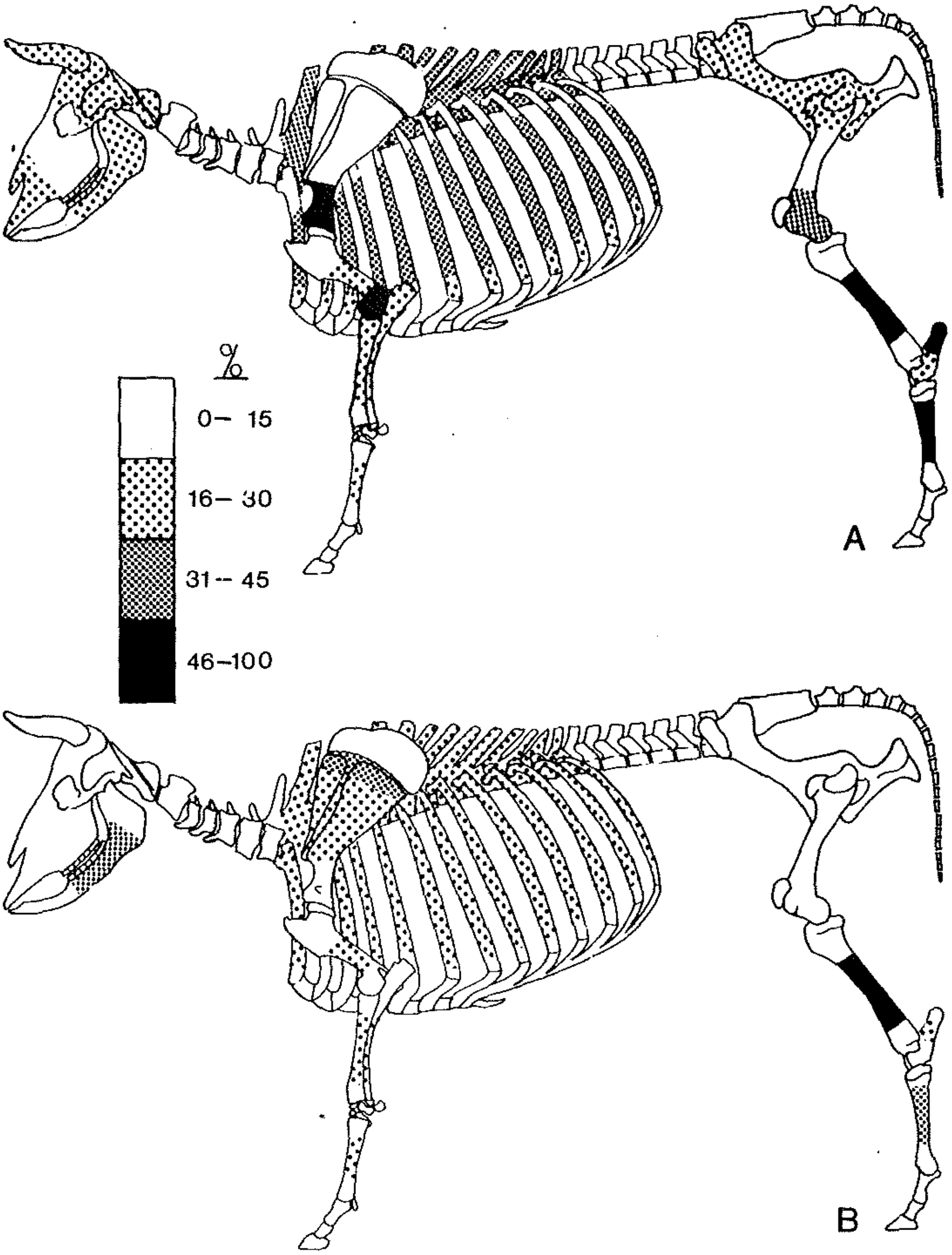


Figure 9

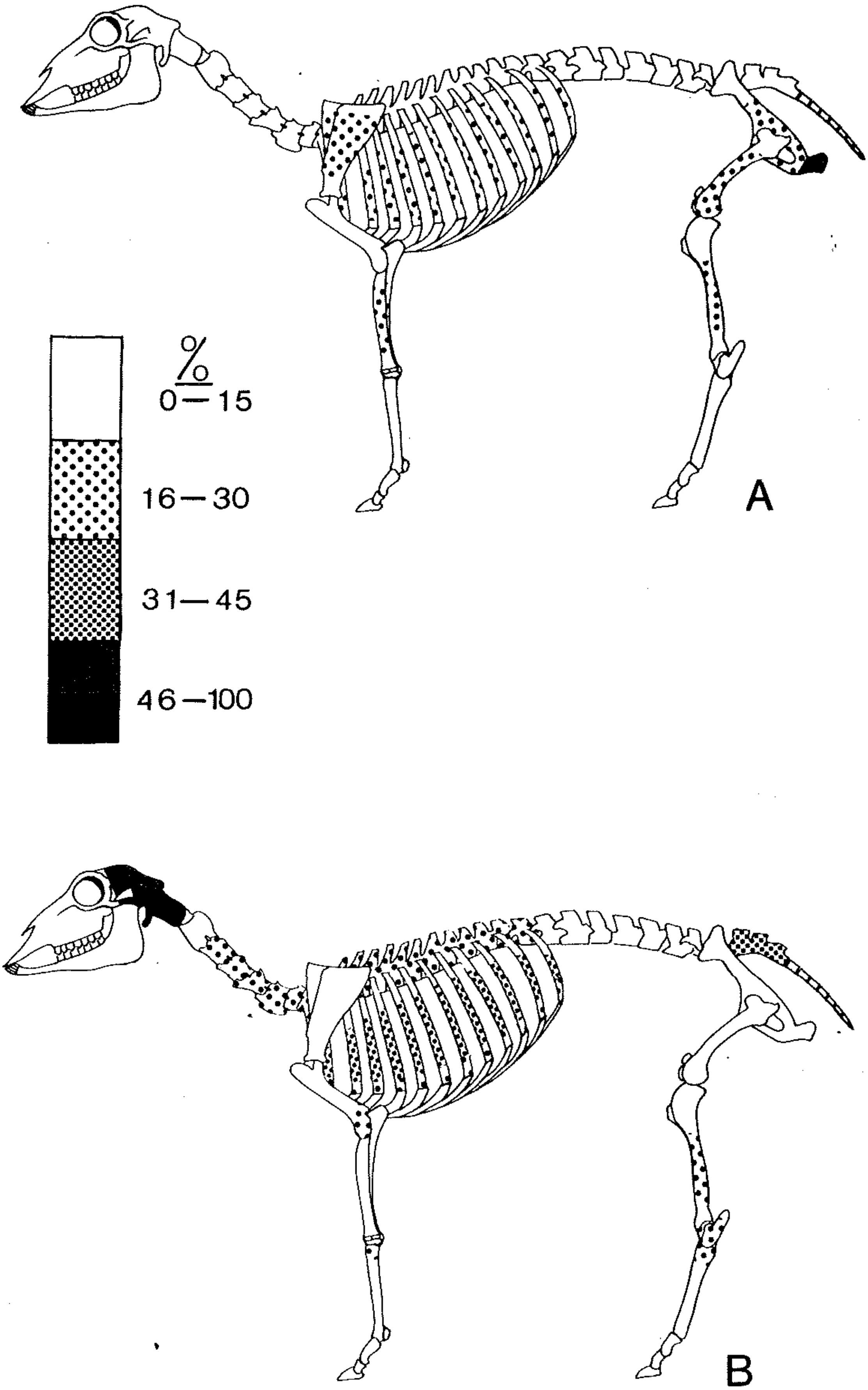
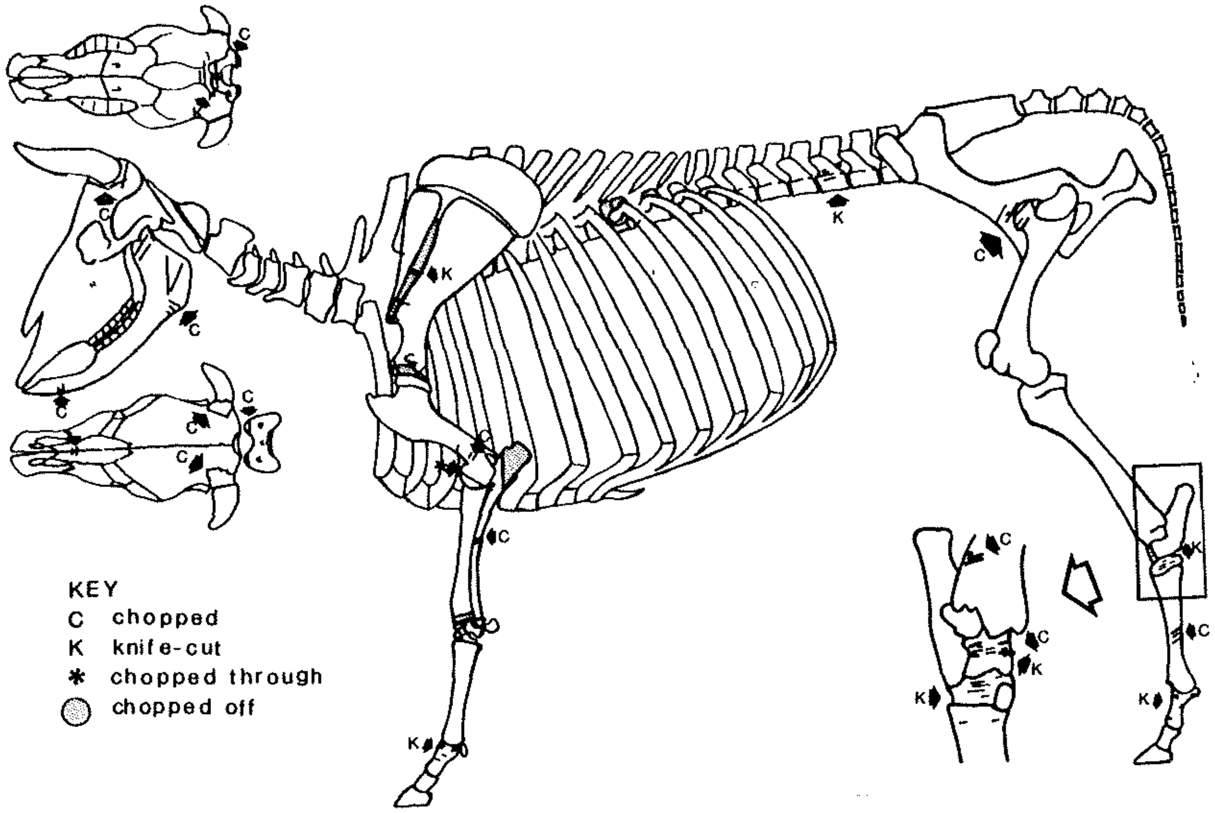


