The Archaeology of York **The Animal Bones** **15/3**

Bones from Anglo-Scandinavian Levels at 16-22 Coppergate

T. P. O'Connor

The Archaeology of York

Volume 15: The Animal Bones

General Editor P. V. Addyman
Co-ordinating Editor V. E. Black

Published by
Council for British Archaeology
112 Kennington Road
London SE11 6RE

The Archaeology of York
Vol. 15: The Animal Bones
Fasc. 3: Bones from Anglo-Scandinavian Levels
at 16–22 Coppergate
1. North Yorkshire (York)—Antiquities.
Archaeological investigation
I. Addyman, P.V.   II. O'Connor, T.P.
III. Council for British Archaeology
IV. York Archaeological Trust
936.2 843

ISBN 0 906780 83 7

Printed by
Henry Ling Ltd
The Dorset Press
Dorchester, Dorset

Cover illustration *Skull of raven from 10th century pit at 16–22 Coppergate*
Photo *S. I. Hill*

Volume 15 Fascicule 3

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By T.P. O'Connor

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Introduction

This report presents the results of a study of over 75,000 fragments of non-human bones recovered by hand-collection during excavation at 16–22 Coppergate, and thousands more fragments recovered from 234 soil samples.

The Coppergate site (Fig.1, *AY* 15/1;Fig.21) was important, both locally and nationally, in that well-stratified urban Anglo-Scandinavian occupation was represented in burial conditions which gave excellent preservation of organic and inorganic materials. Studies of bone debris from Saxon and medieval sites in other English towns have provided

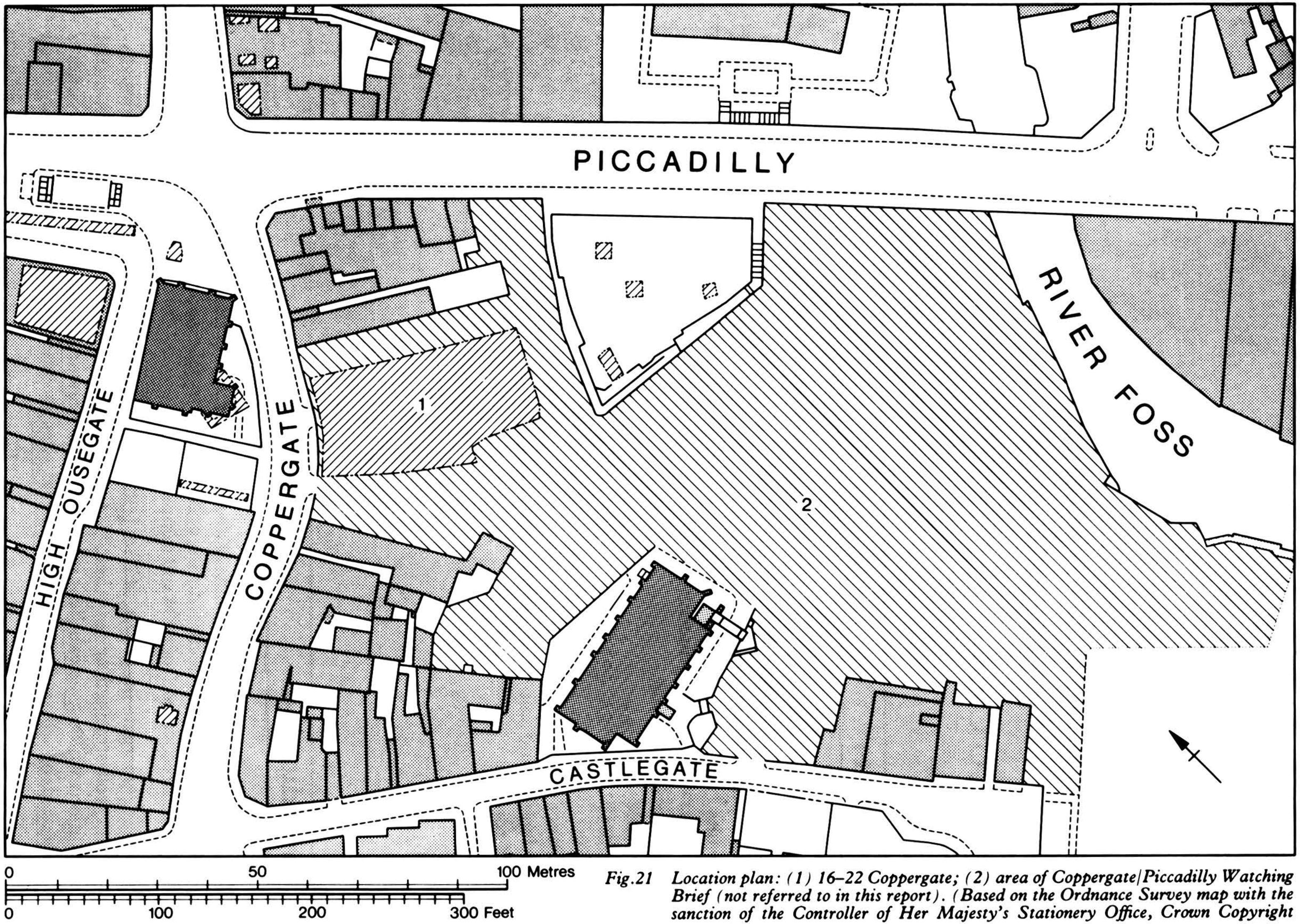


Fig.21 *Location plan: (1) 16–22 Coppergate; (2) area of Coppergate/Piccadilly Watching Brief (not referred to in this report). (Based on the Ordnance Survey map with the sanction of the Controller of Her Majesty's Stationery Office, Crown Copyright reserved.) 1:1250*

information about the exploitation of livestock and wildlife by these different communities. Coppergate afforded the opportunity to investigate the same themes in a different cultural setting. In the context of York, information about the Anglo-Scandinavian period will be important in understanding the subsequent economic development of the medieval town.

The excavation at Coppergate produced an enormous archive of well-preserved and, for the most part, closely datable bone fragments. An estimated half of this archive derives from deposits dated to the Anglo-Scandinavian period, the mid 9th to mid 11th centuries (Table 38). Dealing with such a large archive brings its own problems, notably that of deciding how much to record and to what level of detail.

It would not have been practicable or desirable to attempt to make a detailed record of every context-group of bones from Anglo-Scandinavian levels. Apart from the huge investment of time required, this would have led to much duplication of information and to the recording of a lot of redundant data. This is a different sampling problem to that discussed by Levitan (1983) and Turner (1984). These writers were concerned with procedures for subsampling a single, large assemblage. The problem posed by Coppergate was that of selecting some bone groups for study from the many which were potentially available. The decision was therefore taken to stop recording in full detail at a point where sufficient groups had been recorded to characterise bone deposition across the site for the main phases of the Anglo-Scandinavian settlement. Where possible, the largest available groups were chosen. This was partly a matter of expedience, and partly done in the belief that large context-groups, i.e. those with a high concentration of bone fragments per volume of sediment, are less likely to comprise only 'background rubbish' than are groups composed of a few fragments from a lot of sediment. To some extent, this selection was further modified by the need to sample different parts of a large and complex site.

