EXCAVATIONS AT MAGIOVINIUM, BUCKINGHAMSHIRE, 1978-80

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Section 10 of 11:

HUMAN BONE AND ANIMAL BONE

EASY ON-LINE ACCESS TO FIGURES AND PLATES:

This report runs to a total of 137 printed pages, which makes it too large for publication on-line as a single digital file. The report has therefore been split into eleven separate sections. Each can be downloaded separately and saved locally.

The report contains 56 drawings ('figures') and 12 photographs ('plates'). For ease of access these have all been saved into a single file titled 'Magiovinium – figures and plates'. The reader should open (or download) this file when reading any of the report's 11 sections. Individual illustrations referenced in the text can then be found by searching for 'Figure XX' or 'Plate XX', where 'XX' is the number of the figure or plate you wish to view.

The full details for academic source references given in the text can be found in the 11th and last section of the report: 'A bibliography of Magiovinium'.

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The Human Bones
by Janet D. Henderson

[Extract from AML Report No. 3548.]

A large sample of inhumed bone was presented for examination. The bone fell largely into three categories: identifiable individuals (i.e. single skeletons); isolated bones found in context; and isolated bones found unstratified. The first two categories are dealt with below; the last is confined to archive only.

The Individual Burials

The state of the 31 identified, inhumed individuals from Site 17 was poor, and in many cases the bones were not sufficiently complete for detailed analysis. The results for each individual and the amount of the skeleton present are summarized in Table 1 below. Note that the measurements are only approximate.

Table 1. Bone Condition and Completeness of the Skeleton: Site 17.

Amount of Skeleton	*Bone Condition* *Poor*	*Fair*	*Good*
Up to ¼	994, 995, 1141, 1142, 1143		
⅓	29, 996. 1522, 1419, 1494, 1897, 1105, 1631, 1704	1867	33
⅓-½	1862, 1783		
½	1818, 1851, 1678	1869	38
⅔	1509, 1903, 1484,212, 1564		691
Over ¾	303		1870

All individuals were assessed for basic demographic data (age, sex and stature) and where possible for details of dentition, cranial and post-cranial metrics and non-metrics and pathologies or abnormalities. Details of results for age, sex and stature are listed in Appendix 1 (archive only).

Age

An assessment of age was made for all the identifiable individuals from Magiovinium. The methods used varied with age and therefore it was necessary to assign each skeleton to the class of infant, juvenile, sub-adult or adult.

Ages were defined as follows: infant—from birth up to six months (this was also referred to as neonate); juvenile—from six months to the beginning of epiphyseal union; sub-adult—the period of epiphyseal union; adult—maturation and growth of the skeleton and dentition are complete.

Infants were aged by means of diaphyseal bone length (hence stature), the development of the tympanic ring, tooth crown development and vertebral development. For the correlation of infant stature with age the methods of Olivier and Pineau (1958 and 1960) and Stewart (1979) were used. The development of the tympanic ring was as outlined by Anderson (1960) and Grant (1972). Tooth crown development was taken from Morrees, Fanning and Hunt (1963) and the development of the neural arches of the vertebrae from Grant (1972), Gray's Anatomy and Frazer (1948),

Results for the material examined showed that eight individuals could be classed as infants: one was foetal, two were from term to three months, four from early post-natal to three months, and one from three to four months. Thus it can be seen that the majority of infant deaths in this group occurred during the first three months of life. Note that the dis-parity between those aged from term to three months and those aged from early neonate to three months was caused by lack of evidence in the former where it was not possible to establish that the individual had survived birth.

There was only one juvenile present in this series; 1869 from the double burial 1871. This was aged on dental development using Schour and Massler's chart (1941), development of the atlas bone and closure of the metopic suture, Age was placed at two to four years; it was not possible to be more specific owing to the methods employed and the normal variability that is found between human populations. There were no individuals present that could be classed as sub-adult.

Of the 22 individuals in the adult age group 10 had insufficient data for a classification other than as 'adult'. The remainder were aged by means of dental wear, Brothwell's chart (1972) (7 individuals), the pubic symphysis, McKern and Stewart (1957) and Gilbert and McKern (1973) (4 individuals), and endocranial suture closure and degenerative joint disease (this last was used for one individual only).

The results showed a fairly even spread of individuals. It should be noted that in several cases a large age range was given (e.g. 1897). This was due to the condition of the material and the general limitations of ageing methods for adults. The size of the sample from Magiovinium Site 17 was too small for detailed analysis of the age distribution but there are a few points worthy of note. There was a noticeable absence of juveniles or sub-adults; this was emphasized further by the number of infants present. With regard to the infants it was interesting to note that all the identifiable individual infants came from Area 1, Trench 1 (with the exception of 1484 which came from the edge of that area).

Sex

Sexing was undertaken by both metric and non-metric means. !n the majority of cases this involved examination of the pelvis and skull and measurement of the vertical diameter of the femoral head. Where sexing by these means was inconclusive the diameter of the humeral head, the width of the medial epicondyle of the humerus and the general size and shape of the bones were ail assessed. In one case (1105) sexing was based on the size of the patella which was extremely large and therefore taken as belonging to a male. Juvenile and infant remains were not assessed for sex. The results showed that there were far more females than males present, namely: female 11 (? + 1), male 4 (? + 2), unsexed 4; total 22. The size of the sample prevents any explanation of this; for example it may be the result of sample bias or of burial practice, but it is not possible to distinguish which.