Figure 10.

A.


KEY
C chopped
K knife-cut
* chopped through
chopped off

B.

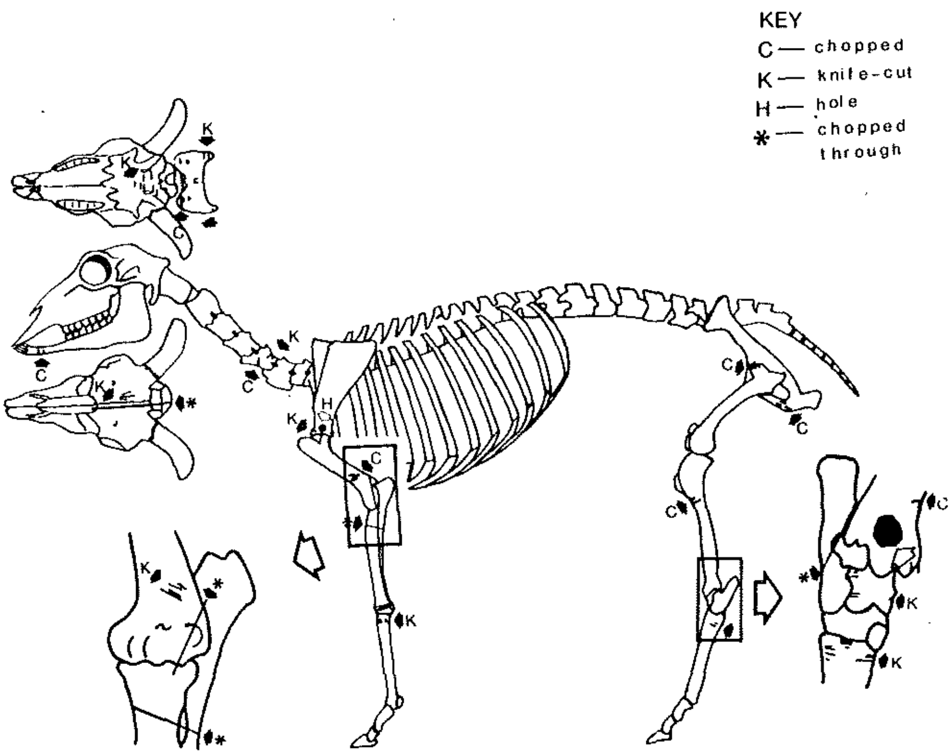

KEY
C — chopped
K — knife-cut
H — hole
* — chopped through

Figure 11

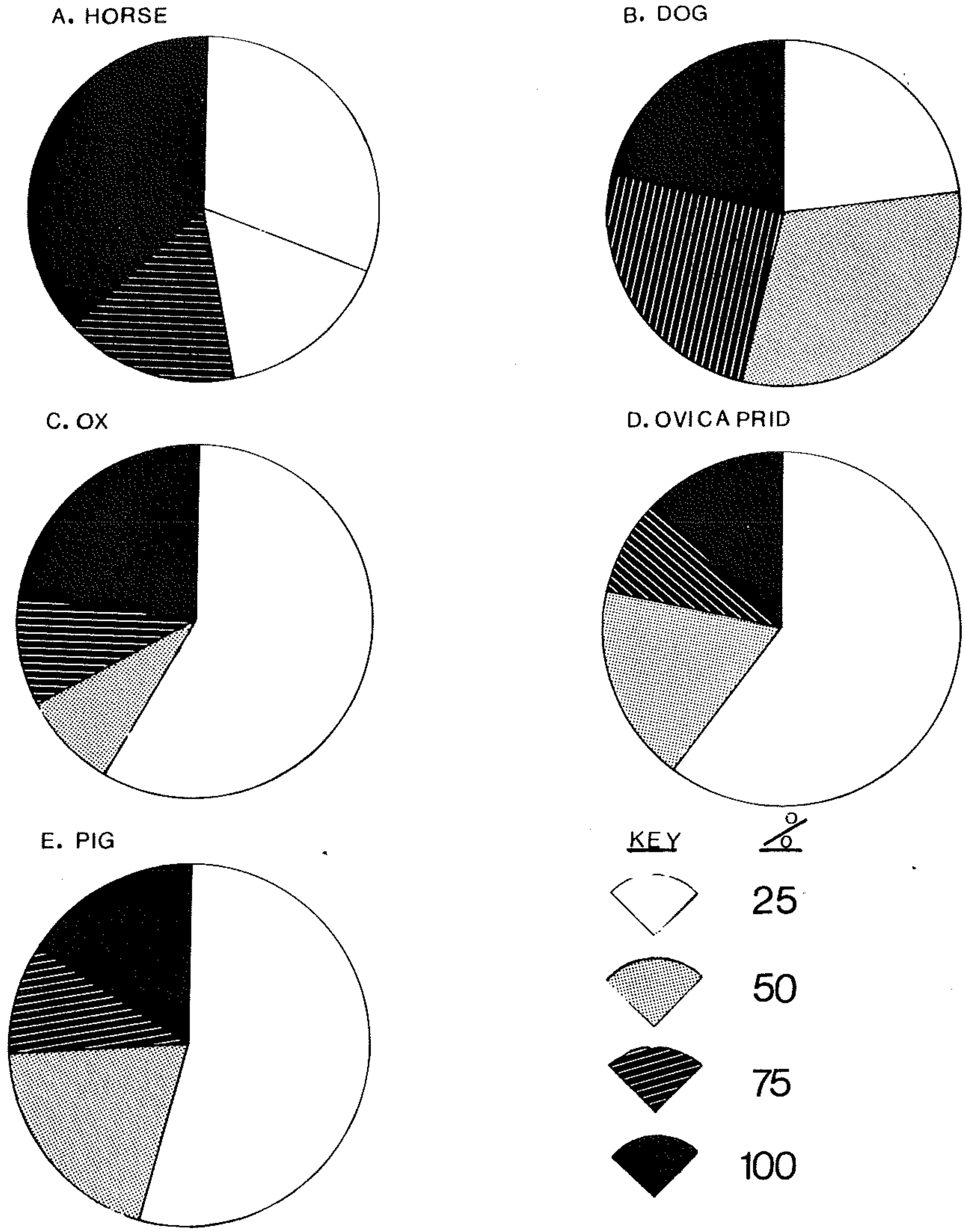


Figure 12

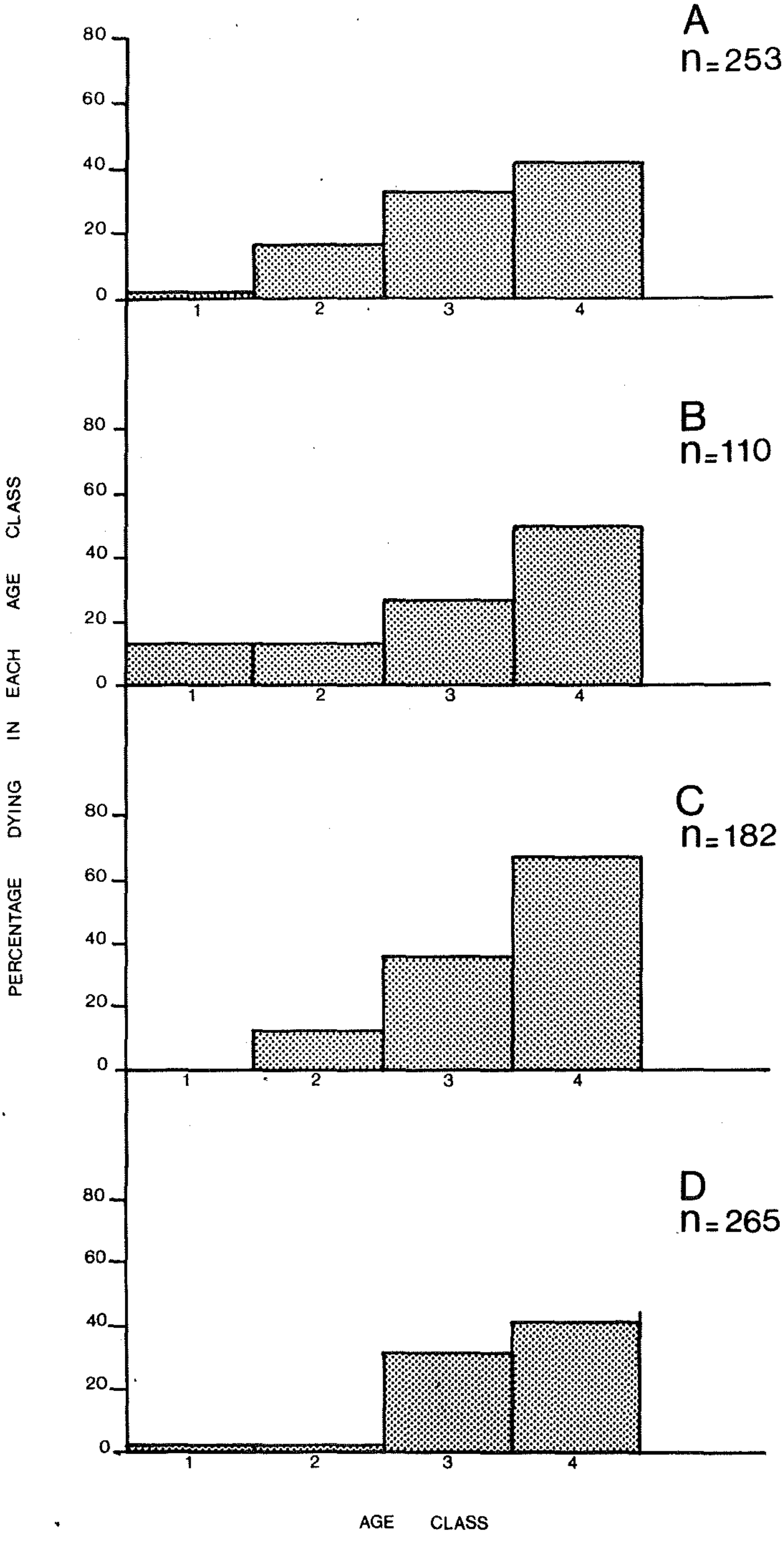

A
n=253
B
n=110
C
n=182
D
n=265
PERCENTAGE DYING IN EACH AGE CLASS
0
20
40
60
80
1
2
3
4
AGE CLASS

PLATE 1 : The most complete cattle skull recovered from the site, in which the frontal bones are intact, indicating that, in this individual at least, the animal had not been slaughtered by pole-axeing. The caudal part of the frontal bones had been chopped through in removing the horns(chop-marks are indicated by an arrow).

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PLATE 3 : Two sheep mandibles showing pathological ohanges.

A : (Right,buccal view). The bone of the ramus has receeded around the base of the second and third molars.

B : (Left, lingual view). Structural changes have occurred in the bone of the ramus around the base of the second and third molars. The bone in this region is more porous.

PLATE 4 : Two sheep mandibles showing pathological changes.

A : (viewed from above). The socket of the third molar is slightly enlarged.

B : (viewed from above). The third molar is missing - probably lost antemortem - and the alveolar cavity is enlarged, and there has been an increase in the bone of the ramus in this region, especially on the lingual side.

PLATE 5 : A sheep mandible showing pathological changes.

The alveolar cavity of the fourth premolar has become enlarged, with concomitant osseous growth on both lingual and buccal surfaces of the ramus extending partly around the first molar in one direction, and the third premolar in the other. The fourth premolar is missing : it may have been lost antemortem.

