2675

Ancient Monuments Laboratory
Report 108/97

IRON AGE AND ROMAN ANIMAL BONES EXCAVATED IN 1996 FROM NORMAN CROSS, TORT HILL EAST, TORT HILL WEST AND VINEGAR HILL, CAMBRIDGESHIRE

U Albarella

Ancient Monuments Laboratory Report 108/97

IRON AGE AND ROMAN ANIMAL BONES EXCAVATED IN 1996 FROM NORMAN CROSS, TORT HILL EAST, TORT HILL WEST AND VINEGAR HILL, CAMBRIDGESHIRE

U Albarella

Summary

Small assemblages of animal bones were hand-retrieved from the Roman sites of Norman Cross, Tort Hill East and Vinegar Hill and from the late Iron Age and Roman site of Tort Hill West. In all periods most bones derive from ditch fills probably associated with a rural settlement present in the area. The majority of the bones belong to the main domestic mammals - cattle, sheep, pig and horse. There is no evidence of major changes in the frequencies of these species between the main phases of occupation. Unusually for British Roman sites horse bones were abundant. This might be related to a specific function of these sites possibly due to their location along the Roman Ermine Street. Neonatal bones of all the main species suggest that these were - at least in some periods - reared on site. Butchery marks were found on bones of all periods, but a peculiar pattern, typical of Roman sites across Europe, was only found at Tort Hill East in phase 2.

Author's address :-

Mr U Albarella
UNIVERSITY OF BIRMINGHAM
Department of Ancient History and Archaeology
Edgbaston
Birmingham
W MIDS
B15 2TT

ANCIENT MONUMENTS LABORATORY REPORTS SERIES

The Iron Age and Roman animal bones excavated in 1996 from Norman Cross, Tort Hill East, Tort Hill West and Vinegar Hill, Cambridgeshire

Umberto Albarella

Introduction

A series of seven Iron Age and Roman sites were excavated by the Birmingham University Field Archaeology Unit (BUFAU) in February-May 1996, in areas which were to be affected by A1 (M) Alconbury to Peterborough road improvements (Fig.1). They are all located in Cambridgeshire along the Roman Ermine street. Only four sites produced animal bones, and these are discussed in this report: Norman Cross (TL 159 907), Tort Hill East (TL 172 848), Tort Hill West (172 848) and Vinegar Hill (TL 186 778) (henceforth "the A1 sites").

The most common structures found during the excavation were linear features such as ditches, gullies and channels were common. Remains of four round houses were found in the late Iron Age level at Tort Hill West. A series of rectangular enclosures in the early Roman phase of the same site are probably also worth mentioning. All sites provide evidence for past use of the landscape and other activities probably related to the life of ordinary rural settlements in the area. There is no evidence of high status, apart from the presence of tile based *opus signinum* which might indicate the presence of a bath house (Morgan forthcoming).

The four sites are dated as follows (see also figure below):

Norman Cross: Phase 1 = 2nd cent. AD
Phase 2 = late 3rd/4th cent. AD.

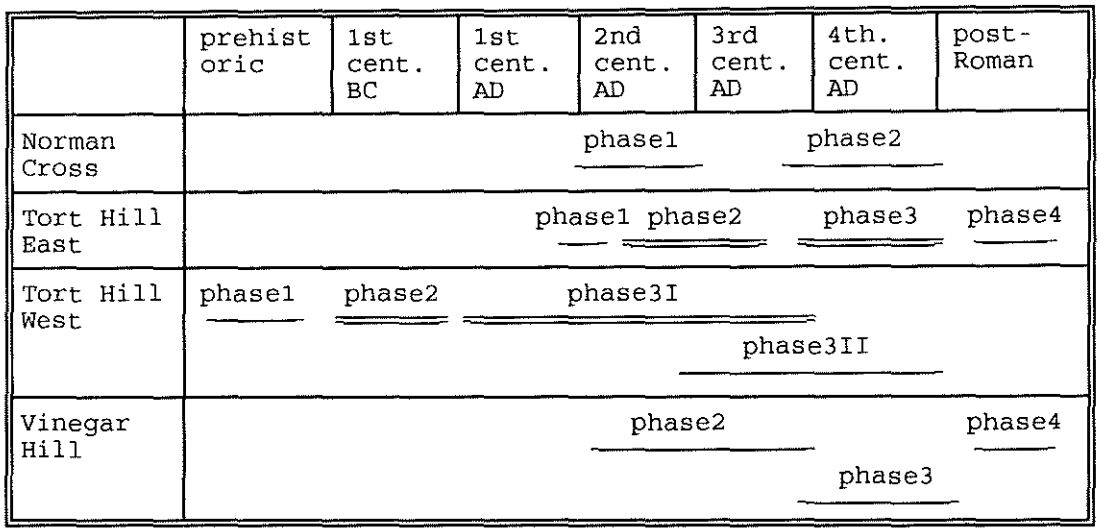
Tort Hill East: Phase 1 = late 1st/early 2nd cent. AD
Phase 2 = early-mid 2nd/mid 3rd cent. AD[1]
Phase 3 = late 3rd/4th cent. AD
Phase 4 = post-Roman

Tort Hill West: Phase 1 = prehistoric
Phase 2 = pre-Roman late Iron Age
Phase 3I = 1st-3rd cent. AD
Phase 3II = late 2nd - 4th cent. AD.

Vinegar Hill: Phase 2 = 2nd/3rd cent. AD
Phase 3 = late 3rd/4th cent. AD
Phase 4 = post-Roman.

[1]This period has been divided into two sub-periods - 2A and 2B - but, to avoid a further reduction of the size of the bone assemblage, it is in this report considered as a single period

single line = < 100 "counted" animal bones
double line = > 100 "counted" animal bones



Although the phase 3I at Tort Hill West spans from the late 1st to the end of the 3rd century, all its features and most of the finds derive from the late 1st/early 2nd cent. AD (Peter Ellis pers. comm.). It is possible that after the early 2nd cent. AD the focus of activities in the area switched from Tort Hill West (phase 3I) to Tort Hill East (phase 2) (Peter Ellis pers. comm.). This would be consistent with the scarcity of archaeological evidence (including animal bones) at Tort Hill West after the 2nd century and at Tort Hill East before this date.

A total of 104 Kg of animal bone was collected. These are distributed across the four sites as follows:
Norman Cross: 5.5 Kg
Tort Hill East: 41.5 Kg
Tort Hill West: 38 Kg
Vinegar Hill: 19 Kg.

However, a rather high percentage of bones from Vinegar Hill were insecurely dated and have been excluded from this analysis. Only bones which derived from contexts which could be phased and that were not seriously affected by problems of residuality or contamination were taken into account.

Methods

The sites were partly mechanically and partly hand-excavated. No programme of coarse sieving for the recovery of animal bones was carried out on these excavations, although a few small samples were taken for flotation and fine sieving. The flotation residues from these latter samples produced a very small number of animal bones which were added to the total of the bones picked by hand (Table 1). The assemblage from sieving was far too small to provide quantitative information on the loss of smaller bones caused by a recovery bias. Since the bones derive almost entirely from hand-collection an under-representation of smaller species and body parts is to be expected on these sites.

The mammal bones were recorded following a modified version of the

method described in Davis (1992) and Albarella and Davis (1994). In brief, all teeth (lower and upper) and a restricted suite of parts of the postcranial skeleton were recorded and used in counts. These are: skull (zygomaticus), scapula (glenoid articulation), distal humerus, distal radius, proximal ulna, carpal 2-3, distal metacarpal, pelvis (ischial part of acetabulum), distal femur, distal tibia, calcaneum (sustentaculum), astragalus (lateral side), naviculo-cuboid, distal metatarsal, proximal parts of the 1st, 2nd and 3rd phalanges. At least 50% of a given part had to be present for it to be counted.