The hand-collected groups described and discussed in the report fall into two categories. Thirty-three context-groups (coded Group 1 to Group 33 in this report) have been selected as having the highest archaeological priority, and have been allocated to the chronological periods into which the stratigraphical record has been divided. A further 29 context-groups of lower priority were taken to be of 'Anglo-Scandinavian' age, without more precise phasing, and data from these groups are used in analyses of results from the Anglo-Scandinavian period as a whole. Details of these context-groups are presented in the archive report (Scott 1984).

The various techniques available for the study of archaeological bones are discussed at length in *AY* 15/1, and further detailed consideration here would be superfluous. For most analytical purposes, the procedures followed for this work are the same as those described for other York sites. Exceptions are described in the text where appropriate.

Vernacular ('common') names of taxa are used throughout the text. Checklists of the taxa referred to will be found in Tables 54, 55 and 56. Nomenclature follows Corbet and Southern (1977) for the mammals, Walters (1980) for birds and Wheeler (1969) for fish. For caprine bones, the convention followed elsewhere in *AY* 15 has been used. Specimens

Table 38 Summary of archaeological development at 16–22 Coppergate

Period	Date	Characteristics
1	late 1st–late 4th century or later	Roman timber and stone buildings; late Roman cemetery. Limited survival of organic materials*
2	5th–mid 9th century	Apparent desertion. Homogeneous loamy deposits which did not preserve organic materials
3	mid 9th–late 9th/early 10th century	Rubbish disposal, suggesting occupation close by. Post/stake and wattle alignments, possibly boundaries. Organic materials preserved only in pit cuts
4A	late 9th/early 10th century–c. 930/5	Realignment of boundaries, suggesting that Coppergate was laid out by this period. Possible buildings at Coppergate frontage. Organic materials preserved mainly in pit cuts
4B	c. 930/5–c. 975	Four tenements distinguishable, with post and wattle buildings at Coppergate frontage. Evidence for iron-working and other trades on a commercial scale. Organic-rich deposits nearer to Coppergate; organic content thinning to zero towards R. Foss
5A	c. 975	Near Coppergate frontage only. Layers between structures of Periods 4B and 5B; probably mixture of dump deposits and soil from 5B semi-basements
5B	c. 975–early/mid 11th century	Perpetuation of boundaries. Introduction of sunken featured structures. street frontage. Organic-rich deposits as in Period 4B
5Cf	mid–later 11th century	Organic-rich deposits at street frontage, associated with buildings which survive only in Tenement D
5Cr	mid–later 11th century	Post-built structure sealed by earliest in a succession of dump deposits. Little organic material surviving.
6	later 11th–16th century	No remains surviving at street frontage, but area to rear increasingly built up above later dump deposits. New methods of building and rubbish disposal, leading to reduction in organic content of deposits

*Bone and antler generally survived well in all periods even where preservation of other organic materials was poor

confidently attributable to goat are described as such. The taxon 'sheep' includes specimens of skeletal elements on which separation of sheep and goat is not normally possible, but which are, in the context of this assemblage, almost certainly attributable to sheep *sensu stricto.*

Materials and data archives are deposited with the Yorkshire Museum under YAT and Museum accession codes 1977–81.7, and sorted data lists have additionally been deposited at the Ancient Monuments Laboratory, London.

Archaeological introduction

By R.A. Hall

The excavated area, of c.1000m^2, lies on sharply sloping ground above the River Foss (Fig.21, 1). The earliest occupation of the site, Period 1, occurred in the Roman period, commencing in the late 1st or early 2nd century and continuing into the late 4th century. Several buildings and a small cemetery were the principal Roman features in this extramural area, 160m south of the Roman fortress. Period 2, the 5th–mid 9th centuries, was marked by the accumulation of up to 1m of grey silty clay-loam, without any trace of buildings or other signs of occupation.

In the mid 9th century, and possibly as a consequence of the Vikings' take-over in 866 or their settlement in 876, activity resumed on the site (Period 3). There was evidence for possible glass-working, pit-digging, the apparently summary disposal of a small number of human corpses, and finally the erection of post-alignments which were not on the alignment of the subsequent tenements. Some of these alignments may have been boundary markers and others may perhaps represent structures. At a date which cannot be ascertained with certainty, but which was probably within a decade of c.900, there was a measure of re-organisation of land use within the excavated area, marked by the erection of new post and wattle or stake and wattle alignments on the orientation followed by all subsequent Anglo-Scandinavian tenement boundaries. At this period, designated Period 4A, which extended until c.935, it is not clear whether the site had been subdivided into narrow tenements, although some buildings may have existed. In Period 4B, beginning c.935, a series of regular tenements was established, running back from what was to continue thereafter as the street line (Coppergate): parts of four tenements, designated by the letters A–D, lay within the excavated area. Each tenement was occupied by a post and wattle building at its frontage, gable-end to the street, with a long, narrow open area behind it on the slope down towards the river. These backyard areas were riddled with pits, dug perhaps for a variety of purposes, but all ultimately backfilled with domestic debris, which also contributed to a continuum of successive yard surfaces. The contemporary buildings, which seem to have been both houses and workshops, were rebuilt and repaired on several occasions.

At the street frontage the last phase of these buildings was covered by up to 1m of soil. This horizon is interpreted as being partly a deliberate dump put down to seal the underlying structures and to prepare the area for rebuilding, and partly the soil upcast from the next phase of building operations. This dump, with contemporary features which included a small number of pits, is assigned to Period 5A. It was cut by a series of buildings entirely different in their construction, erected c.975. They had floors sunk below the contemporary ground surfaces for up to 1·75m, and their walls were built of oak beams, planks and posts. These structures and their associated layers are assigned to Period 5B, in which the basic tenemental layout remained constant. On several of the tenements there was evidence for rebuilding within this period, and on three of the tenements the buildings were arranged in two ranks at the street frontage. The backyards were still occupied by many pits. Period 5B continued into the 11th century, but the date at which these buildings were abandoned is uncertain. At the street frontage modern intrusions had destroyed nearly all of the levels above the buildings. Only on the Tenement D frontage did traces of the following phase of structures designated Period 5Cf survive. These consisted of limited areas of the foundations of two contemporary buildings. Their absolute date is uncertain, but they may be broadly contemporary with the only building discovered at the rear of the site near the river (in levels designated Period 5Cr); dendrochronology indicates that this structure, perhaps a warehouse or boat shed, was erected in the period c.1014–54. It, and the entire rear half of the site, was sealed by up to 2m of soil in the late 11th or 12th century, thus protecting it from all but the deepest later medieval features, and minimising the possibility of intrusive material contaminating Viking Age deposits. The upper layers of this dump, and the later medieval material above it, are designated Period 6: animal bones from these levels will be discussed in a further fascicule in this series. The sequence of occupation is summarised in Table 38.

The phased bone groups

The 33 groups used for inter-period comparisons are listed below. They were chosen as the largest well-stratified groups available from the main phases of human activity. Some groups comprise a single large context, whilst others include data from several immediately related contexts grouped together. Their distribution is shown on Fig.22.