PLATE 6 : A dog mandible (left, lingual view) showing antemortem loss of all three incisors and the canine, with subsequent ossification of the alveolar cavities.

PLATE 7 : A cattle metatarsal(right, anterior view). The proximal joint surface has a moderate degree of exostosis, and the centroquartal, and fused second and third tarsals,have become attached by by extra bony growth to the metatarsal. The lateral distal shaft of the metatarsal has an area of exostosis, which has distorted the course of the vascular groove in this region.

PLATE 8 : A cattle second phalanx showing gross deformity due to an arthritic-type condition.

PLATE 9 : A cattle second phalanx (viewed from above). A lesion is visible on the proximal articular surface.

PLATE 10 : A pig skull (caudal view). The left side of the squamous part of the occipital bone has been depressed as the result of a trauma .

PLATE 11 : A pig skull (dorso-lateral view). The two loci of a healed trauma can be seen

PLATE 12 : Roman tile bearing the impression of a domestic cat's paw.

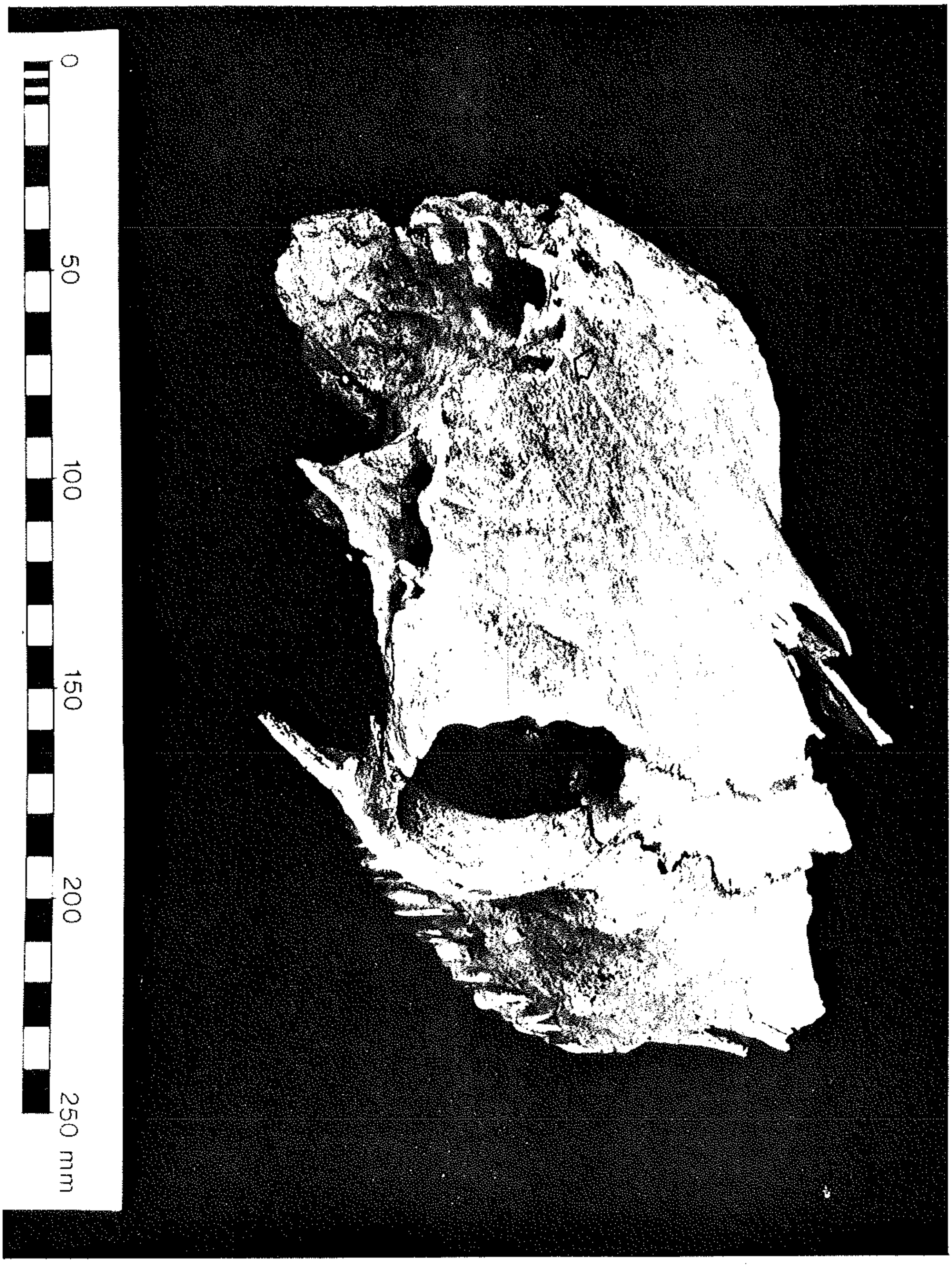
PLATE 13 : A horned sheep skull.

PLATE 14 : A naturally polled sheep skull, with a rudimentary horn bud.

PLATE 15 : A pig metapodial (A) from a Roman context at Brancaster with that from a modern zoo-bred wild boar(B) for size comparison.

PLATE 16 : A horse metatarsal which has been sawn through below the proximal articulatio probably in order to use the middle, shaft section, of the bone for bone working.

PLATE 17 : The centrum of a whale vertebra. Numerous chop-marks can be seen : possibly the result of butchery.