For birds the following were always recorded: scapula (articular end), proximal coracoid, distal humerus, proximal ulna, proximal carpometacarpus, distal femur, distal tibiotarsus, distal tarsometatarsus.

Horncores with a complete transverse section and "non-countable" elements of particular interest were recorded, but not included in the counts.

Wear stages were recorded for all P_4s and dP_4s as well as for the lower molars of cattle, caprines and pig, both isolated and in mandibles. Tooth wear stages follow Grant (1982) for cattle and pig and Payne (1973 and 1987) for caprines.

Measurements are listed in Appendix 2. These in general follow von den Driesch (1976). All pig measurements follow Payne & Bull (1988). Humerus HTC and BT and tibia Bd measurements were taken for all species as suggested by Payne & Bull (1988) for pigs. Measurements taken on equid teeth follow Davis (1987). The width of caprine teeth represents the "maximum" width.

The bones from this site will be stored in an appropriate Museum store which has yet to be approved by the Cambridgeshire County Council (Gwilym Hughes pers.comm.).

Provenance and preservation

The animal bones derive from a variety of different contexts and features but at all sites the majority were found in ditch fills, including a ring ditch from the late Iron Age level (phase 2) at Tort Hill West. However, a number of bones also derived from gullies and, to a lesser extent, from pits, layers, from a midden at Tort Hill East phase 3 and from a palaeochannel at Vinegar Hill phase 3.

The preservation of the bones varied across sites, areas, features and periods, but it was on average fairly good at Tort Hill East and worse at the other sites, in particular at Norman Cross. The natural fragmentation - as opposed to that caused by human action - was higher at Tort Hill West than at Tort Hill East. In the former site, most identifiable specimens are represented by isolated teeth, which are the most durable elements and therefore those which are found and identified even when the levels of preservation and fragmentation are high. Whereas in the two main periods at Tort Hill West, teeth (upper and lower) represent more than half of the "counted" specimens, this proportion goes down to 50% at Tort Hill East phase 3 and to 35% at Tort Hill East phase 2.

The fragmentation of the bones is probably the result of a complex series of factors including human butchery (discussed below) and a variety of taphonomic processes. Among these the action of scavengers on the bones was quite severe. Gnawing marks were common throughout and suggest that many

bones may have been moved by dogs and other scavengers from the place where they were initially discarded and were not therefore in primary deposit. Gnawing marks were more common at Tort Hill East than Tort Hill West, despite the poorer preservation at the latter site. This probably indicates that at Tort Hill West the amount of gnawing was so intense that bones could no longer be identified. The same type of clayey soil (Peter Leach pers. comm.) was present at the two sites, thus the nature of the soil cannot be considered to be the cause of the difference in preservation.

Most of the gnawed bones belong to cattle, although chewed bones of equid, sheep and pig were also found. A few sheep and pig bones from Tort Hill West bear clear marks of partial digestion (see Payne and Munson 1985).

Not all contexts had evidence of disturbance. Bones in articulation - suggesting material still found in primary deposit - derive from context 1102 at Norman Cross phase 2, context 5068 at Tort Hill East phase 2 (a horse foot) and context 5013 at Tort Hill East phase 3. A partial skeleton of a dog came from context 5058 at Tort Hill East phase 2 and one of cattle from Tort Hill West phase 3I. Both these last two contexts are from ditches, where these animals - probably killed by a disease or some accident - were eventually discarded. Context 1204 (ditch fill) at Vinegar Hill phase 3 produced a number of complete and totally unbutchered bones of cattle and horse, none of which articulate. These are specimens deriving from animals which were not eaten and which ended up there possibly as a consequence of the reworking of a deposit containing complete skeletons.

Occurrence and frequency of species

At all sites and all periods the bone assemblages are dominated by the main domestic mammals - cattle, caprines, pig and equids. Domestic birds are rare and wild animals virtually absent - they are just represented by a lapwing (*Vanellus vanellus*) bone from Tort Hill West phase 2 and a corvid (*Corvus frugilegus/corone*) bone from Tort Hill East phase 2, both of which may not be remains of human consumption (Table 1).

The predominance of domestic mammals and the scarcity of wild game are typical of Roman sites in Britain. Domestic fowl[2] is never found in great abundance in Roman sites, so the scarcity of this species at the A1 sites also conforms to the general pattern of the period. Although the frequency of domestic fowl is likely to be underestimated because of a recovery bias, there can be little doubt that in Roman Britain this species was less common than in the subsequent Saxon and medieval times.

The total absence of fish at these sites is probably due to the fact that the small bones of these animals are easily over-looked during excavation. However, their genuine absence cannot be ruled out, although this would be rather surprising considering that oysters were imported from the coast, probably as far

[2]It cannot be excluded that the bones belong to the morphologically similar pheasant or Guinea fowl, although these species are very rarely found on archaeological sites (the distinction is possible only on a few anatomical elements)

as the south coast (Winder forthcoming)[3]. A number of amphibian bones (Table 1) were found in a ditch fill at Tort Hill East phase 2 (context 8008).

In many sites in Britain there is evidence for a decrease in the importance of sheep at the transition between the Iron Age and the Roman period. Cattle seems to become increasingly more frequent during the Roman occupation (A.King 1978; Grant 1989). The Roman enclosure of Werrington, in Cambridgeshire (J.King 1988) has provided results consistent with this trend, but our evidence is different. Cattle are more frequent at the late Iron Age level at Tort Hill West than in the subsequent Roman phases, and no meaningful differences could be noted between earlier and later Roman phases (Fig.2). Although the possibility that the Tort Hill sites represent an exception to the rule has to be considered it is also possible that the higher frequency of cattle bones at Tort Hill West phase 2 is the consequence of the difference in preservation between different phases. If we also take into account that we are dealing with small samples the evidence from Tort Hill must, sadly, be considered inconclusive.

Unlike Tort Hill West, most Iron Age sites in Britain have produced animal bone assemblages in which sheep predominate. At the site of Edix Hill, (Barrington), also in Cambridgeshire (Davis 1995), bones were also hand-collected and recorded with a system similar to that used in this study, but sheep were twice as common as cattle.

It is difficult to assess to what extent differences in the relative frequency of cattle and sheep at different sites depend on differences in preservation and recovery. However, it is probably worth mentioning that in other Roman rural sites in the area, such as Grandford (Stallibrass 1982) and Stone (Stallibrass 1996) sheep bones outnumber those of cattle. At the Roman Fort of Longthorpe, near Peterborough (Marples 1974), cattle is predominant. The A1 sites, with their roughly equal number of sheep and cattle in the Roman levels, seem to be intermediate in this respect.

All caprine bones which could be identified to species level belong to sheep (Table 1). The absence - or scarcity - of the goat is not surprising as this species is rare in Iron Age and Roman sites throughout Britain. No goat bones were found at Werrington, Grandford and Longthorpe. However, at Stone about 10% of the caprine bones belonged to goat.

Equid bones and teeth are very common in all four sites, in particular in Roman times (Tables 2 and 3). A biometrical analysis of three complete equid first phalanges, using a method devised by Davis (1982), suggests that these specimens all belong to horses rather than donkeys (Fig.3). This is consistent with the evidence from complete tooth rows which also indicate that teeth have morphological characters typical of horses. Donkeys were important animals for the Romans, who used them as pack-animals and for ploughing light soils in the Mediterranean (Columella VII.1.2). However, we do not know to what extent their use in the colder and damper climate of Britain was equally successful. The archaeological evidence seems to suggest that donkeys were in fact uncommon in Roman Britain.

---

[3]Angela Monckton tells me that a few fish scales were found in the flots

High frequencies of horse bones have only been found in Roman sites in Britain which had a specific function, such as the amphitheatre at Silchester (Grant 1989), or sites where "ranching" was an important farming activity (A.King 1978). At all other sites horse remains are only found in small numbers. The high frequency of horses at the A1 sites is therefore interesting, especially in view of the fact that the sites represent roadside settlements. Perhaps the inhabitants of these sites became specialised in providing horses for people travelling along Ermine street.