Period 5Cf
Group 1: Layer in Tenement D upon which Structure 5/10 was constructed
Context: 7868
Group 2: Layer in Tenement D upon which Structure 5/10 was constructed
Context: 14184

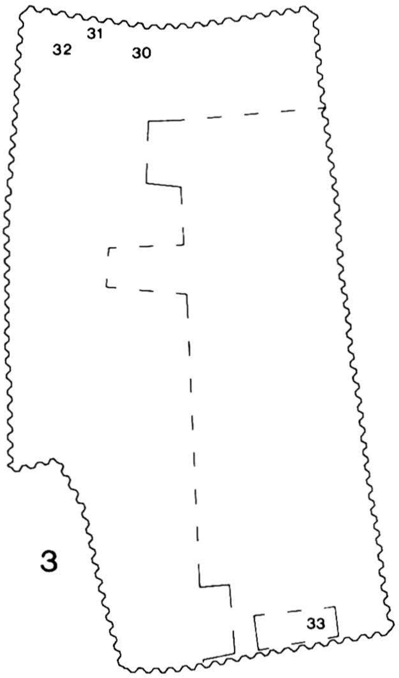
Period 5B
Group 3: Floor levels in Structure 5/3, Tenement B
Contexts: 15470, 15471, 15475, 15639, 15644, 15645
Group 4: Floor levels in Structure 5/4 Tenement B
Contexts: 8519, 8520, 8524, 8525, 8526, 8528
Group 5: Backfill in Structure 5/2, Tenement A
Contexts: 15176, 15177, 15189
Group 6: Backfill in Structure 5/3, Tenement B
Context: 13716
Group 7: Backfill in Structure 5/7, Tenement D
Contexts: 21554, 29263
Group 8: Backfill in Structure 5/5, Tenement C
Contexts: 21746, 21925
Group 9: Fill in Tenement D pit 29810
Context: 21510
Group 10: Dump in Tenement A
Contexts: 8051, 8444, 8445
Group 11: Layer at front of Tenement D
Context: 14973

Period 5A
Group 12: Layer at front of Tenement B
Context: 18286
Group 13: Layer at front of Tenement C
Contexts: 20131, 20132, 20143
Group 14: Layer in mid Tenement A
Context: 8358
Group 15: Layer in Tenement B
Context: 26953
Group 16: Layer at front of Tenement B
Context: 15173
Group 17: Fills in Tenement A pit 27389
Contexts: 27388, 27428, 27680, 28043, 34189
Group 18: Layer in Tenement B
Contexts: 8232, 8290, 8453, 26871

Period 4B
Group 19: Layer in Tenement A
Context: 18602
Group 20: Fill in Tenement B pit 37089
Contexts: 28904, 32105
Group 21: Layer in Tenement C
Context: 29926
Group 22: Layers in Tenement A
Contexts: 27093, 27203
Group 23: Fills of Tenement B pit 28729
Contexts: 28589, 28728, 28730
Group 24: Fill of linear cut 19684 to rear of site
Context: 19644
Group 25: Layer to rear of site
Context: 26636
Group 26: Layer to rear of site
Context: 19643

Period 4A
Group 27: Fills of pit 27920
Contexts: 27915, 27919, 27921, 27943
Group 28: Layer to front of site
Context: 27621
Group 29: Layer to front of site
Context: 30352

Period 3
Group 30: Fills of pit 31064
Contexts: 31072, 31073, 31595, 31601, 31602
Group 31: Fills of pit 31524
Contexts: 31389, 31609
Group 32: Fills of pit 27478
Contexts: 27448, 27486, 27555, 27498
Group 33: Layer to rear of site
Context: 19739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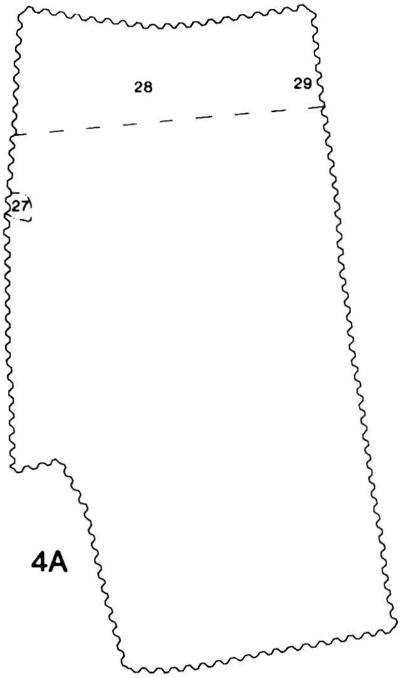
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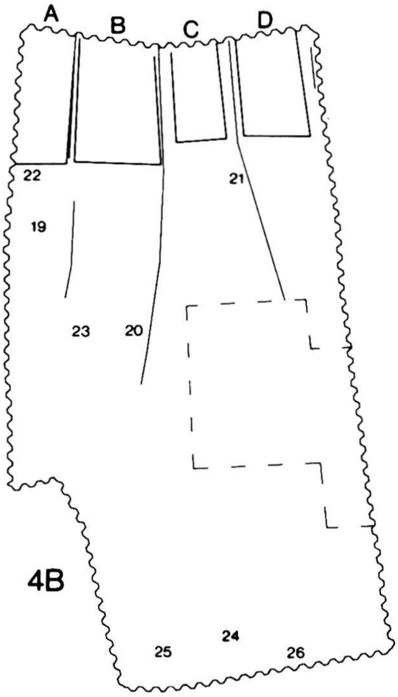
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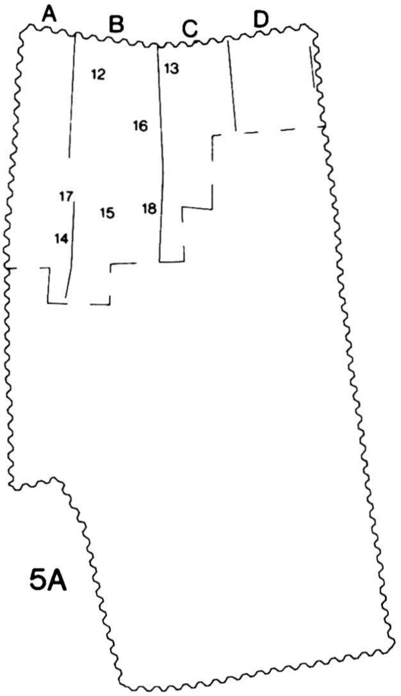
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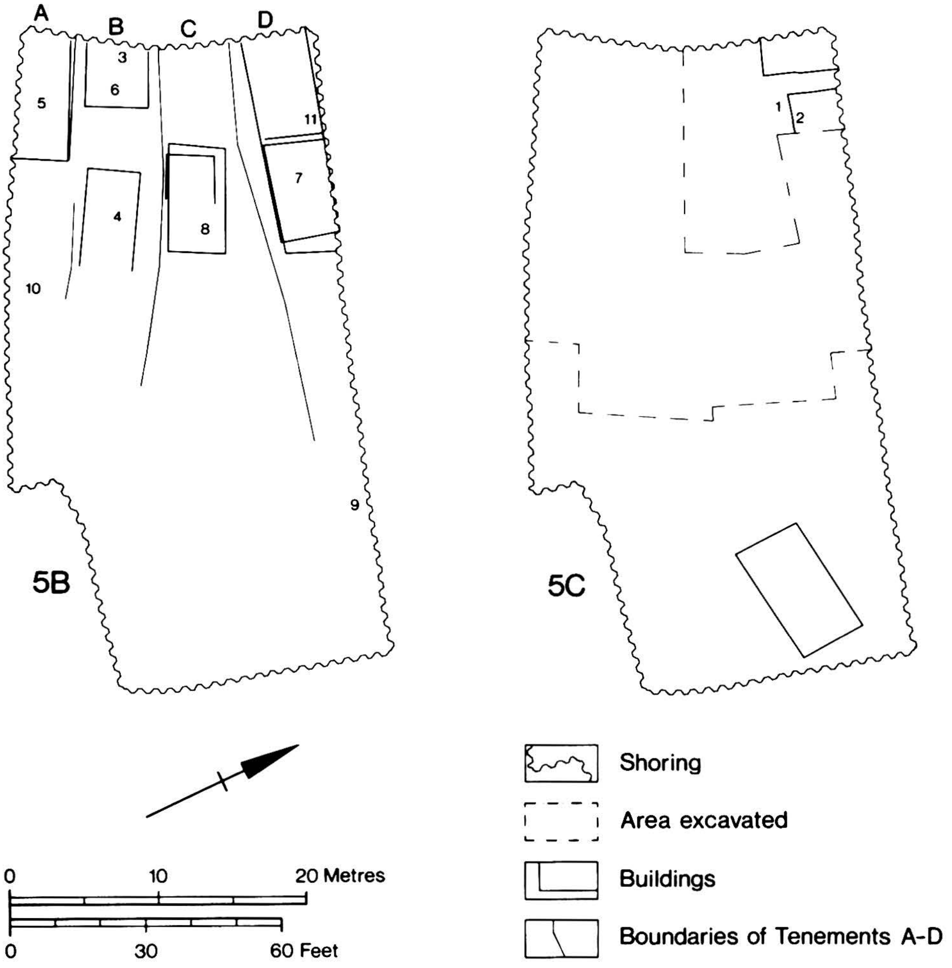