Stature

Stature was estimated on the maximum lengths of the long bones using the regression equations listed by Trotter (1970). Where possible the bones of the lower extremity were used in preference to those of the upper for greater accuracy. No correction was made for individuals over 30 years because the age estimates available covered too great a range, therefore for these individuals stature estimates must be taken as being high (by *c*. 1-2 cm). Note that the standard deviation ranged anyway (according to bone used) from ±4.32 to ±3,37 cm. All estimates were rounded to the nearest whole figure. Owing to the poor state of bone preservation results were available for only 11 individuals, as follows: 9 females, 153-67 cm; 2 males, 174 and 181 cm.

Although there is a clear disparity between male and female heights the fact that only two males were assessed must be emphasized, and it is likely that a truer picture would show an area of overlap between male and female, although males would be generally taller. Thus for 130 adult males and females assessed for height from Trentholme Drive, York there was a clear margin of overlap as follows: 30 females, 142-68 cm; 100 males, 160-83 cm. However, modal heights for Trentholme Drive, 152 cm for females and 173 cm for males, show that in Fact for the most part there was a fair degree of sexual dimorphism as regards stature, similar to that shown at Magiovinium. (Trentholme Drive may be categorized as a Romano-British cemetery, one of many serving the town and garrison of Eburacum, The site was in use from c.140 to the end of the fourth century, being used for inhumation burials (i) with cremations *c*.180-280 and (ii) inhumations only *c*.280-400, A sample of 350 skeletons was excavated. Data from Warwick (1968).)

The Dentition

Only 13 individuals had teeth available for analysis. The full list of teeth present is given in Appendix *2* (archive only).

Very little data was available for the two individuals with deciduous dentitions. 1419 was an infant of three to four months; there were only two tooth crown buds present with which it was possible to age the individual. 1869 was aged two to four years and there were seven teeth present *in situ* (the rest of the dentition was missing). There was no dental wear, caries, abscesses or rotation or crowding of teeth. There was some very slight periodontal disease but no calculus and no observation was possible for the presence of enamel hypoplasia. The precise aetiology of periodontal disease is unknown but dietary deficiency, poor denial hygiene, dental wear and calculus deposits may all contribute (Brothwell 1972, El-Najjar and McWilliams 1978). In this case, as would be expected in a juvenile, the disease presence was not extensive; it is suggested that in the absence of calculus deposits and dental wear, nutritional imbalance and lack of dental hygiene might have been causative. No analysis was made of the morphology of the teeth since this was a deciduous dentition.

All of the permanent dentitions were assessed for details of dental wear, caries, abscesses, occlusion, dental morphology, periodontal disease, enamel hypoplasia, calculus deposits and any other anomalies. There was insufficient data for analysis of the age and sex distribution of any results to be made.

Wear was analysed both for ageing purposes and for information with regard to diet, chewing habits etc. Unfortunately only three out of the 11 dentitions available could be regarded as having a sufficient number of teeth present for analysis other than for ageing. On 303 wear was symmetrical on the maxilla but on the mandible was found to be very slight on the premolars although much more severe on the incisors, canines and molars. However, complete loss of the mandibular left molars may be a possible cause of the asymmetry observed, in particular when compared to 1522 where wear was symmetrical all round. On 1509 wear was marginally greater on the maxillary teeth than on the mandibular and on the right than on the left. The reasons for the variability seen in tooth wear may include diet, tooth structure and food preparation, but with so little evidence available it was impossible to make a more specific analysis.

Dental Disease

All teeth were assessed for dental disease, the most common example of this being caries. Of the total number of teeth present (150) 11 could be shown to be carious (7.33%) which was actually less than found by Mummery (29%) and slightly less than Brothwell (12%) (sec Moore and Corbett 1971). The difference in incidence is probably a result of sample bias caused by the small sample used at Magiovinium. For possible later comparison with other sites or regions the DM rate (decayed + missing ante-mortem per 100 teeth) was calculated. This is only a very generalized statistic since it makes no allowance Tor the fact that ante-mortem loss of a tooth is not necessarily the result of a carious infection but may be caused by, for example, alveolar recession, dental wear or trauma. At Magiovinium Site 17 the DM rate was approximately 9/100,

Further observation was made of the teeth affected and the precise location of carious infections. The small numbers of each tooth present indicate that although they may provide data for a few individuals the pattern revealed is not necessarily true of the whole population sample. The caries rate per tooth (e.g. canines) is calculated as:

Number of carious teeth present x 100

÷Number of teeth present

Teeth of each category being included from all four quadrants of the dentition give the following results:

Table 0. Results for caries incidence per tooth at Magiovinium Site 17.

Tooth Type	*No. of Teeth*	*Carious Teeth*	*Caries (%)*
Incisors	All incisors were free of caries		
Canines	20	1	5
Premolars	27	1	3.7
Firs) molars	13	1	15.39
Second molars	12	5	41.66
Third molars	II	7	18.18

As would be expected, by far the highest incidence of caries was found in the molar teeth. This result has been found elsewhere and a simple anatomical explanation postulated: molar tceth possess larger crown dimensions, thus more surface area and also more fissures in which food particles may collect (Morrees in El-Najjar and McWilliams 1978). It is not possible to analyse the greater number of caries in second molars than in any other teeth without taking into account the age distribution of the caries and this was not considered feasible in the light of the imprecise age estimates that were available.