Finally it must be mentioned that two human bones were found mixed with animal bone refuse at Tort Hill East phase 3 and at Tort Hill West phase 3I. Moreover, remains of the skeleton of a human infant derive from a context belonging to the late Iron Age level at Tort Hill West.

Frequency of body parts

These assemblages are too small to allow any detailed analysis of the distribution of the body parts. Although different anatomical elements were present in different numbers, this variation could be entirely explained by taphonomic and recovery biases - namely more fragile and small elements were more rarely found. The better preservation at Tort Hill East explains the relatively higher number of post-cranial bones on this site. Most body parts of the main domestic animals were found. If animals were sold or purchased at these sites, this must have occurred in the form of living beasts or complete bodies, rather than of dressed carcasses. This latter practice would have indeed caused a bias in the distribution of the body parts.

The scarcity of horncores is worth mentioning (see appendix 2). The absence of chopping or cut marks on these elements suggests a substantial lack of horn-working activities in the excavated areas. It is possible that horns were worked in other areas of the sites or exported elsewhere. However, the possibility that most animals present on site were hornless - possibly females - must be considered.

Kill-off patterns

A number of neonatal and very juvenile bones of cattle, sheep, pig, horse and domestic fowl indicate that these species were bred on site. They are listed in the table below:

	Cattle	Sheep	Pig	Equid	Domestic fowl
Tort Hill East, phase 2		x			
Tort Hill East, phase 3	x				x
Tort Hill West, phase 2			x		
Tort Hill West, phase 3I		xxx		xx	
Vinegar Hill, phase 3			x		

The presence of living equids (probably horses) on site is also attested by the finding of a shed milk tooth at Tort Hill West, phase 3I. A shed milk tooth of cattle was found in a cleaning layer at Tort Hill East which predominantly included 3rd century material.

The small sizes of the assemblages makes our interpretation of the ages at slaughter of the main domestic animals very difficult. Both cattle and sheep were killed at a variety of ages (see appendix 1), which, in turn, suggests a variety of functions. Given their large size cattle must have provided by far the greatest amount of meat, but they were probably mainly reared as traction animals. Sheep were bred for different purposes which included meat - note the relatively high number of immature mandibles (stages C and D) in all Roman levels - as well as their wool and milk. The Romans preferred sheep's milk to cow's milk (White 1970). Pig, as always, was an exclusively "meat" animal.

It must be emphasized that the kill-off patterns discussed above only concern specimens which *died* on site and do not necessarily reflect a more general culling strategy for all animals *present* on site. The evidence of on-site breeding and the location of these sites along a main road suggests that they leaned more towards "production" than "consumption". It is therefore possible that some animals were sold on the market or to travellers, so do not appear in the archaeological record.

Butchery

Forty (i.e. 12%) of the 337 post-cranial bones of the main domestic mammals bear recognizable butchery marks. The percentage would be much higher if we were taking into account "non countable" fragments of cattle long bones which, in the Roman period, were often heavily chopped.

Maltby (1989) has noted a prevalence of cut marks in cattle bones deriving from Roman rural sites, whereas a prevalence of chop marks could be noted in assemblages from Roman towns. Cut and chop marks were more or less equally represented at the A1 sites, whereas the admittedly small number of marks from the Iron Age level are all cuts rather than chops. However, the samples are definitely too small to claim a significant difference in butchery techniques between the Iron Age and the Roman period.

An interesting pattern is represented by the presence of a number of assemblages of intensively chopped cattle long bones, all deriving from Tort Hill East phase 2. Only cattle long bones, chopped both transversally and longitudinally, are present in these contexts; these are all broken into small fragments. This butchery practice has been frequently recorded on Roman sites, not only in Britain (Grant 1989, A.King 1978). I have noted similar patterns at the other Roman sites of Elms Farm (Essex) and Orton's Pasture, Rocester (Staffordshire) (Albarella 1996; Albarella and Lawless in prep.), but in most studies of Roman sites, including Lincoln (Dobney *et al.* undated) and Stonea (Stallibrass 1996), there is mention of intensively butchered cattle bones.

The breakage of the long bones into fragments certainly enabled the extraction of marrow, but such an intensive process may have different explanations, such as the use of these bones for making soups (van Mensch 1974

quoted by A.King 1978) or for producing glue (Schmid 1972). More recently Dobney *et al.* (undated) have argued that the specialized production of marrow and marrowfat may be a more likely explanation. Whatever the explanation there is little doubt that this technique is typically Roman. At the A1 sites these peculiar assemblages have only been found at Tort Hill East phase 2, in five different contexts.

Cut marks on cattle and equid phalanges from the Roman levels at the two Tort Hill sites are related to skinning and indicate an interest in the hides of these animals. A few more horse bones bear butchery marks, suggesting that horse flesh may have been occasionally used - either for feeding people or dogs. Butchered horse bones have been found at other Roman sites in Britain, such as Grandford and Stonea (Stallibrass 1982 and 1996).

The size of the animals

Measurements of bones and teeth are listed in appendix 2. These represent a useful database for comparison with other sites, but they are too few to allow meaningful comparisons between different phases of occupation at the A1 sites.

There are just sufficient cattle lower third molars to enable such a comparison. No significant differences were noted between the size of the animals between different phases (a Student's t-test was applied), but it is difficult to say whether this is just due to the insufficient size of our samples. A difference was however detected when our measurements were compared with those from the 1st century AD site of Dodder Hill (Hereford and Worcester) (Davis 1988). The cattle from the A1 1st-3rd century period are significantly larger than those from Dodder Hill (Fig.4). Since artiodactyl molar teeth show little sexual dimorphism (Degerbøl 1963; Payne and Bull 1988) and are also less susceptible than bones to environmental variations, it is likely that the difference between the two sites is attributable to the presence of two different types of animals. Regional or chronological variations are both possible explanations for the larger size of the A1 cattle. It is also possible that the larger Roman cattle imported from the continent (see Teichert 1984; Lauwerier 1988) had provided a greater contribution to the genotype of the A1 animals than at Dodder Hill.

Conclusions

Most of the evidence that we have about the Roman animal economy in Britain derives from towns, forts and villas, whereas we have insufficient information from farmsteads and villages. Any new contribution from such sites, even though from small assemblages such as those of the A1 sites, is therefore most welcome.

Despite the limitations due to their small size, the animal bone assemblages discussed in this report indicate that:

- the animal economy of the A1 sites was entirely based on domestic resources
- all the main domestic species were bred locally; this supports the assumption that these were mainly "producer" sites

- unlike other Roman sites in Britain, horses played an important role in the local economy; they were probably also bred locally
- no obvious difference could be found in the frequency of species and the size of the animals between the late Iron Age and the Roman phases at Tort Hill West; however, the presence of a typically Roman butchery practice by the 2nd-3th century AD at Tort Hill East, suggests that by then the area was occupied by people leading a Roman way of life.

The animal bones alone cannot provide sufficient information for an understanding of the function of the A1 sites and of the excavated features. However, the fact that a variety of living animals was definitely kept on site may raise questions about where these animals were bred and where were their grazing areas. The possibility that some of the identified enclosures may represent ranches for animals should perhaps be considered. Finally, the high frequency of horses may lead to the speculation that the local economy was strongly influenced by the location of these sites along a main road. This might have stimulated the people living in the area to trade with travellers or at a local market, presumably easily accessible through Ermine street.