Fig.22 (above and facing) Period plans showing the location of Groups 1–33

For the purposes of examining diachronic changes in bone debris through the Anglo-Scandinavian era, the 33 groups are considered in four sets; those for contexts of Periods 3; 4A and 4B; 5A; and 5B and 5C. Period 5A is considered separately from the rest of Period 5 because of differences in the bone assemblages recovered from 5A compared with 5B and 5C. Periods 4A and 4B, and 5B and 5C showed no such differences and have thus generally been considered together to simplify matters. Period 5A, which marks a phase of rebuilding, is important archaeologically, and determining the source of Period 5A bones may be crucial to the archaeological interpretation of these deposits, i.e. in showing whether bones and artefacts in Period 5A deposits were mostly reworked from underlying 4B deposits. Although floor levels within buildings of Period 4B were identified during excavation, these layers were highly organic and contained very few bone fragments. Thus it has not been possible to include a sample of Period 4B floor levels in this analysis, even though otherwise similar floor deposits in Period 5B buildings yielded modest but useful quantities of bones (Groups 3 and 4).

Results

Preservation and taphonomy

Anglo-Scandinavian deposits at Coppergate ranged in character from humic sands and silts to highly organic layers rich in a variety of fibrous plant materials. Although deposits of Periods 3 and 4A were generally less highly organic than those of Periods 4B and 5A–C, the one characteristic which different deposits shared to some extent was water retention, and concomitant anoxic burial conditions. Preservation of bone in most contexts was accordingly very good, with little of the leaching and softening of bone normally associated with the free movement of well-oxygenated ground water. Given the combination of roughly neutral pH, high soil phosphate concentrations (from bone and from excrement), and waterlogging, good preservation of both the mineral and protein elements of bone could be predicted (O'Connor 1987a). The bones were typically hard and smooth-surfaced, and often heavily stained by mineral deposition. Although no systematic study of the minerals involved was undertaken, the red and brown oxides of iron were conspicuously absent, other than in some Period 3 deposits, the predominant colours being a dark purplish-brown and black. Patches of vivianite (iron phosphate) were common, and several small areas of pyrite (iron sulphide) were noted. One of these, on a cattle premolar, showed the brassy, slightly iridescent colouring typical of chalcopyrite, a mixed sulphide of iron and copper (Read 1948, 230–2). To summarise, burial in highly organic silts and clays provided burial conditions in which lack of oxygen inhibited decay of collagen by hydrolysis, and ground water stagnancy effectively prevented decomposition of bone minerals by 'leaching'.

A small proportion of fragments of all sizes in almost every sample had a markedly different appearance to that described above. These fragments were typically ochre or pinkish in colour, slightly to very friable (implying loss of collagen), and had an eroded surface giving a grainy appearance. The most likely explanation for these fragments is that they are residual fragments of bone of Roman date from features cut into the underlying glacial deposits. Curiously enough, the largest deposits of vivianite were found on these apparently residual fragments of bone reworked into otherwise highly organic deposits. These residual specimens were few in number, and not always unambiguously recognisable as residual, so it was not thought to be worthwhile to exclude them from the record.

The taphonomic history of archaeological bone samples is invariably complex and poorly understood, with many different and interacting factors determining disposal patterns and decay trajectories. The human activities which produce the deposited assemblage may be complex enough, but subsequent decay and destruction processes will add their own characteristics and may mask the evidence of butchery and disposal practices. The processes of bone diagenesis offer plenty of scope for a fertile imagination (e.g. Binford 1981); too much scope to justify an exhaustive examination here. However, two taphonomic factors which would have been particularly important are exposure of bones to trampling and subaerial weathering on ground surfaces, and gnawing of bones by carnivores. The former factor will affect the surface appearance of bones and will tend to increase fragmentation, whilst the latter will tend to damage and to remove particular bones or parts of bones favoured by scavenging dogs, cats and pigs (Binford and Bertram 1977). The recording of gnawing was a relatively straightforward matter of recognising the characteristic damage wrought by carnivore teeth, or much less frequently, the distinctive surface damage produced by alimentary acid secretions on fragments which had been swallowed and passed with faeces. The consequences of surface abrasion were less easily recognised, however, and compromise criteria were sought. For the purposes of this work, a record was kept of specimens which appeared to show clear surface abrasion (e.g. rounded angles) or which were generally much less well preserved than the rest of the bones from that context. In most samples, these abraded fragments were infrequent and easily recognised. In others, however, they were numerous, and the designation of what constituted 'abraded' became more subjective. Despite this, it was felt to be worth attempting some comparison of the frequency of abraded and gnawed fragments in different samples.

If bones were allowed to accumulate on active surfaces such as living floors and yards, and if dogs and cats were allowed to scavenge freely, then some positive correlation between gnawing and abrasion might be expected. This argument simplistically assumes that the longer a pile of bones was accessible on a surface, the greater the degree of both gnawing and abrasion which could accrue, at least up to the point at which dogs would lose interest in the bones. Conversely, bones which were rapidly buried would show little or no abrasion or gnawing.