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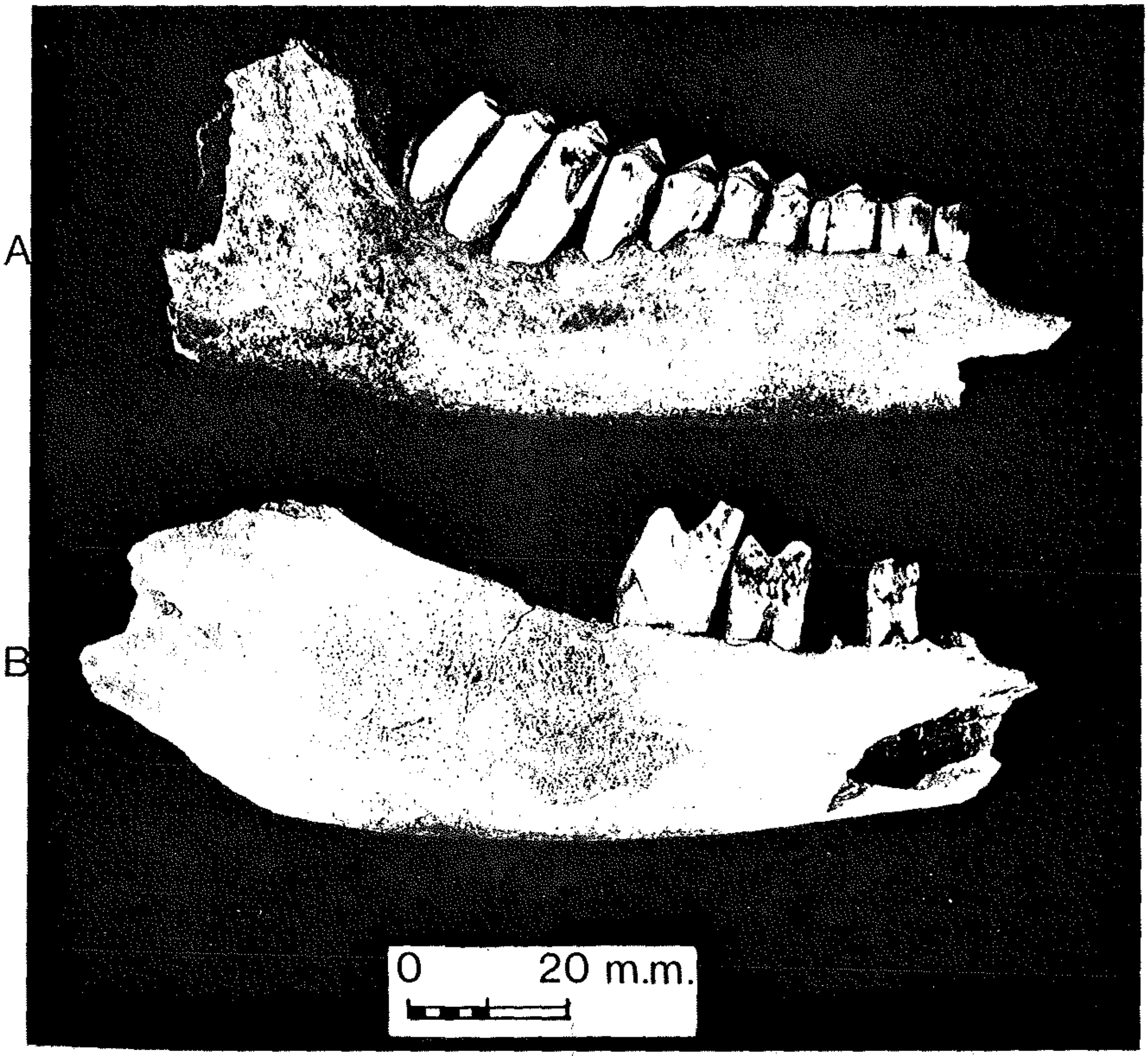

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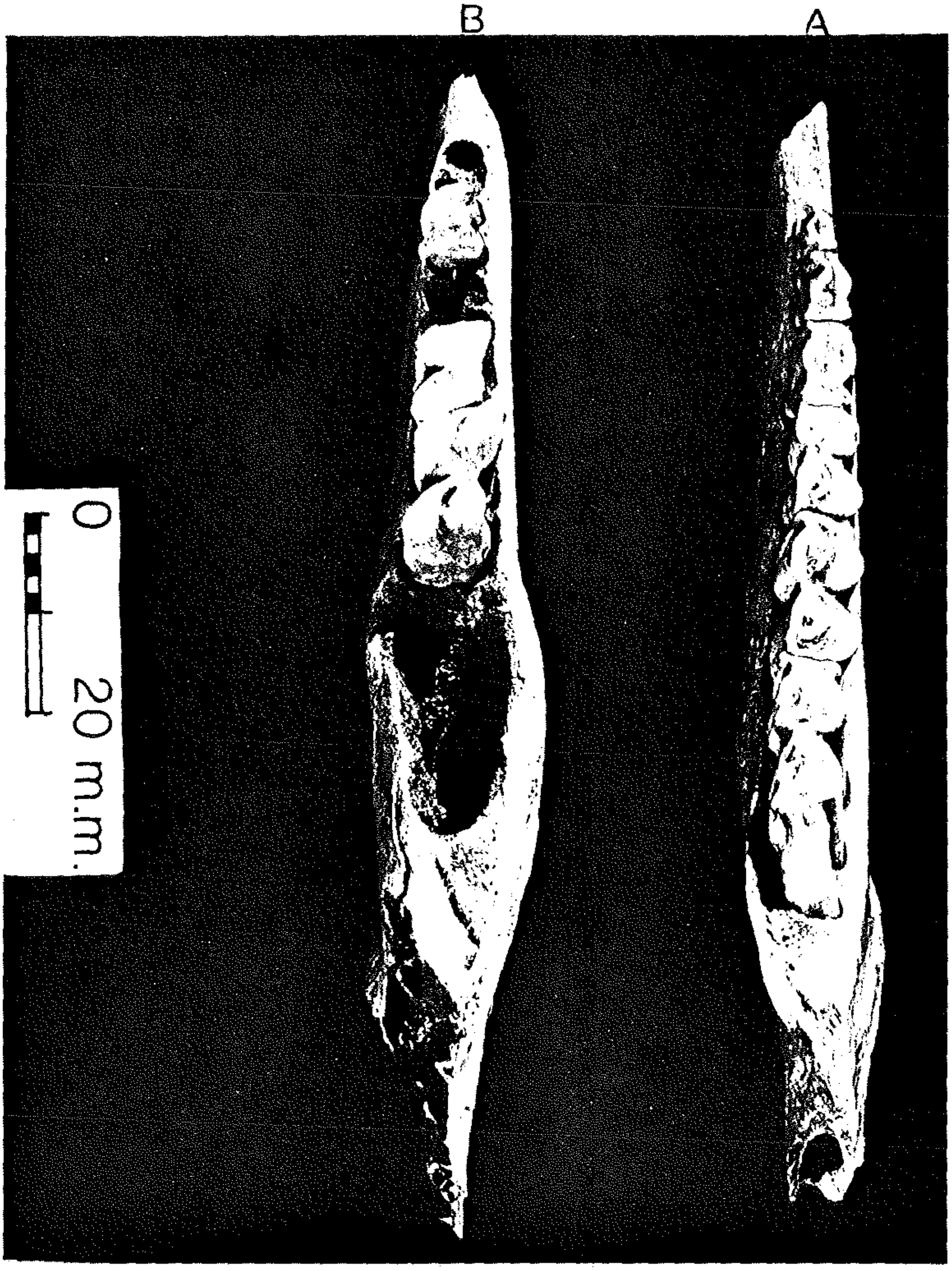

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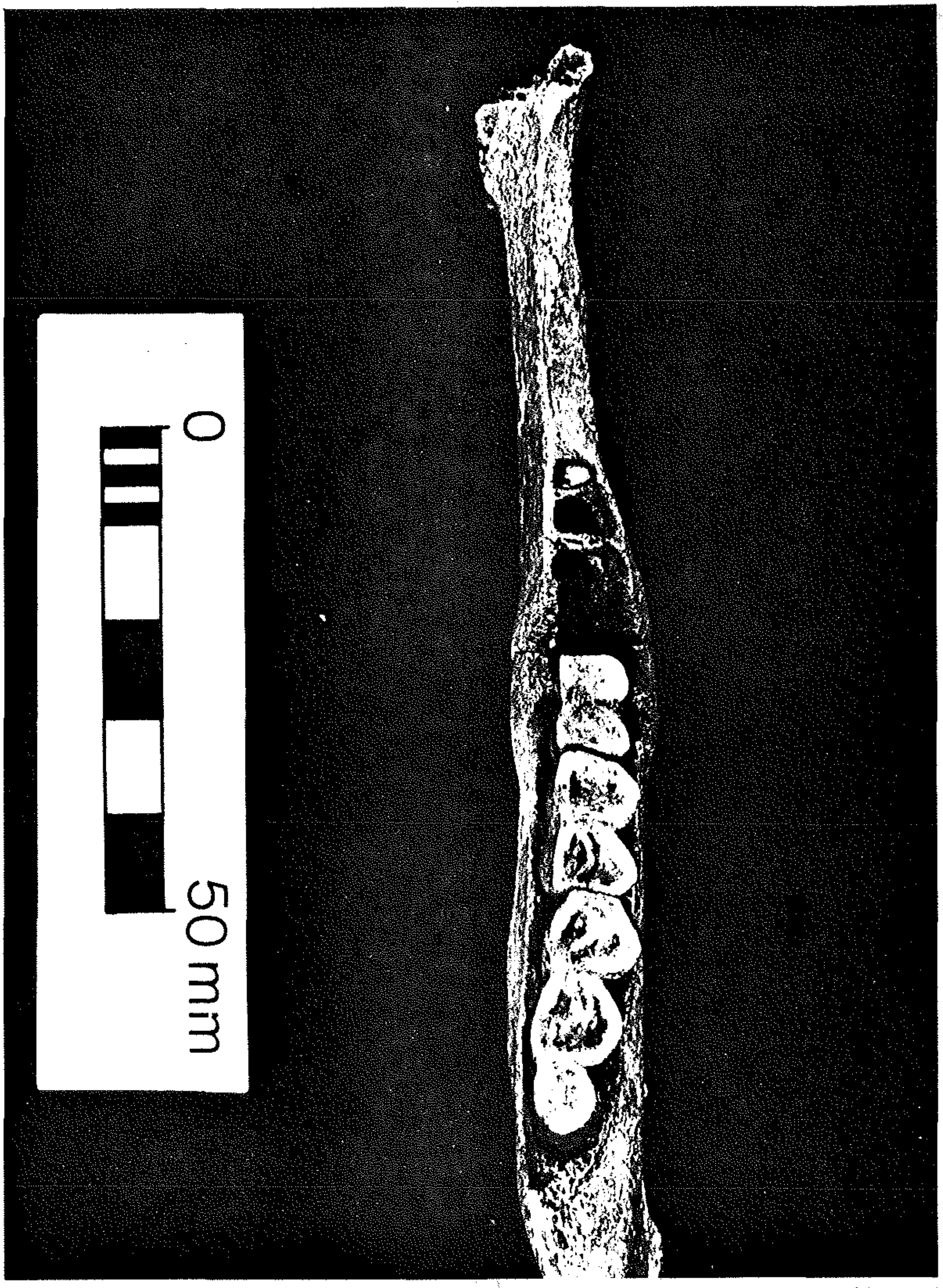