Acknowledgements

I would like to thank Gwilym Hughes for asking me to study the animal bones from the A1 sites and Gwilym himself, Peter Leach, Peter Ellis and Annette Hancocks for patiently answering my many questions about the sites and their excavations. I am also grateful to Simon Davis, Peter Ellis, Angela Monckton and Richard Thomas for their comments on an earlier draft of this report. Figure 1 is here included courtesy of the Birmingham University Field Archaeology Unit.

References

Albarella, U. 1996. *Elms Farm, Heybridge (Essex). Assessment of the animal bones*. Unpublished typescript.

Albarella, U. and Davis, S. 1994. *The Saxon and Medieval animal bones excavated 1985-1989 from West Cotton, Northamptonshire*. London: English Heritage AML Report 17/94

Albarella, U. and Lawless, F. In preparation. *Orton's Pasture, Rocester (Staffordshire). Assessment of the animal bones.*

Davis, S. 1982. *A trivariate morphometric method to discriminate between first phalanges of Equus hydruntinus, asinus/hemionus and caballus*. Unpublished typescript

Davis, S. 1987. The dentition of an Iron Age pony. In Ashbee, P. Warsash, Hampshire excavations, 1954, pp.52-55. *Proceedings of the Hampshire Field Club Archaeological Society* 43, 21-62

Davis, S. 1988. *Animal bones from Dodder Hill, a Roman Fort near Droitwich (Hereford and Worcester) excavated in 1977.* London: English Heritage AML Report 140/88

Davis, S. 1992. *A rapid method for recording information about mammal bones from archaeological sites*. London: English Heritage AML Report 71/92

Davis, S. 1995. *Animal bones from the Iron Age site at Edix Hill, Barrington, Cambridgeshire, 1989-1991 excavations*. London: English Heritage AML Report 54/95

Davis, S. 1996. Measurements of a group of adult female Shetland sheep skeletons from a single flock: a baseline for zoo-archaeologists. *Journal of Archaeological Science* 23, 593-612

Degerbøl, M. 1963. Prehistoric cattle in Denmark and adjacent areas. In Mourant A. and Zeuner F. (eds.). *Man and cattle*, pp.69-79. London: Royal Anthropological Institute.

Dobney, K., Jaques, D. and Irving, B. Undated. *Of butchers and breeds*. Report on vertebrate remains from various sites in the City of Lincoln. Lincoln Archaeological Studies 5

Driesch, A. von den. 1976. *A guide to the measurement of animal bones from archaeological sites*. Peabody Museum Bulletin 1: Cambridge Mass., Harvard University

Grant, A. 1989. Animals in Roman Britain. In Todd, M. (ed.). *Research on Roman Britain: 1960-1989*, pp.135-146. London: Britannia Monograph Series, 11

Grant, A. 1982. The use of tooth wear as a guide to the age of domestic ungulates. In Wilson B., Grigson C. and Payne S. (eds.). *Ageing and sexing animal bones from archaeological sites*, pp. 91-108. Oxford: BAR British series 109

King, J. 1988. Animal bones. In Mackreth D. Excavation of an Iron Age and Roman enclosure at Werrington, Cambridgeshire, pp.146-149. *Britannia* 19

King, A. 1978. A comparative survey of bone assemblages from Roman sites in Britain. *Bulletin of the Institute of Archaeology (London)* 15, 207-232

Lauwerier, R. 1988. *Animals in Roman times in the Dutch Eastern River area.* Amersfoort: ROB

Maltby, M. 1989. Urban rural variations in the butchering of cattle in Romano-British Hampshire. In D.Serjeantson and T.Waldron (eds.). *Diet and Crafts in Town. The evidence of animal remains from the Roman to the Post-Medieval periods*, pp.75-106. Oxford: BAR British Series 199

Marples, B.J. 1974. Animal bones from the Roman Fort at Longthorpe, near Peterborough. In Frere, S. and Joseph, K. The Roman Fortress at Longthorpe, pp.122-128. *Britannia* 5, 1-129

Morgan G. Forthcoming. *A1 (M) mortar and plaster analysis.*

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

Payne, S. 1987. Reference codes for wear states in the mandibular cheek teeth of sheep and goats. *Journal of Archaeological Science* 14, 609-614

Payne, S. and Bull, G. 1988. Components of variation in measurements of pig bones and teeth, and the use of measurements to distinguish wild from domestic pig remains. *Archaeozoologia* 2, 27-65

Payne, S. and Munson, P. 1985. Ruby and how many squirrels? The destruction of bones by dogs. In Fieller N., Gilbertson D. and Ralph N. (eds.). *Palaeobiological investigations; research design, methods and data analysis.*, pp.31-39. Oxford: BAR International Series 266

Schmid, E. 1972. *Atlas of animal bones.* Amsterdam-London-New York: Elsevier

Stallibrass, S. 1982. The faunal remains. In Potter, T and Potter, C. *A Romano-British village at Grandford, March, Cambridgeshire*, pp.98-122. London: British Museum

Stallibrass, S. 1996. Animal bones. In Jackson R. and Potter T. *Excavations at Stonea, Cambridgeshire 1980-85*, pp.587-612. London: British Museum Press

Teichert, M. 1984. Size variation in cattle from Germania Romana and Germania Libera. In Grigson C. and Clutton-Brock J. (eds.) *Animals and archaeology: 4. Husbandry in Europe*, pp.93-103. Oxford: BAR International Series 227

White, K.D. 1970. *Roman Farming*. London: Thames and Hudson.

Winder J. Forthcoming. *Report on the marine* Mollusca *from excavations at Tort Hill East, Cambridgeshire.*

SITE	Norman Cross			Tort Hill East					Tort Hill West					Vinegar Hill				
PHASE	**1**	**2**	**Tot**	**1**	**2**	**3**	**4**	**Tot**	**1**	**2**	**3I**	**3II**	**Tot**	**2**	**3**	**4**	**Tot**	**TOTAL**
cattle (*Bos taurus*)	2	14	16	3	47	47	2	99	1	64	78**	4	147**	11	30	-	41	303
sheep/goat (*Ovis/Capra*)	4	8	12	-	37	41	1	79	5	39	64	14	122	1	5	2	8	221
(sheep (*Ovis aries*)	(-	(2	(2	(-	(10	(10	(-	(20	(-	(9	(14	(2	(25	(-	(2	(-	(2	(49
(goat (*Capra hircus*)	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-
pig (*Sus scrofa*)	-	1	1	3	6	6	-	15	3	14	15	-	32	-	2	-	2	50
equid (*Equidae*)	-	4	4	2	19	17	-	38	4	9	55	1	69	-	19	4	23	134
cattle/equid	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1
dog (*Canis familiaris*)	-	-	-	-	16*	-	-	16*	-	5	10	-	15	1	-	-	1	32
dog/fox (*Canis/Vulpes*)	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	1
domestic fowl (*Gallus gallus*)	-	4	4	-	-	1	-	1	-	-	-	-	-	-	-	-	-	5
lapwing (*Vanellus vanellus*)	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1
crow/rook (*Corvus corone/frugilegus*)	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1
frog/toad *(Anura)*	-	-	-	-	35	-	-	35	-	-	-	-	-	-	-	-	-	35
(frog (*Rana sp.*)	(-	(-	(-	(-	(8	(-	(-	(8	(-	(-	(-	(-	(-	(-	(-	(-	(-	(8
(toad (*Bufo sp.*)	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-	(-
TOTAL	6	31	37	8	161	112	3	284	13	132	223	19	387	14	56	6	76	784

Table 1.