Figure 23 shows the proportions of gnawed and abraded specimens in Groups 1–33. The distribution of points goes some way towards conforming to the simple model proposed above, with most of the points clustered together and showing a weak positive correlation between the two attributes. However, there are outliers. Two groups show high abrasion and low gnawing, and one shows a remarkably high incidence of gnawing with low abrasion. The two groups showing high abrasion are both from Period 3, and both are from pits (Groups 30 and 32). It seems likely that both contained an appreciable amount of abraded bone reworked from Roman and Anglian levels during pit-digging in Period 3, and they may also have been used for the secondary disposal of refuse which had previously accumulated as a surface deposit.

Group 21 (a Period 4B layer) and Group 28 (a Period 4A layer) both show a high frequency of gnawed specimens, indicating that the bones were accessible to dogs for some time before burial, although not so long that the bones became abraded through trampling and subaerial weathering. Overall, Period 4 groups show the highest frequency of gnawing

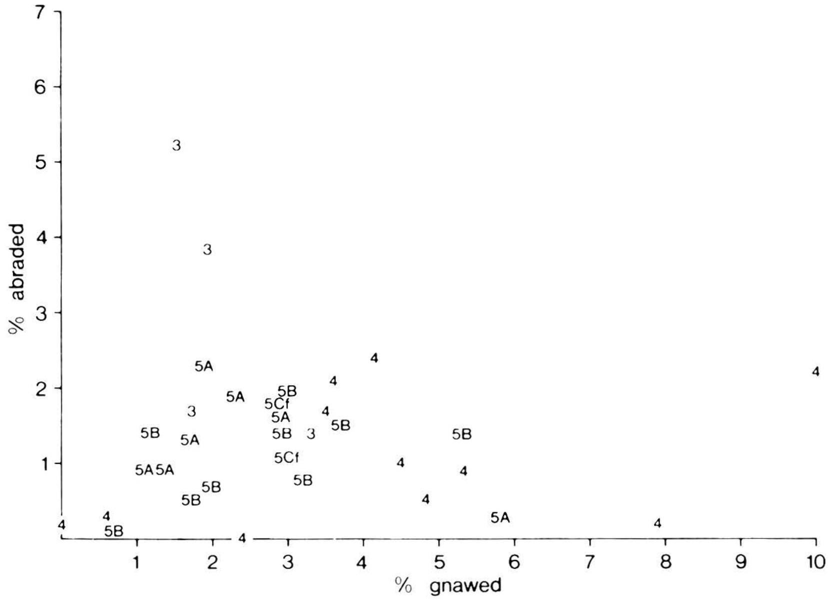


Fig.23 Proportions of gnawed and abraded fragments in Period 3, 4, 5A and 5B groups expressed as a percentage of the total of identified fragments

and Period 5B groups the lowest. What this result actually indicates about changes in bone disposal during the Anglo-Scandinavian period is far from clear. There may just have been a greater tendency in Period 4 to leave bones lying around in exposed heaps for longer intervals before burial, perhaps indicating less pressure on living space, or a greater tolerance of squalor, than in later periods. Certainly there was no evidence of a consistently greater degree of gnawing damage on bones from any one part of the site as compared with the rest.

Certain parts of bones were particularly favoured for gnawing. The vicinity of traction epiphyses such as the tuber calcis and the olecranon process were more frequently gnawed, presumably because of the thick tendons and ligaments attached to these epiphyses. Other popular zones were the articulation of the scapula, and limb bone epiphyses such as the distal femur and proximal humerus which have a large volume of cancellous bone and a thin layer of compact bone. Nearly all specimens showed the blunt pitting and widely-spaced tooth marks typical of dogs, but there were several specimens of clearly cat-gnawed bone and some which were of uncertain attribution. Although many long bones had been cracked open, in none of these specimens could the cracking be attributed solely to dogs. Gnawing seems to have concentrated at the ends of bones, removing the relatively soft cancellous tissue. Dog faeces from Anglo-Scandinavian deposits include quantities of small bone chips (Jones, *AY* 14/7 in prep.), and a cattle carpal and calcaneum each exhibited a form of surface erosion which suggested that they had passed through the gut of a dog. There is thus evidence for the role of dogs as a mechanism for sample reduction at all stages in the alimentary process.

Jones (1986) has demonstrated the extent to which dogs and pigs may completely destroy the relatively small bones of fish, and this point will be returned to when the fish bones are discussed (p.197).

This examination of abrasion and gnawing has given some indication of the processes to which bones were subjected before burial. Clearly some bones have been totally destroyed by dogs, and there is evidence of some reworking of earlier material into Anglo-Scandinavian layers. However, this knowledge permits limits of inference to be defined more clearly, and increases the confidence with which conclusions about the groups can be drawn.

Recovery of bones by hand during excavation constituted a conventional but inefficient means of recovery, the biasing effect of which was shown by comparison with the numerous bulk-sieved samples as a control. Examination of 2mm sieve residues and comparison with assemblages recovered by hand from the same context showed that sieving was essential for the consistent recovery of fish, amphibian and small mammal bones, but that most identifiable large mammal and bird bones were recoverable by hand, albeit giving a sample biased against the smaller skeletal elements. Details of the bones recovered by sieving from Anglo-Scandinavian levels are given in a later section of this report (p.187), and some comparison of the efficiency of bone recovery by hand-collection and wet-sieving is given in pp.104–10, *AY* 15/2.

Species abundance

Table 39 presents numbers of fragments identified to the major taxa in the bone groups, and these data are summarised and compared with a range of other assemblages in Table 40. Fragment counts are a blunt instrument when compared with some of the more refined techniques of species quantification but, as Gautier (1984) has cogently argued, the sophistication of most other procedures greatly exceeds the suitability of the data. The figures given in Table 39 are sufficient to show an increase in the relative abundance of pig and bird bones through the Anglo-Scandinavian period, with a corresponding decline in cattle bones. The predominance of cattle bones is well-marked throughout, however, and must represent a heavy reliance on beef and dairy products as dietary mainstays.

Comparison with other approximately contemporaneous English and European sites in Table 40 shows the proportion of sheep bones to be generally lower at Coppergate than at other sites in England, Coppergate being more similar to Dorestad, the Netherlands, in terms of the relative proportions of major species. Results from Viking Dublin were not fully available at the time of writing, but figures from 10th–11th century levels at Fishamble Street show a marked preponderance of cattle bones, with pig bones ranking second and very few sheep (McCormick 1982, 92–4; also pers. comm.). Further afield, Hedeby (Haithabu), north Germany, and Mecklenburg, East Germany, both yielded substantial proportions of pig bones, whilst sheep bones comprised nearly half of the huge

Table 39 Numbers of hand-collected bone fragments attributed to major taxa from Groups 1–33 and from the sum of other Anglo-Scandinavian groups (see p.188 and archive report Scott 1984)