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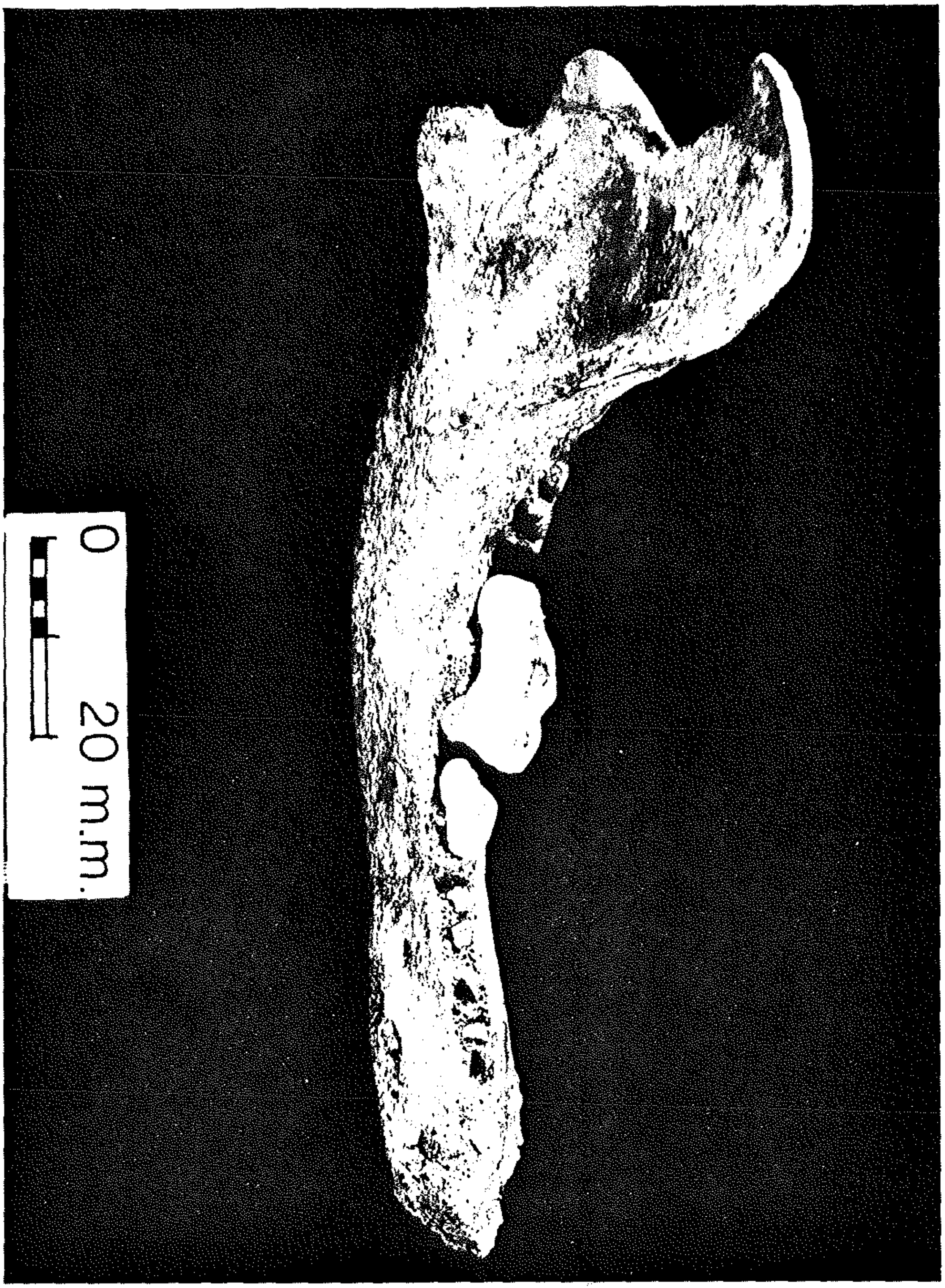

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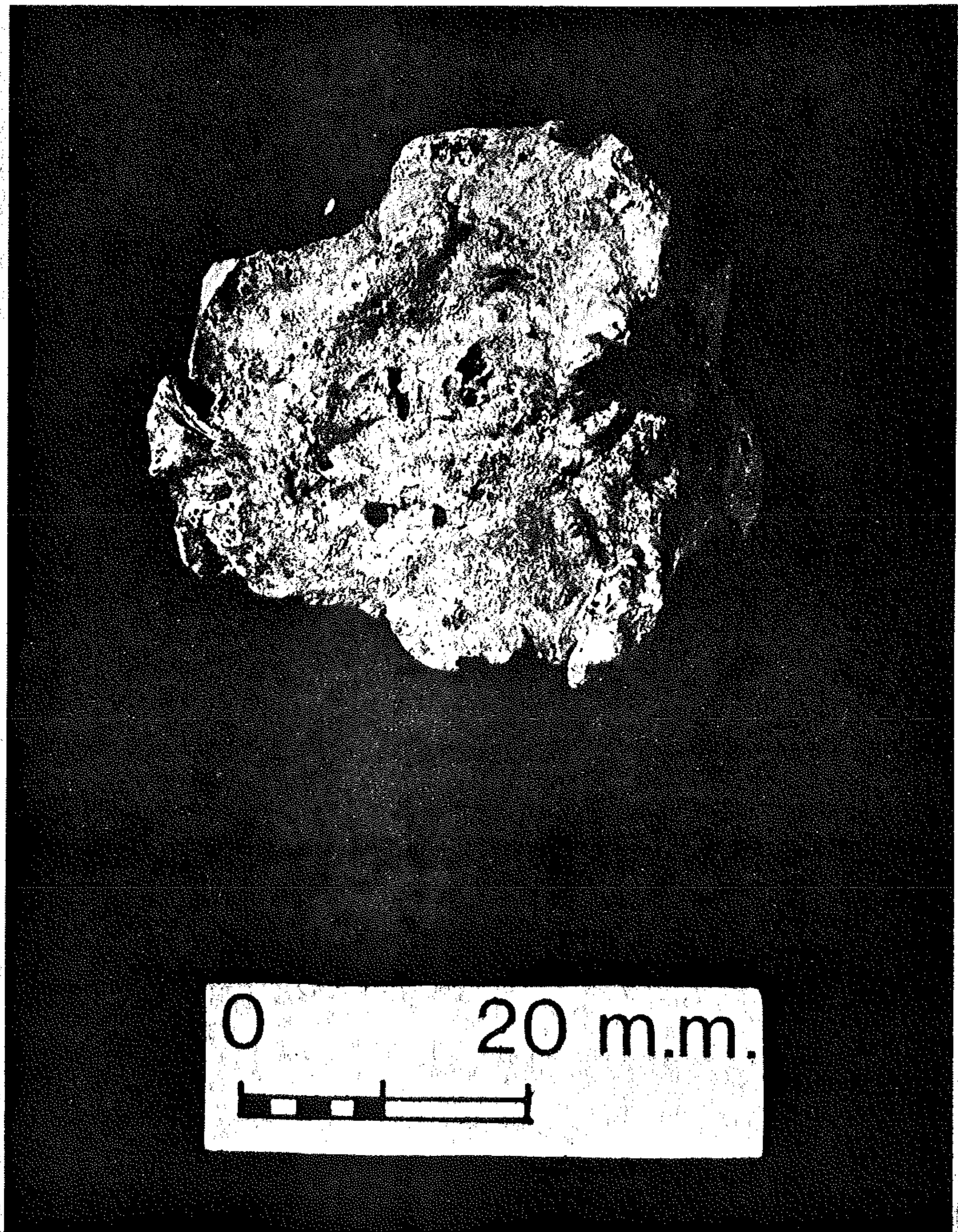