Number of identified specimens (NISP). The assemblage is largely hand-collected; the few specimens from sieved samples have been added to the counts. "Sheep/goat" also includes the specimens identified as "sheep" and "frog/toad" also includes the specimens identified as "frog". The figures in brackets are not included in the totals. Norman Cross: Phase 1 = 2nd cent. AD, Phase 2 = late 3rd/4th cent. AD. Tort Hill East: Phase 1 = late 1st/early 2nd cent. AD, Phase 2 = early-mid 2nd/mid 3rd cent. AD, Phase 3 = late 3rd/4th cent. AD, Phase 4 = post-Roman. Tort Hill West: Phase 1 = prehistoric, Phase 2 = pre-Roman late Iron Age, Phase 3I =1st-3rd cent. AD, Phase 3II = late 2nd - 4th cent. AD. Vinegar Hill: Phase 2 = 2nd/3rd cent. AD, Phase 3 = late 3rd/4th cent. AD, Phase 4 = post-Roman. * 15 specimens derive from a partial skeleton; ** 14 specimens derive from a partial skeleton.

	Tort Hill East				Tort Hill West			
	Phase 2		Phase 3		Phase 2		Phase 3I	
	n	%	n	%	n	%	n	%
cattle	47	*43*	47	*42*	64	*51*	64	*32*
sheep/goat	37	*34*	41	*37*	39	*31*	64	*32*
pig	6	*6*	6	*5*	14	*11*	15	*8*
equid	19	*17*	17	*15*	9	*7*	55	*28*
TOTAL	109		111		126		198	

Table 2.
Numbers and percentages of identified specimens (NISP) for the **main domestic mammals** in the main phases. Tort Hill East: Phase 2 = early-mid 2nd/mid 3rd cent. AD, Phase 3 = late 3rd/4th cent. AD. Tort Hill West: Phase 2 = pre-Roman late Iron Age, Phase 3I = 1st-3rd cent. AD.
The 14 cattle specimens deriving from a partial skeleton at Torth Hill West phase 3I have in this table been considered as just 1 specimen.

	Pre-Roman late Iron Age		1st-3rd cent. AD		late 2nd-4th cent. AD	
	n	%	n	%	n	%
cattle	64	*51*	127	*38*	95	*45*
sheep/goat	39	*31*	106	*32*	68	*32*
pig	14	*11*	24	*7*	9	*4*
equid	9	*7*	76	*23*	41	*19*
TOTAL	126		333		213	

Table 3.
Numbers and percentages of identified specimens (NISP) for the **main domestic mammals** for all sites divided by phase. "Pre-Roman late Iron Age" includes Tort Hill East phase 2; "1st-3rd cent. AD" includes Norman Cross phase 1, Tort Hill East phases 1 and 2, Tort Hill West phase 3I and Vinegar Hill phase 2; "late 2nd-4th cent. AD" includes Norman Cross phase 2, Tort Hill East phase 3, Tort Hill West phase 3II and Vinegar Hill phase 3. The 14 cattle specimens deriving from a partial skeleton at Torth Hill West phase 3I have in this table been considered as just 1 specimen.

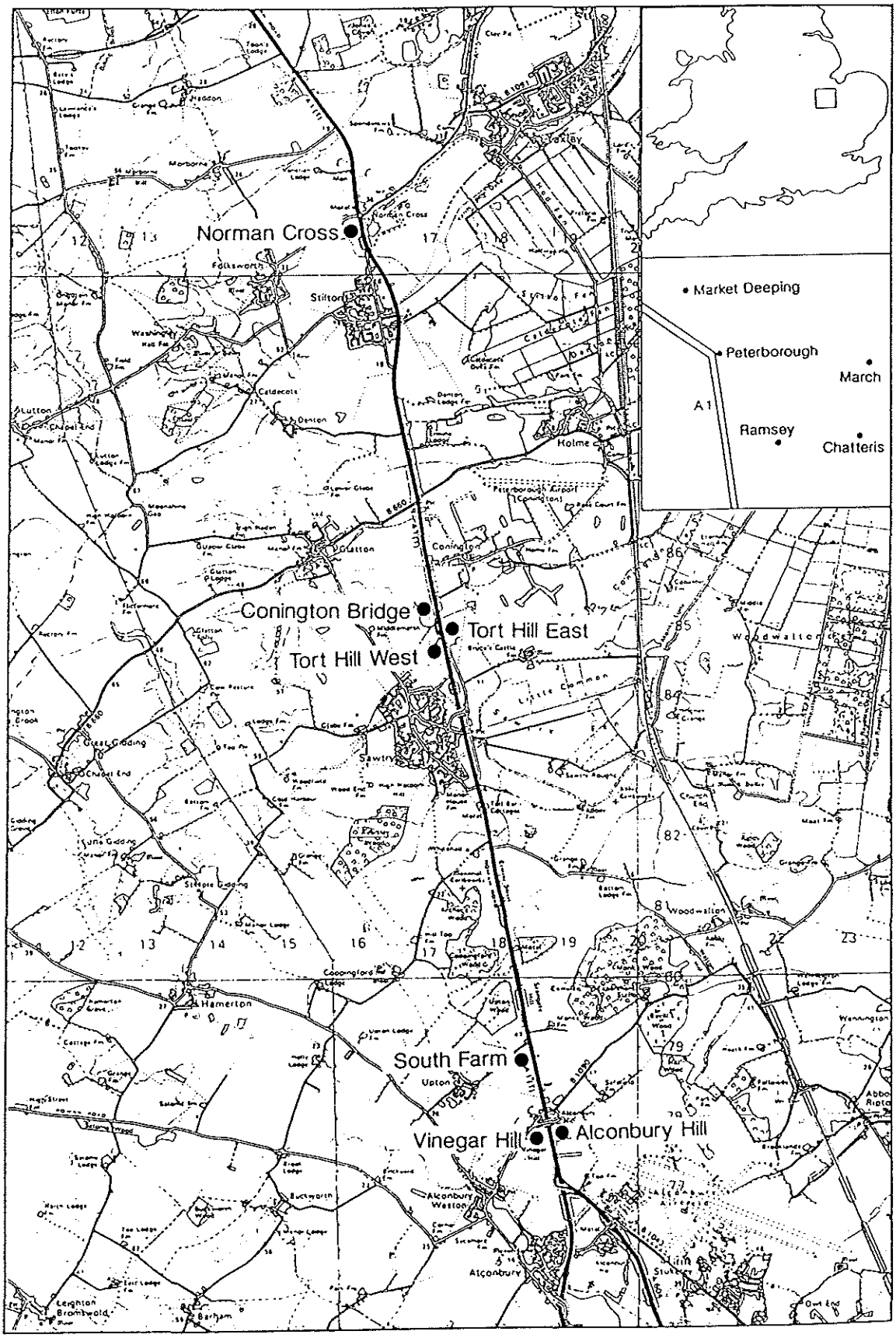
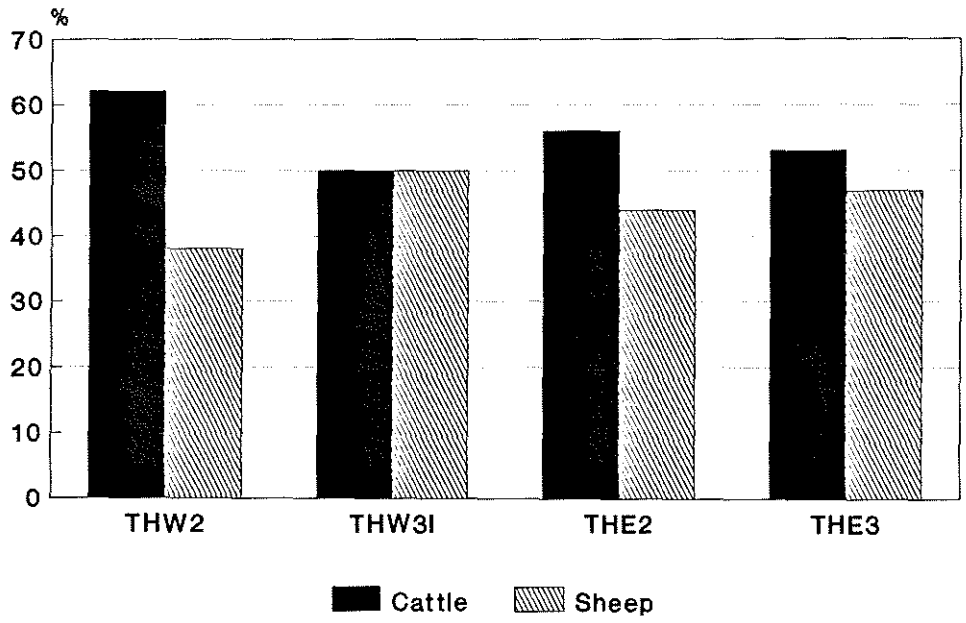