Period	Group	Horse	Cattle	Sheep	Goat	Red deer	Roe deer	Pig	Wild boar	Cat	Dog	Hare	Human	Other mammal	Fish	Bird	Total identified	Unidentified	Total	Abraded	Gnawed
5Cf	1	2	351	141	1	3	–	92	–	1	2	–	1	–	–	23	617	250	867	11	18
	2	2	745	243	–	4	–	163	–	–	5	–	–	–	–	65	1227	400	1627	13	27
5B	3	–	280	137	–	3	–	60	–	1	4	–	2	–	2	24	513	227	740	7	6
	4	1	213	105	–	1	–	48	–	1	1	–	–	–	3	35	408	292	700	2	7
	5	1	695	364	1	3	–	176	–	4	5	–	–	–	3	73	1325	390	1715	11	42
	6	4	1436	549	3	1	1	1033	1	6	5	–	–	–	31	399	3474	2000	5474	4	24
	7	3	1491	558	8	2	–	365	–	3	34	4	–	–	–	130	2598	695	3293	19	51
	8	7	1499	356	–	10	–	315	–	3	14	–	4	1	2	130	2341	700	3041	45	70
	9	9	487	129	–	1	–	171	1	1	5	–	–	–	–	43	847	195	1042	12	45
	10	4	481	182	–	5	–	177	–	1	4	–	1	–	10	69	934	450	1384	14	35
	11	2	675	374	–	2	–	278	–	1	4	–	1	–	–	145	1482	600	2082	21	43
5A	12	4	418	127	1	1	–	73	1	3	4	–	–	–	1	10	643	300	943	15	12
	13	3	628	242	–	5	1	172	–	1	1	1	3	1	3	42	1103	575	1678	10	13
	14	1	190	37	–	4	–	49	–	–	1	–	–	–	–	21	303	100	403	4	5
	15	–	277	71	–	1	–	65	–	–	–	–	–	–	–	38	452	150	602	4	6
	16	3	296	72	1	2	–	86	–	2	3	–	–	–	–	9	474	120	594	9	11
	17	1	297	92	–	–	–	60	–	–	3	3	1	–	2	17	476	93	563	1	32
	18	8	1274	366	3	7	2	299	–	5	16	–	1	–	2	92	2075	535	2610	36	61
4B	19	1	323	139	–	–	–	101	–	–	2	–	–	1	–	67	634	135	769	–	15
	20	–	386	111	–	1	–	61	–	5	1	–	–	–	5	35	605	130	735	13	22
	21	1	520	131	–	3	–	152	–	–	–	–	–	–	2	89	898	280	1178	2	71
	22	2	250	101	–	3	–	60	1	–	1	–	–	–	–	15	433	72	505	2	21
	23	2	333	142	–	1	–	80	–	1	–	–	2	–	2	36	599	191	790	10	21
	24	19	749	422	2	–	–	69	–	1	–	–	1	–	–	39	1302	485	1787	2	–
	25	18	742	666	1	1	–	127	–	2	–	–	–	–	–	27	1584	700	2284	16	72
	26	13	465	158	1	1	–	52	–	–	7	–	6	1	–	16	720	420	1140	2	4
4A	27	–	270	61	1	3	–	53	–	–	–	1	–	–	–	24	413	92	505	10	17
	28	2	339	236	–	3	–	147	–	1	4	–	–	–	–	27	759	450	1209	17	76
	29	1	1162	480	–	13	–	30	2	2	–	–	–	–	–	50	1740	250	2264	18	107
3	30	7	471	152	4	8	1	53	–	4	–	–	1	–	–	16	717	280	997	37	11
	31	1	172	39	–	–	–	11	–	–	–	–	2	–	–	5	230	82	312	4	4
	32	7	162	66	1	–	–	15	–	1	–	–	–	–	–	10	262	61	323	10	5
	33	38	1451	349	5	6	1	150	–	–	19	–	–	–	–	31	2050	320	2370	29	67
	Other	124	12332	4298	50	68	10	2100	–	51	48	12	15	2	45	632	19787	8972	28729	329	293
	Total	291	31860	11696	83	166	16	6943	6	101	193	21	41	6	113	2484	54020	20992	75012	738	1324

Table 40 Comparison of the relative abundance of major taxa at a range of sites around northern Europe grouped chronologically

The table gives the number of identified fragments for each site or phase, and the relative abundance for each taxon calculated as a percentage of this total. Approximate equivalents to Coppergate periods are given in brackets. There will be minor discrepancies between the results obtained by different workers. Not all the sources listed totals for fish bones, and not all listed goat separately. Where given, goat has been counted as 'other mammal'. Note that * signifies no counts for fish bones given in this source. Sources: Flaxengate, Lincoln (O'Connor 1982a, 8–9); Dorestad, Netherlands (Prummel 1983, 74–5); Eketorp, Sweden (Boessneck, von den Driesch and Stenberger 1979, 26–7); Mecklenburg, East Germany (Müller 1984); Melbourne Street, Southampton (Bourdillon and Coy 1980, 82); Site 1092, Thetford, Norfolk (Jones 1984, 188); North Elmham Park, Norfolk (Noddle 1980a, 378–9); Hedeby, north Germany (Reichstein and Tiessen 1974, 53)

	n frags. ident.	Cattle %	Sheep %	Pig %	Cat %	Dog %	Other mammal %	Fish %	Bird %
Coppergate									
Period 5C	1844	59·4	20·8	13·8	0·1	0·4	0·7	–	4·8
Period 5B	13917	52·1	19·8	18·8	0·2	0·5	0·6	0·4	7·5
Flaxengate, Lincoln									
TIV–V (5B)	1091	45·0	36·5	9·8	0·4	0·8	0·2	–	7·3
Dorestad, Netherlands									
(5B–later)	5600	64·6	14·9	12·1	0·1	0·5	6·8	0·1	1·0
Eketorp, Sweden									
Ek.III (5B–later)	210548	32·1	49·2	13·5	0·2	2·1	1·5	0·4	1·0
Coppergate									
Period 5A	5526	61·2	18·2	14·5	0·2	0·5	1·1	0·1	4·1
Period 4	9687	57·2	27·3	9·6	0·1	0·2	1·0	0·1	4·4
Flaxengate									
TIII (4–5A)	1927	56·8	25·4	11·9	0·2	0·9	0·7	2·6	1·7
Mecklenburg, East Germany									
(4–post 5B)	8054	22·0	13·7	53·5	0·1	0·1	3·9	*	6·8
Coppergate									
Period 3	3259	69·2	18·6	7·0	0·2	0·6	2·4	–	1·9
Flaxengate									
TI–II (3)	6503	56·1	27·1	10·3	0·1	3·0	0·9	0·1	2·5
Melbourne Street, Southampton									
(pre 3–3)	48258	49·5	30·0	14·4	0·3	0·1	0·6	2·7	2·5
Site 1092, Thetford, Norfolk									
(3–4)	2386	38·5	26·1	16·5	0·1	1·8	4·7	2·8	9·6
Coppergate									
All Anglo-Scandinavian	54020	59·0	21·7	12·1	0·2	0·4	1·2	0·2	4·6
Flaxengate									
All Anglo-Scandinavian	13104	52·7	27·2	10·4	0·4	4·6	0·7	0·7	3·3
North Elmham Park, Norfolk									
II (3–5C)	3892	26·9	38·6	21·2	0·4	1·3	4·6	0·1	7·0
Hedeby, north Germany									
(3–5C)	29772	47·3	14·3	37·1	0·1	0·2	0·4	*	0·6

assemblage from Eketorp, Sweden. The generally high proportions of cattle bones at sites with a 'Scandinavian' influence (York, Dublin, Lincoln, Hedeby) tempts cultural interpretation but these four sites were also all major towns. The rural village at Eketorp, whilst undeniably Scandinavian, hardly fits the pattern and it seems likely that local agricultural and economic circumstances would have dictated stock-keeping policy to a greater degree than would ethnic affiliations.