Examination of the sites of caries showed that they were relatively evenly distributed between buccal, mesial and distal locations. No lingua) caries were observed. However, in the 11 carious teeth, six had caries at the cemento-enamel junction, two on the crown or at contact areas, and for three no data was available. Again the high prevalence of caries at the cemento-enamel junction is a common finding in population samples of this date although always with the point that the apparent absence of carious lesions from occlusal or fissure areas may be an artefact of dental wear which obscures the development of cavities. To analyse the significance of this would require a larger number of deciduous, mixed and permanent dentitions than were available at this site.

On only two individuals were abscesses found: 1522 and 1564. On 1522 the maxillary left first molar was involved and it is likely that the abscess was involved in the ante-mortem loss of that tooth.

On 1564 there were three abscesses; on the maxillary right first molar, the maxillary left second molar and the mandibular right first molar. Only in the case of the second molar was there possible association with a carious lesion. The cause of the other two abscesses remains unknown.

Owing to the small sample available further analysis was not considered justifiable.

The amount of calculus (tartar) on each individual's teeth was recorded. Its presence is significant in that it may be involved in the onset of periodontal disease and may also bring some degree of immunity from carious infection. In seven individuals from Magiovinium moderate to heavy calculus deposits could be shown to be present, In the three cases where apparently there was no calculus it is suggested that probably the true situation was masked by the small number of teeth present and possible accidental loss of any such deposits.

On the individuals for whom periodontal data was available four showed moderate periodontitis (now partially exposed), three showed severe alveolar recession (nearly complete exposure of roots) and one came between the two classes (moderate to severe). In one case (303) severe periodontal disease could possibly be associated with ante-mortem loss of the mandibular left molars. There was severe periodontitis in other individuals without loss of the teeth. However, this may reflect the ages of those concerned; unfortunately the only means for ageing 303 was dental wear so that comparison by ages would be invalid. There was insufficient data available for analysis of the causes of periodontal disease at Magiovinium other than to suggest that poor diet, bad oral hygiene, calculus deposits and dental wear were probably all contributory.

The presence of enamel hypoplasia, whether as pits, transverse lines or grooves, indicates a disturbance in the production of enamel during the period of active enamel matrix formation. Of six individuals for whom data was available five showed no trace of enamel hypoplasia and one had slight lines. Obviously on such a small sample it is not possible to say that there was no childhood disturbance (e.g. dietary deficiency or disease) sufficient to cause disruption of tooth formation in this population, merely that on the few individuals available there was no disturbance of sufficient magnitude to cause enamel hypoplasia.

Dental Morphology

Observations were made for absence of teeth, occlusion, rotation or crowding and supernumerary teeth or cusps. Unfortunately, as so many teeth were missing, it was only considered justifiable to record these features and no analysis was undertaken.

Cranial Observations

Since data for cranial metrics was available for three individuals only (303, 1522, 1851) and these involved only the cranium, it was decided that detailed analysis of the measurements could not be justified and the information was merely recorded, (The results for the three individuals were all very similar.) Details on cranial morphology could be taken on five individuals only. Analysis could not therefore be justified and the results were simply recorded. No anomalies were found.

Post-cranial Observations

Post-cranial metrics were available for 11 individuals only and thus there was insufficient data to justify detailed analysis of the material other than to say that all femora exhibited platymeria (flattened shafts) and all tibiae were eurychemic (wide shafts). The small number of individuals and the poor condition of the material meant that very few post-cranial morphological observations could be made. The only example of interest was on 996 where there was a rare reduction in size of the left humeral medial epicondyle.

Degenerative Joint Disease

All individuals were assessed for any pathology or abnormality including degenerative joint disease, trauma, infectious disease, stress or any other affection. Of those examined for degenerative joint disease nine had none present, in six the spine only was involved, in two the spine and hips (the latter only slightly) and in one the fingers and toes were affected as well as the hip and spine.

Arthritis in the spine for the most part was present as vertebral osteophytosis (i.e. affecting the centra only) and was confined to the lumbar vertebrae (28, 212. 994, 995, 1564, 1818 and 1867), the exception being 1851 where the osteophytosis was altogether more severe and ran from the fourth thoracic vertebrae to the base of the spine. However even in this case —where the osteophytes were more marked on the right side—there was no fusion of the vertebral centra but almost certainly compression of the centra and narrowing of the joint spaces between them. (An indication of this narrowing was found on 28 and 995 where Schmorl's nodes were present on the vertebral centra.)

Osteoarthritis of the hip joint was found in 28, 29 and 1851. On all of these there was slight lipping of the acetabular rims and the femoral heads and on 28 and 29 at the sacro-iliac articulation also.

On 29 osteoarthritic lipping was observed on the first left metacarpal and on the shafts and distal extremities of the hands and also on the first phalanges of the feet.

It is probable that the above observations are incomplete for the individuals observed, owing to the fragmentary nature of all the skeletons. On such a small sample analysis in depth (e.g. of sex and age distribution) cannot be justified.

Other Pathology (Disease, Stress, Trauma etc.)