Fig 1 Location of Sites

Fig.2. Percentages of cattle and sheep bones in a time sequence



THE=Tort Hill East, THW=Tort Hill West

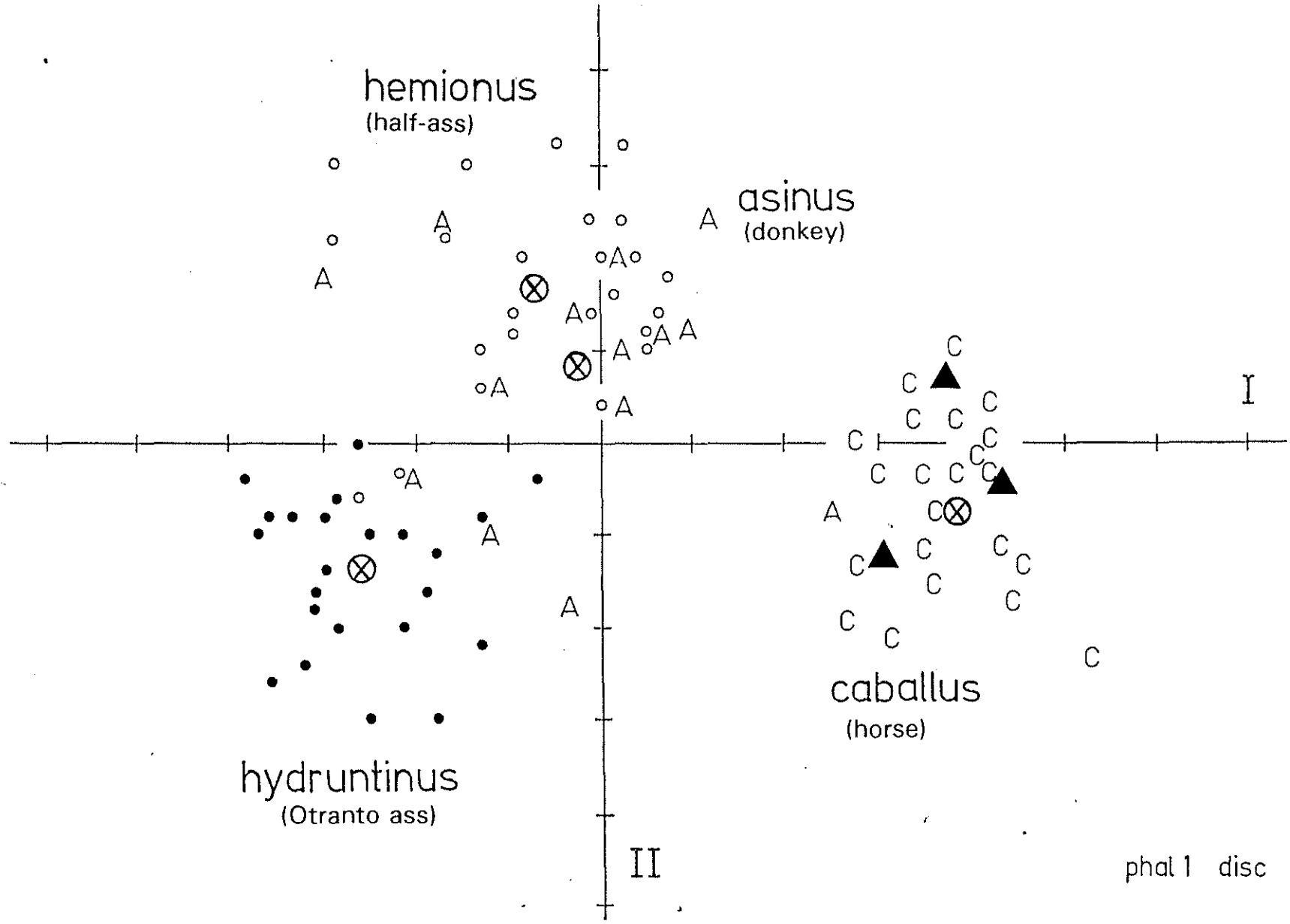


Figure 3.
Identification of complete equid phalanges from the A1 sites (black triangles in the diagram) using a multivariate morphometric system devised by Davis (1982). The measurements considered are: GL, Bp, Dp, SD, Bd and Dd (*sensu* von den Driesch 1976). Two phalanges are from Tort Hill West phase 3I and one is from Norman Cross phase 2. The diagram describes a "plot of the first and second canonical variables of sample means (circled X) and individual specimens as follows: black dot = *Equus hydruntinus*, white dot = *Equus hemionus*, A = *Equus asinus*, C = *Equus caballus*. The scale for canonical variable I extends from -6 to +7 and for variable II from -5 to +4" (Davis 1982).

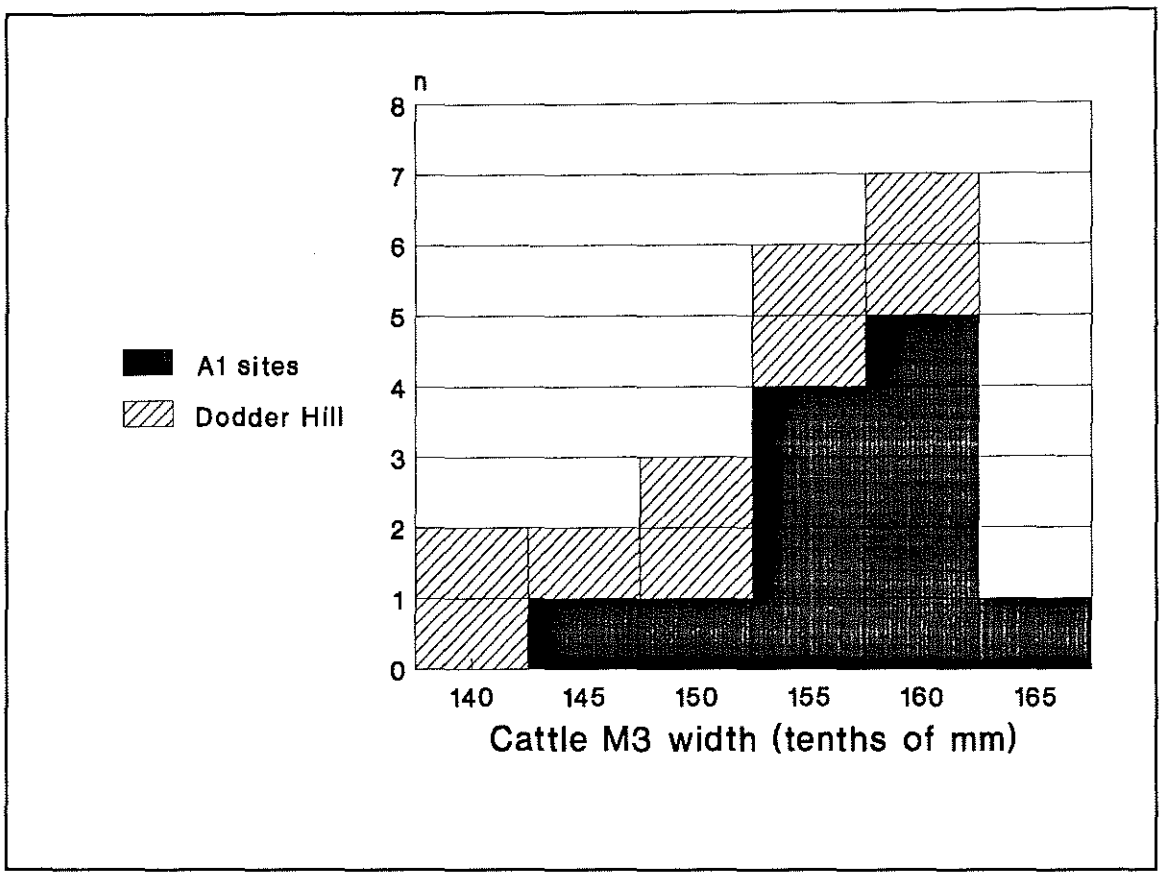


Figure 4.