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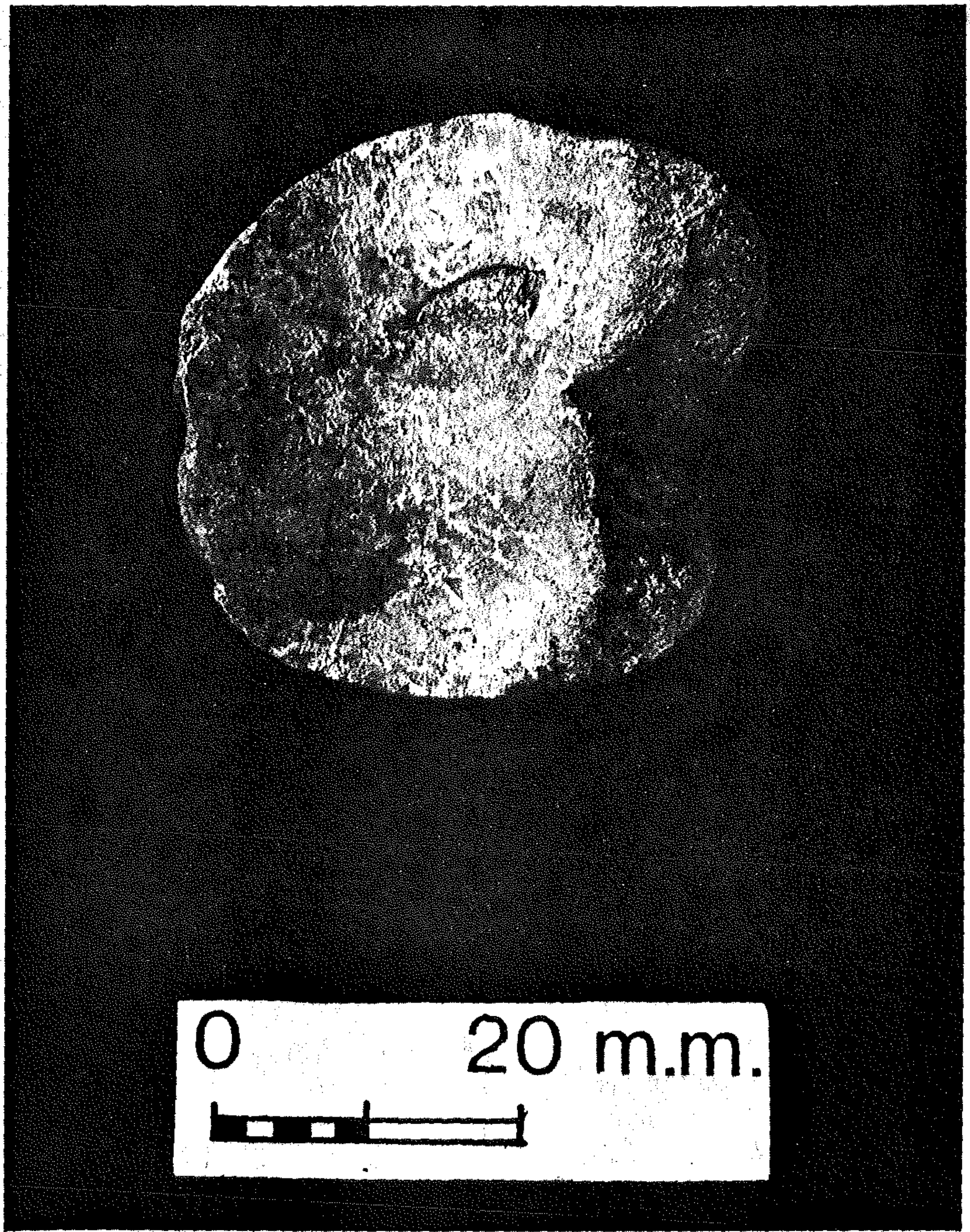

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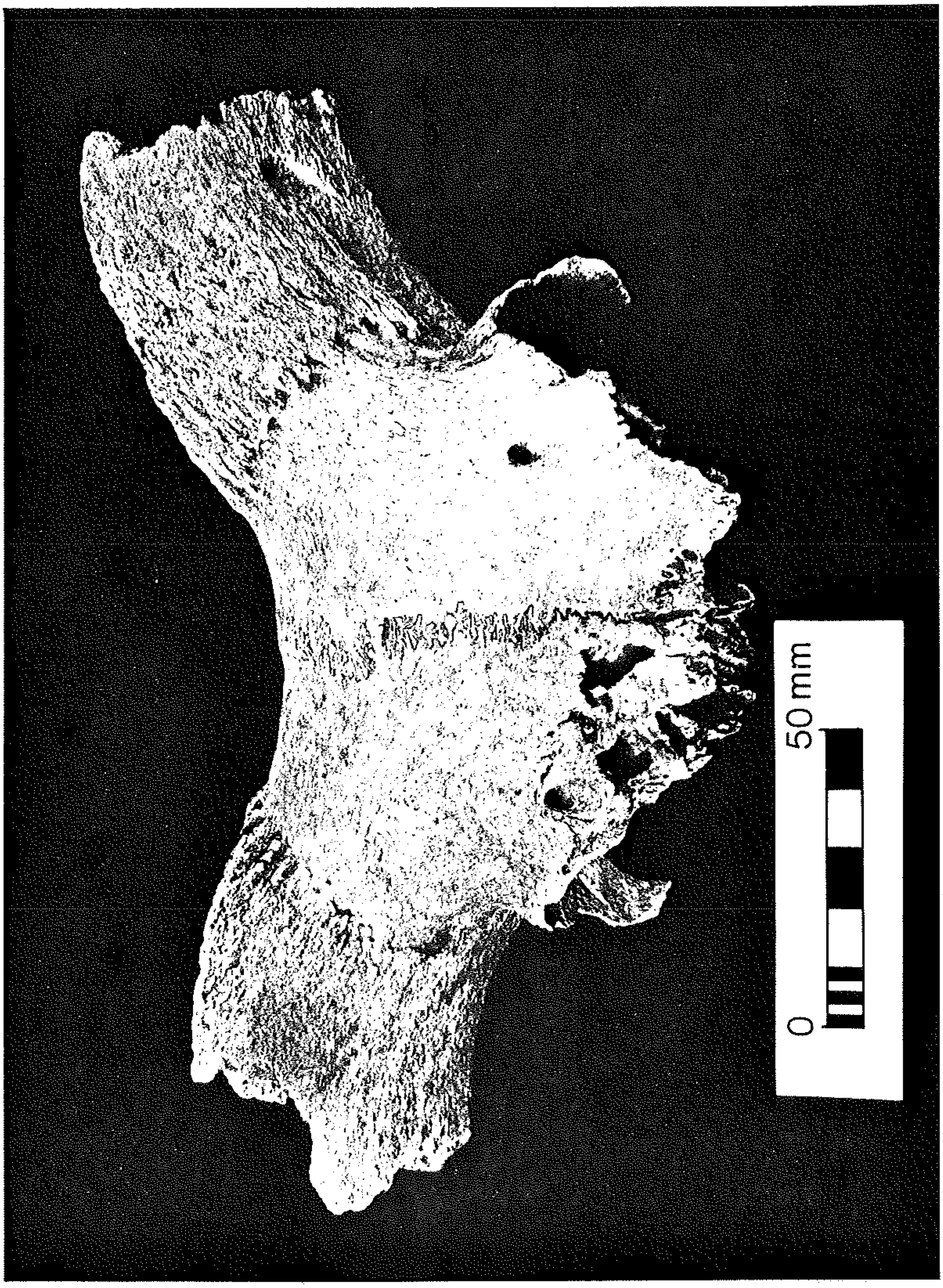

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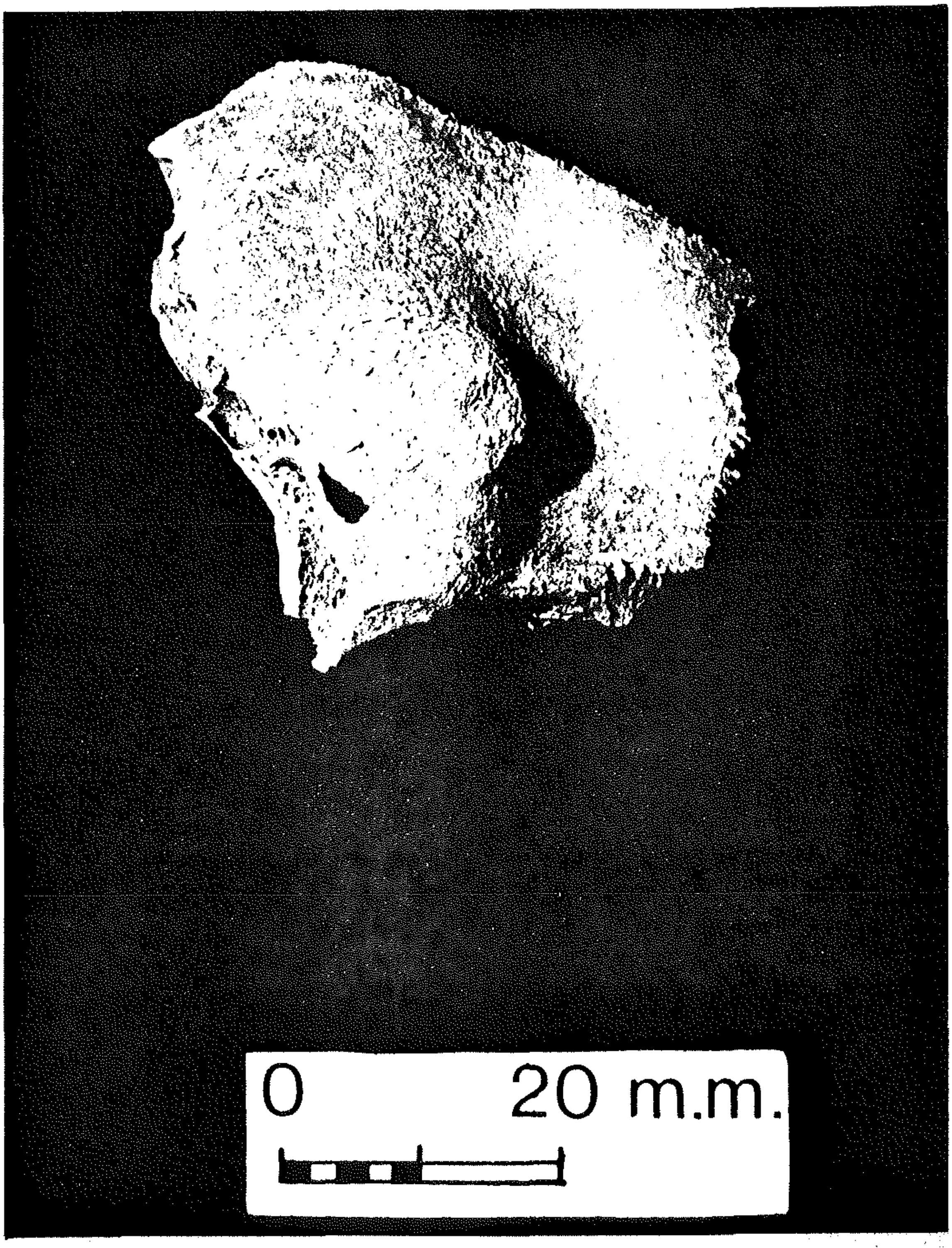