Owing to the poor preservation of the material there was very little evidence for any other pathologies and with the exception of two individuals it was recorded throughout as absent. On 1818 there was some evidence for an increase to cortical bone thickness on the medial borders of the tibial diaphyses. The precise cause of this was not clear but there was no suggestion of any infection or disease on the tibiae or any of the other bones of the skeleton and it is likely therefore that it was the result of some local stress or trauma. On 1870 there was some slight hyperostosis on some of the cranial fragments but as there was so little of the skull present a diagnosis was not possible.

Other Skeletal Finds

Material Found with Identified Individuals

A few of tile burials already described were found to include human bone which could not belong to the main skeleton.

Burial 646

The burial was of Skeleton 29 but an additional ulna bone from an adult individual was also present. It was not clear whether this represented another individual or post- excavation confusion of the material.

Burial 996

The main burial was of an adult female (996) but there was also a femur from a human foetus present. This was aged on maximum length of the bone at approximately 7¾ lunar months (31 weeks).

Burial 187I
There were two skeletons in this grave, 1869 (a juvenile) and 1870 (an adult female).

The Cremations

A total of 16 samples of cremated human bone were submitted for examination; in none of these was there any evidence found to suggest that more than one individual was present.

All the samples of material were small: this is perhaps best illustrated by examination of the total bone weights which ranged from 23 g (1147) to 760 g (2254). The normal weight of the dry, fat-free skeleton varies from 2 to 4 kg, and that of a cremated skeleton averages about 1.6 kg. Clearly none of the cremated samples from Magiovinium Site 17 were even half of that weight, and therefore any analysis of observations made on that material must remain tentative (Krogman 1962 and Evans 1963).

Eleven of the cremations could be aged as being 'probably adult'. These were 1547, 1540, 1813, 2228, 2249, 2254, 1130, 1146, 1144, 1129. 449. On numbers 1581, 1172, 1147, 1148, 1140 no age estimate at all was possible. Ageing where undertaken was based on tooth fragments, cranial suture closure, epiphyseal union (1144 only) and size and thickness of the bones.

Sex could be assessed on two individuals only. 1540 was possibly a male, on the size of the scapular and vertebral fragments. 2249 was probably a male, on the approximate radial head diameter and the general size of the bone fragments. Although all the material was observed for information with regard to stature it was not feasible to assess this on any individuals. No pathology or abnormality was observed on these cremations but it must be emphasized that the evidence available was very limited, therefore it cannot be stated that any pathology or abnormality was absent.

Other information which may be deduced from these cremations concerns the mode of burial involved. All of the bones showed signs of burning but it was interesting to note that they varied in colour from black to blue-grey and white. The black, it is suggested, was a result of the presence of charcoal in the fire or of post-burial staining in the ground (if this is not the case then it is indicative of a low level of burning). The blue-grey and white reflect the degree of burning at the time of cremation. During the process of cremation bone gradually changes colour, eventually becoming white. The blue-grey bone found indicates both incomplete cremation and also the presence of organic matter.

The small size of the fragments (maximum length *c.*2-6 cm) suggests a degree of post-mortem breakage of bone, most probably to facilitate the inclusion of the material in a funerary urn or container. Analysis of whether it was the practice to include all of the remains in the final burial or only representative parts was hampered by the small size both of the fragments and the samples, However, in most individuals fragments of skull, teeth, vertebrae, ribs, pelvis and long bones could be recognized, which suggest that there was probably no discrimination. The only exception to this was 1144, where for such a small sample of bone (2279) there was an unusually high proportion of bones from the hands and feet present.

Acknowledgements

1 should like to thank Justine Bayley of the Ancient Monuments Laboratory for the data on inhumation burials 212 and 1564 and Guy Grainger for details of weight and identifiable bone for cremation No. 449 (AML 7711143).

The Animal Bones

by Alison Locker

Excavations at Magiovinium produced 11,306 bones from a series of Roman gullies and ditches, mainly dated to the second and third centuries, but with a few of first-century dale. There were also a small number of unstratified bones (1,370) from the topsoil which may have received some admixture of later material but seem essentially the same as the stratified and sealed deposits,

The proportions of different anatomies recovered for each species are given in full in the site archive and AML Report No. 4543.

For the purposes of analysis ox and ox-sized fragments have been combined as it is likely that they belong to the same species. Ox-sized fragments are heavily fragmented through butchery while horse bones tend to be fairly complete. Similarly, ovicaprid and ovicaprid-sized fragments have been amalgamated; pig and roe deer, to whose size range they might also belong, occur less frequently. The term ovicaprid has been used to cover possible bones of goats that could not be positively identified; the vast majority of ovicaprids would in fact be sheep.

The following species were identified: ox (*Bos* sp.) 11.8%; goat (*Capra* sp.) 0.008%; ovicaprid *(Ovis* sp./*Capra* sp,) 8.2%; pig *(Sus* sp.) 1.8%; horse (*Equus* sp.) 5.5%; red deer *(Cervus elaphus)* 0.04%; roe deer *(Capreolus capreolus)* 0.01%; ox-sized fragments 32.1%; ovicaprid-sized fragments 11.4%; dog (*Canis* sp.) 0.8%; fox *(Vulpes vulpes)* 0.008%; cat *(Felis* sp.) 0.008%; hare *(Lepus* sp.) 0.04%; unidentified mammal fragments 27.2%; domestic fowl (*Callus* sp.) 0.4%; domestic duck/mallard (*Arias* sp.) 0.008%; raven *{Corvus corax)* 0.008%; barn owl *(Tyto alba)* 0.08%; swan (*Cygnus* sp,) 0,008%.