Width of the **cattle** lower third molars from the 1st-3rd cent. AD levels at the four A1 sites and from the 1st cent. AD site of Dodder Hill (Hereford and Worcester) (Davis 1988). Despite the small samples the A1 specimens are significantly (at the 5% level) larger than those from Dodder Hill, according to a two tailed Student's t-test (probability = 0.035).

APPENDIX 1

Mandibular wear stages for cattle, sheep/goat and pig.

Tooth wear stages for cattle follow Grant (1982) and for sheep/goat follow Payne (1973 and 1987). Mandibular wear stages for cattle follow O'Connor (1988) and for sheep/goat follow Payne (1973). Mandibular wear stages are only provided for mandibles with two or more teeth (with recordable wear stage) in the dP_4/P_4 - M_1 row.

NC = Norman Cross, THE = Tort Hill East, THW = Tort Hill West, VH = Vinegar Hill
TAX = TAXON B = Cattle O = sheep/goat OVA = sheep S = pig
P = tooth present, but wear not recordable

CATTLE and PIG:

J = juvenile
IMM = immature
SA = subadult
A = adult
E = elderly

SHEEP/GOAT:

A = c.0-2 months
B = c.2-6 months
C = c.6-12 months
D = c.1-2 years
E = c.2-3 years
F = c.3-4 years
G = c.4-6 years
H = c.6-8 years
I = c.8-10 years

SITE	Phase	TAX	P4	dP4	M1	M2	M3	Mandibular stage
NC	1	B		h	g	b	V	SA
NC	2	B			n	l	l	E
NC	2	B					b	
NC	2	B	f					
THE	1	B	a		g	e	E	SA
THE	2	B		h	f	H		IMM
THE	2	B			l	k	g	A
THE	2	B	g		l	j	g	A
THE	2	B	f			l	k	E
THE	2	B					j	
THE	2	B					l	
THE	2	B					m	
THE	2	B				k		
THE	3	B		j	e	E		IMM
THE	3	B	f		o	l	g	A
THE	3	B	h		l	k	j	E
THE	3	B			o	m	m	E
THE	3	B					k	
THE	3	B				h	g	
THE	3	B		b				
THE	4	B		m				
THW	2	B		j	f			IMM
THW	2	B				g	e	A
THW	2	B				g	f	A
THW	2	B					a	
THW	2	B					h	
THW	2	B					j	
THW	2	B		j				
THW	2	B		k				
THW	2	B		k				
THW	3I	B			g	b		SA
THW	3I	B		j	g	c	E	SA
THW	3I	B		k	g	e		SA
THW	3I	B			k	j	g	A
THW	3I	B		j	h	g	c	A
THW	3I	B			k	k		A/E
THW	3I	B					f	
THW	3I	B					j	
THW	3I	B					j	
THW	3I	B		j				
THW	3I	B		n				
THW	3I	B	a					
THW	3I	B	a					
THW	3I	B	f					
THW	3II	B					g	
VH	2	B		j	b			IMM
VH	2	B		j	c			IMM
VH	2	B		P				
VH	3	B		j	f	E		IMM

SITE	Phase	TAX	P4	dP4	M1	M2	M3	Mandibular stage
NC	1	O			15A	10A	11G	H
NC	1	O					11G	
NC	2	O	11S		11B	9A		F/G
NC	2	O					11G	
THE	2	OVA		20M	9A	6A		D
THE	2	O			9A	8A	4A	E
THE	2	O	12A		15A	9A	11G	G
THE	2	O					11G	
THE	2	O					11G	
THE	2	O					5A	
THE	2	OVA		14L				
THE	2	OVA		14L				
THE	3	O		14L	6A	C		C
THE	3	OVA		14L	5A			C
THE	3	OVA		16L	5A			C
THE	3	O			9A	8A	H	D
THE	3	O			9A	7A		D/E
THE	3	O	4A		9A	8A	2A	E
THE	3	O	8A		9A	9A	6A	E
THE	3	O			15A	9A	11G	G
THE	3	O					10H	
THE	3	O					11G	
THE	3	O					4A	
THE	3	O					5A	
THW	2	OVA		14L	6A			C
THW	2	OVA		16L	7A			C
THW	2	O		16L	9A	6A		D
THW	2	O	14S		15A	11B	11G	H
THW	2	O					10G	
THW	2	O					11G	
THW	2	OVA		14L				
THW	2	OVA		13L				
THW	3I	OVA		14L	4A			C
THW	3I	OVA		16L	4A			C
THW	3I	O			9A	6A		D
THW	3I	O	8A		9A	9A	9G	F
THW	3I	O	12S		12A	9A	11G	G
THW	3I	O			15A	11A	11G	H
THW	3I	OVA		14L				
THW	3I	OVA		14L				
THW	3I	OVA		14L				
THW	3I	O					10G	
THW	3I	O					5B	
THW	3I	O					8G	
THW	3I	O					9G	
THW	3I	O					P	
THW	3I	O		P	7A			
THW	3II	O	8A		9A	9A		E/F
VH	3	O			9A	5A		D

SITE	Phase	TAX	P4	dP4	M1	M2	M3	Mandibular stage
THE	2	S	c		j	e	b	A
THE	3	S		e	b			IMM
THE	3	S	d		e			SA
THW	2	S		k	c	E		IMM
THW	2	S	e		g			SA/A
THW	2	S					a	
THW	3I	S			e	P	V	SA

APPENDIX 2.

Measurements of animal bones and teeth. All measurements are in tenths of a millimetre. See text for an explanation of how measurements are taken. Measurements are given in the following order: lower teeth, horncores, postcranial bones.

Key:

Site:
NC = Norman Cross
THE = Tort Hill East
THW = Tort Hill West
VH = Vinegar Hill

Parts of skeleton (ELEM) are coded as follows:
HU humerus
RA radius
MC metacarpal
PE pelvis
FE femur
TI tibia
AS astragalus
CA calcaneum
MT metatarsal
P1 1st phalanx

Taxa are coded as follows:
B *Bos* (cattle)
OVA *Ovis* (sheep)
O *Ovis/Capra* (sheep/goat)
S *Sus* (pig)
EQ *Equidae* (equid)
EQC *Equus caballus* (horse)
CAF *Canis familiaris* (dog)
CV *Canis/Vulpes* (fox)
GNP *Gallus/Numida/Phasianus* (domestic fowl, guinea fowl, pheasant)
VAV *Vanellus vanellus* (lapwing)
COF *Corvus frugilegus/corone*

Epiphysial fusion/age (FUS) is coded as follows:
F fused
H fused/fusing
G fusing
UM unfused diaphysis

Approximate measurements are designated:
c - within 0.2
e - within 0.5 mm

The metapodial measurements "a", "b", "1", "3" and "4" are the equivalent of "WCM", "WCL", "DEM", "DIM" and "DEL" as described in Davis (1996).