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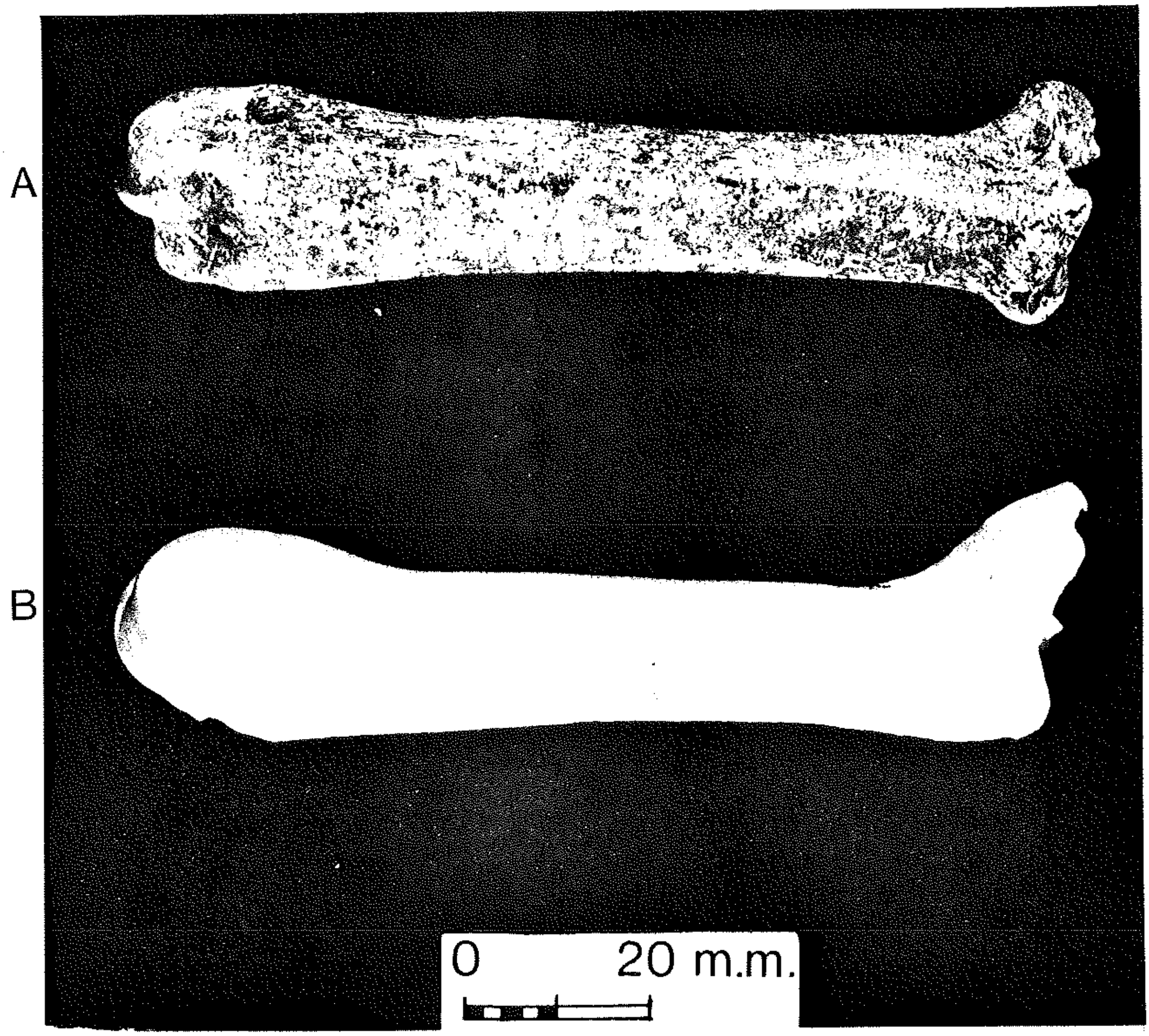

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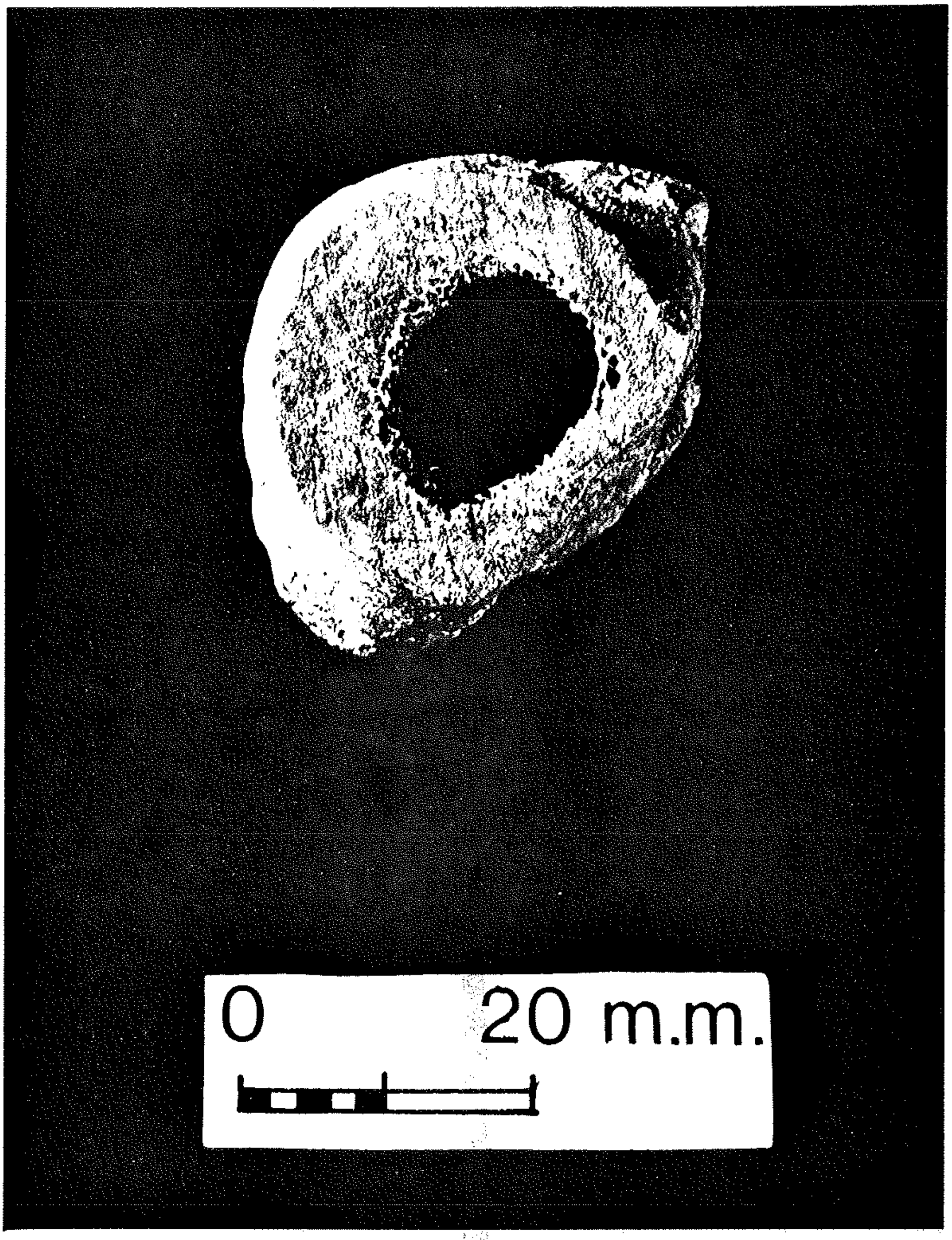