Recording Methods

Each bone was encoded onto punchtape using the method outlined in Jones *et al.* 1981, The information was then transferred onto floppy disks and, using a Research Machines 38OZ microprocessor, paper archives were produced of both the descriptive and metrical data.

Spatial Distribution

Although the bones were not phased through lime, three groups were distinguished spatially on site, each area being composed of gullies and ditches, and each group being examined in comparison with the others. It was hoped to observe differences in carcase disposal in the groups although there was no evidence archaeologically for functional differences between them. Little success was met using chi-squared tests (used to indicate whether the differences in the recorded data could reasonably be attributed to chance variation) comparing the distribution of the most common species (divided into different anatomical groups) between areas and against the distribution of the whole site. The level of chi (or X^2) was so high as to suggest that the data was unsuitable for this sort of analysis; perhaps the group divisions were too crude and were bound to suggest great variability. Very high values were obtained both comparing species between areas and for pairing species in different levels of fragmentation which was successfully carried out on the Brancaster material (Wall *et al.* 1985).

Cluster analysis using the weighted pair group average for certain anatomies did not reveal any significant differences between species, and observation of the distribution between different groups did not suggest any variance in carcase disposal.

The inconclusive results of some of the tests may be the result of problems with the data, such as the bias against the recovery of small bones since no sieving was carried out; for example the smaller phalanges of sheep will stand less chance of recovery than those of ox. Some bones survive better than others, for example jaws and metapodials. Gram (1975, 384) cites the proximal ends of humeri and tibiae and skull and vertebrae fragments as having a low specific gravity and therefore unlikely to survive well.

Similarly, the denser early-fusing bones should survive better than the late-fusing bones; the latter include the proximal ends of humeri and tibiae and also the distal end of the femur. There are therefore two sources of bias operating. At a more basic level the fragmentation of bone reduces the chances of recovery, especially if no sieving is carried out. If one accepts the above points the bones which stand the best chance of survival are those from animals that are not eaten, hence not butchered, and are fully mature at death so that the bones are at their maximum size and density. Horses seem to satisfy most of these requirements. In this report the assumption has been made that the distribution of species and anatomies across the site is random, and that no deliberate disposal of bone waste related to specific activities was exclusive to any one area.

Fragmentation

Fragmentation of the major food species cannot be separated from butchery and thus the least fragmented species occurring appear to be horse and dog. Sheep require less chopping than ox to produce manageable joint sizes; the extremities of both animals tend to be complete since these areas produce little meat. The major limb bones are well fragmented both for their meat and for their marrow. In cattle some of the heaviest fragmentation occurs in the mandibles, maxillae, skull and os coxae. The hind limbs are more fragmented than the Tore except for the scapulae which as well as being subject to extensive butchery easily fragment in the blade area. By comparison, most sheep bones have a higher proportion in the 50% range except for os coxae and scapulae which are heavily fragmented. None of the fragmentation of horse was due to butchery; according to Wilson (1973, 72) the Romans discouraged the consumption of horse-meat.

Pig bones were too few for any interpretation of their fragmentation, but a high level of fragmentation was suggested for mandibles and maxillae, Scapulae tended to be more complete than for ox and sheep, 46% fall in the 50% size range, possibly indicating a different butchery technique, radii are greatly fragmented with 50% in the 25% size range and 53% of humeri in the 25% size range.

Butchery

The presence of different parts of the anatomy suggests that animals for food were slaughtered locally, rather than imported as dismembered carcasses. All parts of the skeleton were reasonably well represented considering the reduced recovery of certain bones due to biases previously mentioned.

Ox

Ox skulls were heavily fragmented, without evidence of poleaxing; horncores were removed from the skull often with part of the frontal bone. Maxillae were very fragmented and mandibles often chopped through around the area of the diastema. (Apparently this is unnecessary for the removal of the tongue. Rixson (pers, comm.) has suggested that chopping through the vertical ramus and through the diastema which are often found together, may have been practised to remove the ox cheek (massetor muscles) with the main part of the mandible, being the only significant amount of meat on the head. Also the chopping of the diastema might be practised for the removal of the marrow from the mandible.)

Scapulae were often found to be chopped obliquely across the neck, or at the glenoid cavity, with the blades normally shattered; there is no evidence for the complementary chopping of the proximal end of the humerus as noted at Brancaster (Wall *et at.* 1985), The proximal humerus as mentioned previously does not survive well owing to its low density and late fusion.

The distal end of the humerus was chopped medio/laterally and also in the midshaft area; metacarpals (one of which showed evidence of canid gnawing) were also sometimes cloven across the shaft; phalanges were mainly whole. Knife cuts were noted at some proximal ends, possibly as a result of skinning.

Os coxae were heavily butchered, and femora were chopped across the midshaft and the distal end, as were tibiae. Astragali were sometimes cloven obliquely, and metatarsals chopped in a similar manner to metacarpals; in one case the distal end of a metatarsal was chopped and covered in knife cuts.

Sheep

Butchery differed from that of ox in that many of the bones were chopped across the midshaft area and not at the proximal or distal end. The mandibles were also chopped around the diastema and alveoli, presumably for marrow extraction. Vertebrae of ox, sheep and pig were cloven both axially and transversely.