Returning to Table 39, species other than cattle, sheep and pigs are notable mainly for their absence. Horse bones were frequent (present in about 11% of context groups examined from all Anglo-Scandinavian deposits) but never abundant, although they comprised a higher proportion of identified fragments in Period 3 and 4 deposits than in Periods 5A and 5B. Red deer was represented almost exclusively by pieces of antler, most of them waste from artefact manufacture, and cats and dogs were consistently present in small numbers. Overall, there is rather more variation in species abundance between groups within periods than there is between periods, though even this spatial variation should not be overstated. In simple terms of the occurrence of the bones of the main domestic species, Anglo-Scandinavian groups from Coppergate were remarkable for their homogeneity. The proportion of unidentified small fragments did vary considerably, however, being generally lower in Period 3 groups than in Periods 4, 5A and 5B, though this may only reflect variation in the efficiency of recovery.

The figures obtained for the minimum numbers of individuals (Table 41) bear out the predominance of cattle, and generally serve to confirm the trends observed in the fragment counts. The values given in Table 41 for number of fragments/MNI show that each identified 'individual' of sheep or pig in these groups was typically represented by far fewer fragments than each 'individual' of cattle.

To consider the relative abundance of the major taxa in more detail, the abundance of pig bones, in particular, shows marked variation from group to group. Pig bones were generally most abundant in Period 5A layers, and Period 5B dumps and floor layers. Amongst the Period 5B groups, the backfill deposit in Structure 5/3 (Group 6) was exceptional, pig bones comprising 30% of identified fragments, most of the pig bones being metapodials and skull fragments. This deposit seems to have had a mixed origin, as the most abundant elements in it included primary butchery waste (cattle horncores and skull) and domestic debris (high numbers of sheep ribs and bird bones). The underlying occupation floors in Structure 5/3 (Group 3) also contained quite a high proportion of pig skull and metapodials, though not to anything like the same extent, with numerous sheep and cattle rib fragments and limb bones. Cattle and sheep limb bones were also abundant in Period 5B floor deposits in Structure 5/4 (Group 4), but without the high proportion of pig skull and metapodials.

The highest proportions of cattle bones were seen in Period 3 Groups 31 and 33, though the former was only a small sample and thus possibly unreliable. Group 33 comprised a layer at the riverward end of the site, and the cattle bones included most parts of the skeleton, though the proportion of rib fragments was markedly low. Similar characteristics were shown by the other Period 3 pit-groups (Groups 30–2), so the high proportion

Table 41 Minimum number of individuals, based on the most numerous non-reproducible skeletal element, with no pairing. The three right-hand columns give 'number of fragments per individual', i.e. the number of fragments attributed to that taxon divided by the number of individuals (n frags./MNI)

														n frags./MNI		
Period	Group	Horse	Cattle	Sheep	Goat	Red deer	Roe deer	Pig	Wild boar	Cat	Dog	Hare	Human	Cattle	Sheep	Pig
5Cf	1	1	5	4	1	1	–	4	–	1	1	–	1	70·2	35·3	23·0
	2	1	11	7	–	1	–	9	–	–	1	–	–	67·7	34·7	18·1
5B	3	–	4	3	–	1	–	3	–	1	1	–	1	70·0	45·7	20·0
	4	1	3	4	–	1	–	3	–	1	1	–	–	71·0	26·3	16·0
	5	1	9	8	1	1	–	6	–	1	1	–	–	77·2	45·5	29·3
	6	1	15	6	1	1	1	35	1	1	1	–	–	95·7	91·5	29·5
	7	1	18	14	2	1	–	10	–	1	3	1	–	82·8	39·9	36·5
	8	1	17	7	–	1	–	8	–	1	2	–	1	88·2	50·9	39·4
	9	1	10	6	–	1	–	4	1	1	1	–	–	48·7	21·5	42·8
	10	4	13	4	–	1	–	6	–	1	1	–	1	37·0	45·5	29·5
	11	1	10	8	–	1	–	7	–	1	1	–	1	67·5	46·8	39·7
5A	12	1	6	5	1	1	–	2	1	2	1	–	–	69·7	25·4	36·5
	13	1	6	5	–	1	1	5	–	1	1	1	1	104·7	48·4	34·4
	14	1	5	2	–	1	–	1	–	–	1	–	–	38·0	18·5	16·3
	15	–	2	1	–	1	–	2	–	–	–	–	–	138·5	71·0	32·5
	16	1	5	2	1	1	–	4	–	1	2	–	–	59·2	36·0	21·5
	17	1	5	2	–	–	–	5	1	–	1	1	1	59·4	46·0	12·0
	18	1	16	13	1	1	1	8	–	1	2	–	1	79·6	28·2	37·4
4B	19	1	6	4	–	–	–	4	–	–	1	–	–	53·8	34·8	25·3
	20	–	7	5	–	1	–	3	–	1	1	–	–	55·1	22·2	20·3
	21	1	5	3	–	1	–	4	–	–	–	–	–	104·0	43·7	38·0
	22	1	4	3	–	1	–	4	–	–	1	–	–	62·5	33·6	15·0
	23	1	7	4	–	1	–	5	–	1	–	–	1	47·6	35·5	16·0
	24	1	9	14	1	–	–	5	–	1	–	–	1	83·2	30·1	13·3
	25	2	11	19	1	1	–	5	–	1	–	–	–	67·5	35·1	25·4
	26	1	11	8	1	1	–	2	–	–	1	–	1	42·3	19·7	26·0
4A	27	–	5	3	1	1	–	5	–	–	–	1	–	54·0	20·3	10·6
	28	1	5	7	–	1	–	4	–	1	1	–	–	67·8	33·7	36·8
	29	1	18	19	–	2	–	19	1	1	–	–	–	64·6	25·3	16·0
3	30	1	10	6	1	2	1	4	–	1	–	–	1	47·1	25·3	13·3
	31	1	5	2	–	–	–	1	–	–	–	–	1	34·4	19·5	11·0
	32	1	4	2	1	–	–	3	–	1	–	–	–	40·5	33·0	5·0
	33	4	23	11	1	1	1	7	–	–	2	–	–	63·1	31·7	21·4

of cattle bones would seem to be a feature of Period 3 assemblages as a whole. Group 28, a Period 4A layer, differed from the Period 3 pits in the same area in containing more sheep and pig bones, and in this respect the assemblage resembled the large sample Group 29, also from a Period 4A layer. These two Period 4A groups both contained quite, though not exceptionally, high proportions of gnawed specimens.