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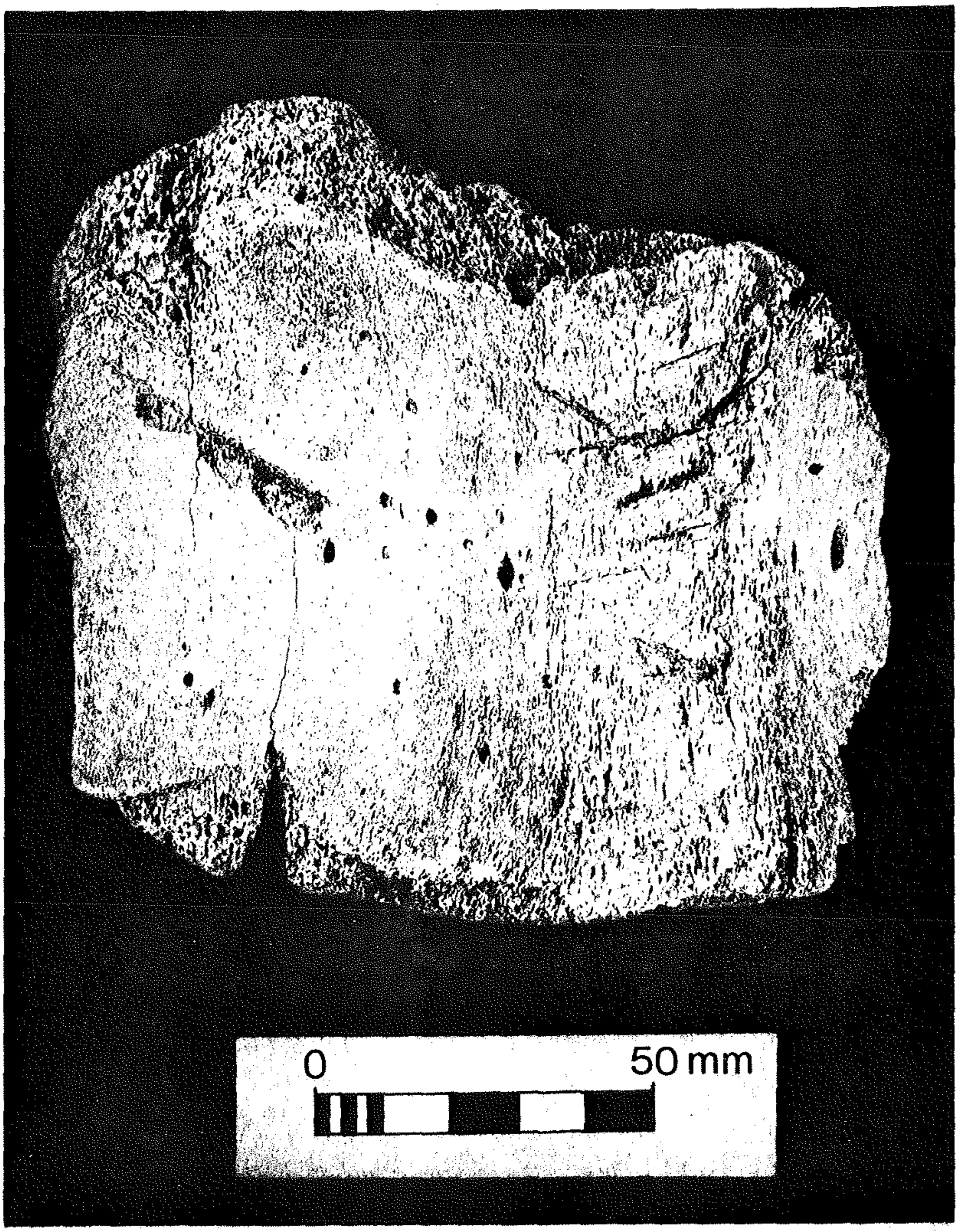

PLATE 17 : The centrum of a whale vertebra. Numerous chop-marks can be seen : possibly the result of butchery.

Worked Bone Objects

An examination of any bone objects found on the site was made. Of the twenty five found, four were from post - Roman, one from late Roman and the rest from earlier Roman contexts. Apart from one object fashioned from an antler tine, probably of red deer, they were all made from skeletal bones of domestic stock. In most cases, it was not possible to determine which species and which bone was used to make the object. However, ten of the objects were bone pins, and pig fibulae or horse 'splint' bones were commonly used for these, though this could not be ascertained with the objects in question and they could equally well have come from a different species and part of the anatomy. Another four of the objects showed no indication of their origin, and of the remaining ten, six were made from ovicaprid metapodials, one from an ovicaprid tibia, two from cattle metatarsals and the remaining object came from the limb bone of a large mammal.

Of note, was one of the ovicaprid bones, a right metatarsal. This bone was almost complete except that a hole pierced the proximal articular surface, 6mms in diameter. Its function can only be guessed at, but other examples have been observed by the authors from various periods including Saxon Ipswich and Medieval Ospringe, Kent. A similar example, but this time in cattle and not sheep bones, has been recorded from Althorpe Grove, Battersea (Locker, 1977). The specimen from Brancaster is also pierced anterio-posteriorly through the diaphysis. Also, Pitt-Rivers (1898) describes a [illegible], metatarsal [illegible] its' length, which is also obliquely scratched [illegible] as if [illegible]. He suggests that it could have been used [illegible] in a [illegible] similar way to one he had seen in use in a crofter's hut close to the Callernish Stones, in the island of Lewis, Hebrides. He describes [illegible] metapodial [illegible] 1875 with a longitudinal hole in the end from the articular surface and a hole transversely through the diaphysis. These he considered to have been used for winding [illegible], or perhaps as netting needles or as a bobbin, and refers to a similar one from Borness Cave, Scotland, which had been interpreted as a whistle.

Thus, where species and anatomy have been ascertained, we find that the metapodials of sheep and cattle - the most common animals on the site - have been utilized for bone working.

Tiles

A number of tiles from the site were examined, bearing foot-impressions of 3 animal species. Petrological analysis by Dr. Williams at Southampton University indicates that these tiles were contemporary with others at the site, all of which are considered to be of local Roman manufacture. Identifications were based on those of modern animals given in Lawrence and Brown (1974). One print was of an ovicaprid and 4 were of dogs. The first of these tiles retains impressions left by both fore feet and the right hind foot of a walking dog which would have been quite a large animal. Another tile has impressions of the right fore and hind foot of a similarly sized dog, but the prints were too badly distorted for any measurements to be taken. A third impression is slightly smaller, and the last is of the right fore foot of a very small or juvenile dog. Finally, the foot impression of the right fore foot of a cat was found (see Plate 12).

The print is small, and may be from a small or young cat, but is almost certainly of the domestic, and not the wild cat, Felis silvestris . A similar find has been made at Roman Silchester (Jones, 1892) where the species in question is also considered to be domestic rather than wild, as the author thought it unlikely that the 'shy' wild cat would venture so near a human dwelling-place. Recently, Cramm and Tulford (1979), in their reappraisal of the tiles with foot-prints from Roman Silchester, have shown that these can give information about the animals themselves and about the tile-making process. They note the general absence of wild animals (which might suggest the ground was fenced) and of pigs (obstreperous animals which are likely to have been kept in sties, or woodland away from human settlements). They consider that the evidence indicates the proximity of a farm or stock-yard, suggesting that the tile makers themselves were, in addition, farmers. Many of the tiles had representations of more than one animal, which supports the case for workshops being close to, or within a farmyard – perhaps the tiles were laid out to dry on the ground, but under cover to which animals had access. Though only a small sample, a similar explanation might be applied to the Brancaster tiles. But a more plausible explanation is that the tile-making area was unfenced: wild animals are unlikely to be so near such an industrial centre. Measurements of the animals tracks are given, together with comparable measurements from Roman Silchester, and modern adult animals taken from Lawrence and Brown, 1974, and Bang and Dahlstrum, 1974 (in Cramm and Tulford, 1979) see Table . They point out that shrinkage of clay on drying subsequent to the foot impression will have reduced the measurements, possibly by up to a tenth.

Table : Measurements of Animal Tracks from Roman Brancaster, with comparable measurements of these from Roman Silchester *and from modern adult animals*.

		Track Length			Track Width		
		Range	Mean	N	Range	Mean	N
Sheep							
	Brancaster	40		1	28		1
	Silchester	24–47	31.5	24	11–30	20.8	29
	Modern	50–60			40–50		
Dog							
	Brancaster (fore foot)	40–75		3	37–70		3
	Silchester (fore foot)	31–67	49.1	14	28.69	48.9	21
	Modern	39–81			31–86		
Cat							
	Brancaster	28		1	25		1
	Silchester	23–50	29.1	7	23–44	28.8	12
	Modern (wild)	40–60			35–60		

* after Cramm and Tulford (1979)

AGEING DATA: EPIPHYSEAL FUSION OF LIMB BONES OF CATTLE AND SHEEP (EARLIER AND LATER ROMAN PHASES COMBINED)

CATTLE					SHEEP		
Age Group	Bone and epiphysis	Number fused	Number unfused	Percentage in age group	Number fused	Number unfused	Percentage in age group
1	Humerus (d)	30	0		16	4	
	Radius (p)	31	1	1.6	10	0	13
2	Meta-carpal (d)	57	7		12	4	
	Tibia (d)	32	9	15	33	3	13
3	Meta-taral (d)	39	20	33	17	6	26
4	Humerus (p)	3	1		0	1	
	Radius (d)	14	5		4	7	
	Femur (p)	10	8		2	1	
	Femur (d)	4	8		1	0	
	Tibia (p)	6	1		0	2	
	Ulna	5	0		1	2	
	Calcaneum	7	14	43	6	1	50