Pig

There is little comment since there were so few bones. One skull was cloven axially, scapulae were chopped across the blade, indicating a slight difference in butchery technique to that used on ox and sheep, and a humerus was chopped across the midshaft.

Few knife cuts were recorded from any species; some have already been mentioned, and generally speaking they most frequently occurred on the first phalanges of ox (probably associated with skinning, although knife marks need not penetrate the bone if this is done expertly). Other knife marks were noted on some rib fragments of ox and sheep, an ox scapula and a hyoid; these are more likely to be associated with honing out. No butchery marks were observed on any other species.

Many long bone splinters in the ox-sized and ovicaprid-sized categories could well be evidence for marrow extraction as suggested by Cram (1973, 151). This involved chopping a bone into fragments and boiling so that the fat could be skimmed-off. Cram also states that metapodials tend to be less broken than some of the main limb bones because they contain less marrow.

There were only a few examples of gnawing, all of them canid, including a fragment of an ovicaprid and the midshaft of an ox metacarpal. Their scarcity might suggest that bone refuse was disposed of fairly quickly and not left lying on the ground surface where it would be found by dogs.

Ageing

Ageing was based on tooth eruption, and to a lesser extent epiphyseal fusion. Although the ageing method devised by Grant (1975, Appendix B, 437-50) was used whenever possible, many of the mandibles were so fragmented that it was impossible to record sufficient to achieve a value. Consequently, tooth eruption was recorded and the information transposed into age groups (better regarded as eruption stages), using Silver's data (1969). Had it been possible Lo use the Grant system (1975) throughout, broadly similar results would possibly have been achieved, but with rather finer divisions.

Ox

Over 50% of the mandibles (the total number aged was 42) have the third molar in wear, indicating the majority were mature individuals, perhaps indicating that breeding was not primarily for meat, but for draught animals. Milk may have been consumed, or made into cheese, although the significance of dairy products in Roman Britain is uncertain. White (1970, 227-78) states that cows' milk was rarely drunk in Italy—sheep and goats' milk being more common. In any event cattle were used for other purposes before their slaughter for meat and hide.

Sheep

Mandibles show a greater variety of eruption stages, with a lower proportion of individuals achieving full dentition—only 19% (of a total number of 62 mandibles) had all teeth in wear. Sheep also provided a wide range of products: wool was the most important, also milk and cheese, and their manure was an important fertilizer. Sheep reproduce more prolifically than cattle, and Columella warns that where fodder is scarce cows should only be allowed to calve every second year, especially if the cows are also used for farm work (White 1970, 278).

Pig

Few mandibles were present but they indicate, as is usually the case, pigs being slaughtered relatively young, often between the eruption of the second and third molar. Using Silver's data from the late eighteenth century (1969, 299) this suggests an age of between two and three years. The pig's primary use is for meat, and as they have a high fecundity level relatively few need be kept for breeding. Scrofa thought that sows should not be allowed to breed until they were twenty months old and should be considered too old for breeding after seven years (White 1970, 317),

Horse

The mandibles were from animals with all permanent teeth in wear. The incisors were often missing due to fragmentation, but the eruption of the molars based on Silver's data (1969, 291) gives a minimum age of three and a half to four and a half years—early in a horse's working life. Race-horses are broken in early, but working horses are usually broken in around three years, reaching their peak at eight years. Excessive wear, which might denote a very aged animal, was not seen on any horse teeth.

Evidence from epiphyseal fusion was also examined, though it is not such a reliable method as tooth eruption and wear, since it only gives a minimum age once a bone has fused. In general, however, full epiphyseal fusion in ox (except for some vertebrae which fuse very late) reflects much the same ageing as the teeth, i.e. that most animals were fully mature. For sheep, fusion suggested a wider age range than for ox (as reflected in tooth eruption). Pig showed a higher proportion of unfused and porous bones than the other species. All the horse bones were fused except for one pair of pelves, which, using Silver's data (1969, 286), suggests an age of one and a half to two years or, using Getty (1975, 298) under one year.

Metrical Analysis

Measurements were taken whenever possible using those outlined in Jones *el at.* 1981, and the complete archive is part of AML Report No. 4543.

Ox

The range of metatarsal total lengths, distal widths, and tibia distal widths from Magiovinium, Corstopitum (Meek and Gray 1910), Portchester Castle (Grant 1975) and Exeter (Maltby 1979) are summarized below. Measurements are in mm and the number of specimens is given in parentheses.

Site	*Metatarsal length*	*Metatarsal distal width*	*Tibia distal width*
Mag.	202-234 (20)	48.3-66.0 (41)	50.8-71.5 (19)
Cor.	181-244 (67)	42.0-65.0 (127)	45.0-68.0 (78)
Port.	183-240 (108)	43.0-70.0 (172)	50.0-69.0 (145)
Ex.	190-219 (15)	36.9-51.1 (49)	49.7-65.1 (10)

The Magiovinium cattle fall within the ranges for Corstopitum and Portchester but the Exeter cattle tend to be smaller, which may be a regional characteristic. The distal tibia widths give Magiovinium a slightly larger range than the comparative material. Bones from the villas at Shakenoak (Cram 1973) and Frocester (Noddle 1979) were also examined but the sites listed had the greatest number of measurements.