LOWER TOOTH MEASUREMENTS

Site	Phase	Taxon	M3L	M3W
NC	2	B		152
NC	2	B	351	151
THE	1	B		160
THE	2A	B		160
THE	2A	B	338	144
THE	2B	B	347	157
THE	2B	B	349	160
THE	2B	B	c384	c163
THE	2B	B	c395	154
THE	3	B	359	156
THE	3	B		147
THE	3	B		154
THE	3	B		168
THE	3	B	369	164
THE	3	B	c378	165
THW	2	B		153
THW	2	B		158
THW	2	B	353	c163
THW	3I	B	341	150
THW	3I	B	355	157
THW	3I	B	372	160
THW	3I	B	379	156
THW	3II	B	361	164
VH	2	B	362	159

Site	Phase	Taxon	P4L	P4W	M1L	M1W
THE	2B	CAF	108	62	182	75
THW	2	CAF			228	95
THW	2	CAF	103	54	187	75
THW	3I	CAF	125	62		
VH	2	CAF			212	86

Site	Phase	Taxon	$P2L_1$	$P2W_a$	$P2W_d$	$P3L_1$	$P3W_a$	$P3W_d$	$P4L_1$	$P4W_a$	$P4W_d$	$M1L_1$	$M1W_a$	$M1W_d$	$M2L_1$	$M2W_a$	$M2W_d$	$M3L_1$	$M3W_a$	$M3W_d$
THW	1	EQ																292	120	
THW	3I	EQ	307	133																
THW	1	EQC	330	153	84	295	164	79	300	160	68	267	154	42	258	146	45	314	133	35
THW	3I	EQC	348	131	84	282	166	52	261	165	56	246	165	32	258	148	36	304	131	38

Site	Phase	Taxon	dP4W	M1W	M2W	M3W
NC	1	O				77
NC	1	O		69	76	80
NC	2	O				83
NC	2	O		67	77	
THE	2A	O				82
THE	2B	O				83
THE	2B	O				94
THE	2B	O			76	82
THE	3	O				83
THE	3	O				83
THE	3	O				85
THE	3	O				86
THE	3	O		67		
THE	3	O		68	82	84
THE	3	O		71	89	85
THE	3	O		74	81	85
THE	3	O		74	82	
THE	3	O	65			
THW	2	O				76
THW	2	O				77
THW	2	O				84
THW	2	O		74	82	85
THW	2	O	59			
THW	3I	O				75
THW	3I	O				75
THW	3I	O				77
THW	3I	O				80
THW	3I	O				82
THW	3I	O		63	70	
THW	3I	O		68	80	82
THW	3I	O		70	82	86
THW	3I	O		81	77	71
THW	3II	O		70	78	
VH	3	O		72	75	
THE	2A	OVA	66	71	78	
THE	2A	OVA	70			
THE	2B	OVA	63			
THE	2B	OVA	64			
THE	3	OVA	61	67		
THW	2	OVA	62	72		
THW	3I	OVA	60			
THW	3I	OVA	60			

Site	Phase	Taxon	DP4L	DP4W	M1WA	M1WP	M2WA	M2WP	M3L	M3WA	M3WC
THE	2A	S			103		127	128		142	138
THE	3	S			103	110					
THE	3	S	189	c88	99	110					
THW	2	S							307	146	135
THW	2	S				98					
THW	2	S			102	108					
THW	3I	S			104	108					

HORNCORE MEASUREMENTS

Site	Phase	Taxon	W_{max}	W_{min}
THE	2A	B	650	442
THE	2B	B	768	580
THE	3	B	581	391
THE	3	B	701	536
VH	2	B	521	380
VH	3	B	517	401
THE	3	OVA	470	334

POST-CRANIAL BONE MEASUREMENTS

Site	Phase	ELEM	Taxon	FUS	GL[1]	Bd	3[2]	BT	HTC	SD	a	b	1	4
THW	2	HU	O	F					112					
THW	2	HU	O	H					124					
THW	3I	AS	O				145							
NC	2	HU	OVA	F				249	131					
NC	2	HU	OVA	F				271	130					
THE	3	HU	OVA	F				247	125					
THE	3	HU	OVA	G				263	124					
THW	2	HU	OVA	F				260	128					
THW	3II	HU	OVA	F				225	114					
THW	3I	MC	OVA	F		227	121				110	107	94	c92
THW	3I	MC	OVA	F		247	134				115	112	107	105
THW	3I	MC	OVA	F	1157	206	121			104	98	97	95	87
THE	3	MC	OVA	F		252								
THE	2B	TI	OVA	F		248								
THE	2B	TI	OVA	F		282								
THE	3	TI	OVA	F		223								
THE	3	TI	OVA	F		269								
THE	3	TI	OVA	F		272								
THE	3	TI	OVA	F		284								
THW	2	TI	OVA	F		220								
THW	2	TI	OVA	F		231								
THW	3I	TI	OVA	F		226								
THW	3I	TI	OVA	F		236								
THW	3I	TI	OVA	F		281								
VH	3	TI	OVA	F		230								
VH	3	TI	OVA	F		243								
THE	2B	AS	OVA		329	197	173							
THW	2	AS	OVA		237	156	154							
THW	3I	AS	OVA		266	173	151							
THE	3	CA	OVA	F	580									
THW	3I	MT	OVA	F		212	130							
THE	2B	MT	OVA	F	1332					115				

Site	Phase	ELEM	Taxon	FUS	GL	HTC
THW	2	HU	S	H		186
VH	3	TI	S	UM	566 (neonatal)	
THW	2	AS	S		373	

Site	Phase	ELEM	Taxon	FUS	Bd	HTC	LA
THE	2B	HU	CAF	F	261	101	
THE	2B	PE	CAF	F			c188
THE	2B	TI	CAF	F	188		
THW	2	TI	CAF	F	223		
THW	3I	HU	CV	F	198	74	

Site	Phase	ELEM	Taxon	FUS	GL[3]	Bd[4]	Dd[5]	BT[6]	HTC	SD	Bp	Dp
NC	2	HU	EQ	F				725	354			
THE	3	HU	EQ	F				740	359			
THW	2	HU	EQ	F				637	c315			
THW	2	HU	EQ	F				716	351			
THW	3I	HU	EQ	F					343			
THW	3I	HU	EQ	F				586	297			
THW	3I	HU	EQ	H				c639	349			
VH	3	HU	EQ	F				633	334			
THE	3	RA	EQ	F	3250					343		
THE	2B	MC	EQ	F	2020	434	312			284		
THE	3	MC	EQ	F	2280	519	384			321		
THW	2	MC	EQ	F		471	355					
THW	3I	MC	EQ	F		461	360			323		
THE	2A	TI	EQ	F		e535						
THE	2B	TI	EQ	F		621						
THE	3	TI	EQ	F		581						
THW	2	TI	EQ	F		634						
THW	3I	TI	EQ	F		743						
VH	3	TI	EQ	F		652						
THW	3I	AS	EQ		475	505	443	484				
THW	3I	AS	EQ		505	554	459	c526				
VH	3	CA	EQ		969							
NC	2	MT	EQ	F		e452	c353					
THE	3	MT	EQ	F		c480	362			286		
THW	3I	MT	EQ	F		460						
THW	3I	MT	EQ	F		460	352					
NC	2	P1	EQ	F	754	c398	c222			313	498	349
THE	2B	P1	EQ	F						284		
THW	3I	P1	EQ	F	689	373	208			294	473	336
THW	3I	P1	EQ	F	775	390	221			314	505	353
THW	3I	P1	EQ	F	c826	423	c214			301		

Site	Phase	ELEM	Taxon	Bd	SC
NC	2	HU	GNP	131	58
THW	2	HU	VAV	99	
THE	2B	HU	COF	148	

1.GL1 in astragalus

2.Dl in astragalus

3.GH in astragalus

4.GB in astragalus

5.BFd in astragalus

6.LmT in astragalus