The total length measurements in mm and number of specimens of other cattle bones are as follows:

Metacarpal	175-230 (17)
Humerus	294 (1)
Radius	268-285 (5)
Femur	326-350(3)

46 withers heights were calculated from the bones listed below, to give the following results (heights in cm):

Metacarpal	107.1-140.7 (17)	Fock 1966 (no sex factor)
Metatarsal	110.0-127.3 (20)	
Femur	113.1-121.4 (3)	Matolsci 1970
Radius	115.2-122.5 (5)	Matolsci 1970
Humerus	121.5 or 126.8 (1)	Matolsci 1970 (using two factors)

The varying withers heights derived from the humerus result from using two separate factors on different length measurements, so perhaps it is more accurate to compare only absolute lengths. This difficulty also occurs with the calculation of horse withers as there seems to be a large discrepancy between the methods of Kieswalter (1974) and Vitt (1967). Accordingly, to avoid error the author has only used absolute measurements for horse—except in one instance when describing their general size range.

The plotting of the distal width index of metacarpals and the midshaft diameter against length revealed no distinct sex groupings, although one outlier occurred in each case. The latter was from a slender bone of long length. Examination by Dr P. Armitage (British Museum of Natural History, Dept of Urban Archaeology) of twelve horncores from Ditch 209 suggested that both short-homed and medium-horned animals were present in sub-adult and adult classes; some castrates were also identified.

Sheep

The range of metacarpal and metatarsal lengths were compared with those from

Gadebridge (Harcourt 1974a), Exeter (Maltby 1979), Brancaster (Wall *et al.* 1985) and Frocester (Noddle 1979).

Site	*Metacarpal length*	*Metatnrsal length*
Magiovinium	120.0-132.0 (3)	127.0-154.0 (6)
Gadebridge	126.0-133.0 (3)	128.0-144.0 (6)
Exeter	112.0-127.0 (3)	120.0-143.0 (9)
Brancaster	122.0-143.0 (4)	128.0-145.0 (11)
Frowsier	1140-125.0 (4)	121.0-140.0 (5)

The metatarsals from Magiovinium are larger at the top end of the range, but the numbers from all the sites are too low for this to be significant. Comparisons with other measurements of humerus distal breadth and metatarsal distal breadth show the Magiovinium range to be slightly larger.

Site	*Humerus distal breadth*	*Metatarsal distal breadth*
Magiovinium	25.5-32.6 (17)	19.7-27.6 (7)
Astiville	23.0-28.0 (2) (Wilson *et al.* 1978)	
Farmoor	30.0-31.0(3) *(ibid.)*	
Gadebridge	25.0-28.0 (5)	21.0-23.0 (4)
Frocester	23.0-28.0 (21)	18.0-24.0 (5)

Data from 80 modern sheep suggests that the maximum distal tibia width of castrates is 4% greater than for ewes (Noddle 1975, 253). The distal width was plotted against the distal depth of the measured sheep tibia from Magiovinium, and the resultant graph suggested that there might be two possible groups with roughly equal numbers of ewes and wethers, with one ram, although they are not necessarily contemporary with one another.

Pig

Measurements were limited because of the low numbers of bones, many of which were immature, but the following ranges have been included:

Humerus distal breadth	34.5-43.3 (5)
Tibia distal breadth	30.0-37.0 (4)

Horse

There were relatively high numbers of bones, often fairly complete so that a large number of measurements could be taken. The greatest number of comparisons could be made between the length ranges of metacarpals and metatarsals for which the following comparisons have been made:

Site	*Metacarpal total length*	*Metatarsal total length*
Magiovinium	207.0-277.0 (13)	240.0-282.0 (12)
Corstopitum	217.0-235.0 (10)	226.0-290.0 (4)
Brancaster	187.0-212.0 (2)	233.7 (1)
Frowcester	210,0-220.0 (2)	
Godmanchester*	206.0-257.0 (2)	
Gadebridge		252.0-280.0 (4)
Farmoor*		238.0-286.0 (4)

*Godmanchester: Westley 1974
*Farmoor: Wilson 1978

The range for Magiovinium seems to be narrow when the number of specimens is considered. The metacarpals are from ponies c.l3-14hh, and the metatarsals show a greater range from 12 to just under 15hh (the latter would be almost the size of a small horse). These conversions may not be entirely accurate but serve to give some indication of the size of the animals.

Other comparative length ranges are as follows:

Site	*Tibia*	*Humerus*
Magiovinimn	309.0-364.0 (10)	282.0 (1)
Godmanchester	342.0-345.0 (2)	259.0 (1)
Gadebridge	320.0 (1)	
Corstopitum	293.0-379.0 (4)	292.0-336.0 (8)
Parnell and Appian Road (Rixson 1972)		320.0-323.0 (2

Although the tibiae are well within the range found at Corstopitum the radius range is rather greater.

Dog

A number of long bones were measured including a femur whose total length was 90 mm and using Harcourt's formula (1974b, 154) the shoulder height was estimated at 27 cm; an unstratified tibia of 114 mm gave a shoulder height of 34.2 cm. The range of the lengths of the lower first molar is 20,0-24.9 cm (n = 7); Harcourt's range is 15.0-24.5 mm. it is probable that Lhese were working animals (there was no evidence for butchery).

Pathology

Instances of pathology are relatively infrequent on animal bones on archaeological sites and Magiovinium was no exception.

Ox

The proximal surface of a metatarsal was affected by a lesion; pitting was most marked on the medial side, which must have affected the conformation of the joint and led to inflammation. This appears to be similar to an infection known as tarsitis, which if it was of the aseptic variety could have affected the animal's mobility. Alternatively it may simply be a case of osteoarthritis, as this specimen shows three of the four changes characterizing this condition as outlined by Baker and Brothwell (1980, 115).

A metatarsal has evidence of exostoses over the distal anterior surface of the bone, but it does not extend to cover the joint surface. Exostosis is also evident on a fore lateral first phalanx, over the proximal medial area and over the lateral side of the proximal articulation with slight eburnation. It is possible that this is a case of ring bone as described in Baker and Brothwell (1980, 120). A rib fragment showed evidence of exostosis near its sternal end.

Sheep

A humerus shaft had become infilled with bone. In dogs the shaft of the femur can become infilled when there is a Vitamin A deficiency; perhaps this is a related condition (Bourne 1972, 201). A fragment of femur shaft was ivoried and may have part of an ossified tendon attached.

Horse

A first and second phalanx had fused. Severe exostoses occur around the distal area of the first phalanx and the proximal area of the second resulting in immobility of the foot.

A lumbar vertebra with a collapsed centrum was found, which in cattle can be an indication of tuberculosis (Greenough *et al.* 1972, 392). Perhaps this may also apply to horse.

Pig

The first premolar of a right mandible has rotated and now points towards the canine; this type of condition is not uncommon in pigs.

Dog

The ante-mortem loss of the third molar in a right mandible was observed, the alveoli had completely healed over and its shadow could be seen in X-ray. The other teeth were all normal in eruption and wear.

Other Mammalian Species

Goat was only positively identified by a single horncore, though it is feasible that there are goats in the ovicaprid category which could not be reliably separated from sheep, A fox was identified from a single fused radius and ulna. The identification was made on the basis of size so it is also possible that it is a fox-sized dog. Cat was represented by a single metapodial.

Hare was identified from five bones from a variety of contexts and together with the few bones of red and roc deer forms the small contribution of game to the economy that is represented in the animal bone. Even the evidence of red deer is not conclusive since this species is represented by fragments of antler that could be cast, plus one upper premolar. The evidence for roe deer is more convincing in the form of fragments of maxilla and mandible.

Birds

A number of domestic fowl bones were identified from a variety of contexts, the ranges of their total lengths (mm) being as follows:

Coracoid	47.0-57.0 (2)
Scapula	63.2 (1)
Humerus	62.0-76.0 (3)
Radius	63,4-68.2 (2)
Ulna	57.5-75.0 (3)
Carpometacarpus	34.9 (1)
Femur	69.6-69.9 (2)
Ti biotarsus	110.0 (1)

Domestic fowl provided eggs and meal; their size range falls within the variation for Roman sites examined by Macready (1976). According to White (1970, 322) poultry keeping was a sophisticated form of husbandry in Roman Italy and there is much ancient literature on the subject. A few bones were also found of crow and raven which may well have been scavengers around the site, also a coracoid of a swan; this species was eaten in Roman times and has been recorded from the military sites of Chester and Ribchester (Davies 1971, 130).

The topsoil also produced evidence of barn owl and duck, (domestic/mallard) though these could be intrusive.

General Discussion

A number of sites have been compared with Magiovinium to compare measurements. The site itself is difficult to classify. Because of its nature and the type of deposits containing the bone, it seems justifiable to view the material as mixed in origin, some from the earlier fort and some from town clearance, but the bulk must originate from the indigenous settlement, As mentioned earlier there were no discernible differences in spatial distribution.

The high percentage of ox plus ox-sized fragments fits in with King's suggestion (1978, 211) that the more Romanized settlements such as villas, roadside villages, towns and forts tend to have fewer sheep than the native sites. The accompanying increase of pig with the dominance of ox is not seen.

The relatively high number of horse bones is both interesting and unusual. At Portchester Castle (Grant 1975, 381), horse together with red deer, roe deer, hare, fox, badger, voles, fallow deer, fish and mice formed only 3% of the total, whereas at Magiovinium horse alone forms 5.5% which in real terms may be relatively higher since the numbers of fairly complete horse bones are being directly compared with heavily fragmented bones, Grant (1975, 383) thought that horses might be buried outside the area of occupation which would explain their rarity in domestic refuse at Portchester Castle and possibly their abundance in the extra-mural ditches and gullies at Magiovinium.

Horses were used by the Romans for cavalry, riding and pulling carriages (White 1970, 288). They were rarely employed for draught purposes, for which donkeys and mules were used. Presumably most of the horses at Magiovinium were for transport, riding and breeding. No mules were identified from the lower first and second molars (Armitage and Chapman 1979, 342). Columella describes three classes of horse (While 1970, 288), noble stock for circuses, breeding stock for mules (the offspring commanded a high price) and ordinary mares and horses. The Magiovinium horses are most likely to belong to the latter group. The role that the mule played in the Roman world appears to be important from the literary and pictorial sources (Armitage and Chapman 1979, 345), but seems to be almost absent from the bone evidence. The difficulties of identification have been pointed out by Armitage (1979, 339) and it may be that many limb bones of mule remain categorized as horse. At Magiovinium stock for transport was vital both when the fort was in use and especially later when heavy traffic passed up and down Watling Street, Ox, and horse (and/or mules) must have been frequently used in this capacity/

This article is concluded in Section 11: Appendix: A Bibliography of Magiovinium