There is little else to be said on the subject of species abundance. Cattle predominate in terms of fragments (53–65% of identified fragments) and individuals (averaging around 40% of cattle + sheep + pigs). Sheep are next most abundant (17–22% fragments), closely followed by pigs (10–18% of fragments), with little of anything else. The Period 3 groups are mostly typified by low proportions of pig and bird and higher proportions of cattle. Overall, horse, red deer, cat and dog are frequent, although never abundant, and goat, roe deer, wild pig (*Sus scrofa* L.), hare, bear and fox occurred occasionally.

Cattle

Carcass distribution and butchery

Primary evidence of butchery procedures takes the form of cutting or chopping marks on bones: secondary evidence comprises a non-random spatial distribution of carcass elements indicating selective dispersal of dismembered carcasses. Butchery marks on cattle bones may be very common in an assemblage and will occur on almost any surface of any bone. What is important, therefore, is the location of concentrations of butchery marks and their interpretation in terms of a process of carcass reduction. All observed butchery marks in the Coppergate groups were recorded with regard to type of damage, degree, location and direction. Although much more or less random bone damage was inevitably recorded in this way, a clear pattern of consistent butchery was noted. This is summarised in Fig.24, and was the same in all samples regardless of period. The question of whether or not specialist butchers were operating on or near the site is discussed below (p. 159).

The observed procedure was evidently intended as the simplest way to reduce a cattle carcass to a number of smaller lumps. Removal of head and feet, and detaching the horncores from the skull, probably took place at the slaughter site when the beast was skinned and drawn. Given frequent identification of chopping through the bones of the basipodium and a high proportion of intact metapodials, it seems likely that the feet were detached at the ankle and wrist. Decapitation was achieved by chopping through the neck between the atlas and axis, resulting in the recovery of large numbers of cut-off odontoid processes. For butchery purposes, then, the atlas functioned as part of the skull. Horncores were generally chopped from the skull, often removing a slice of frontal bone as well. Knife marks indicative of the head being skinned were rare. Most cattle skulls were recovered in fragmentary condition, which may indicate the method of slaughter, and two skulls from Period 3 deposits each bore a punched-in hole of about 50mm diameter in the frontal bone, above and between the eyes. Subsequent reviewing of the lower priority groups has produced several more examples of these 'punched-in' frontals, not all of them from Period 3, and one example where the frontal bone had been partially stove in by a blunt instrument.

Regarding the main part of the carcass, although Fig.24 records concentrations of butchery marks, it is evident that not all cattle carcasses were cut into joints—and thus not all bones were cut—in the same way. Some distal femora and ulnae were intact, and not all humeri exhibited signs of butchery at the distal end. It seems likely that some carcasses

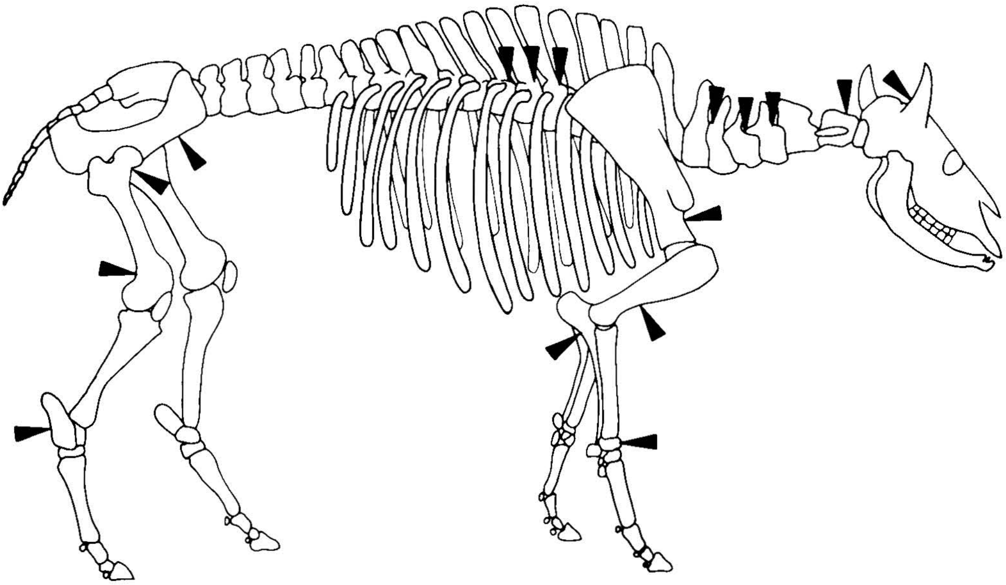


Fig.24 Cattle skeleton, showing the most frequently recorded sites of butchery

were 'boned-out', i.e. large blocks of steak were removed from the legs and the fore and hind quarters before any major division of the carcass took place. The vertebrae were most consistently butchered, a high proportion being chopped through in the axial plane (i.e. down the mid-line of the back of the carcass) or transversely across the centrum, or both. Up to a third of the vertebrae in some groups had been chopped down the axial plane or close to it, suggesting that at least some cattle carcasses were butchered as sides of beef. This was evidently not systematically done, however, and there seems to have been considerable variation in the detail of the butchery procedures used.

Cervical vertebrae generally showed the highest incidence of butchery, possibly as a result of the neck being chopped into small pieces suitable for the stew-pot. The thoracic and lumbar regions appear to have been chopped across transversely to produce joints similar to the modern top-rib and T-bone cuts.

The important point about the butchery of cattle carcasses is the lack of any clear evidence for a change in procedures during the period under study. Although reconstruction of the butchery process must be to some degree conjectural, it is clear that the same procedures were being followed in Period 5 as in Period 3. This means that the analysis of the distribution of carcass elements which follows need not take account of differences between groups brought about by a change in butchering procedures. It is probably safe to interpret, for example, a high frequency of cattle metapodials in a Period 3 group in the same way as in a Period 5 group. The only spatial variation noted in the butchery of cattle

Table 42 Counts of cattle, sheep and pig skeletal elements grouped by carcass component. Note that these are counts for discrete elements, not for fragments. Thus pelves are counted as the total of left and right acetabulae, limbs by totals of discrete articular ends, etc.

		Cattle									**Sheep**									**Pig**					
Period	Group	Horncores	Skull	Vertebrae	Scapulae and pelves	Forelimb	Hindlimb	Metapodials	Phalanges	Ribs	Horncores	Skull	Vertebrae	Scapulae and pelves	Forelimb	Hindlimb	Metapodials	Phalanges	Ribs	Skull	Vertebrae	Scapulae and pelves	Forelimb	Hindlimb	Metapodials III and IV
5Cf	1	1	8	27	16	10	25	18	23	54	1	3	21	5	2	5	10	1	45	4	12	4	8	9	8
	2	6	18	46	34	38	44	46	33	144	1	13	12	12	19	14	28	–	78	13	10	6	14	24	29
5B	3	2	5	17	9	11	12	7	16	51	–	5	12	7	6	7	9	2	38	5	5	3	4	3	17
	4	1	4	16	2	10	11	5	10	47	–	3	11	4	9	4	8	4	27	1	7	4	6	7	3
	5	15	17	54	19	35	32	36	35	118	8	17	23	16	27	17	28	2	113	12	14	12	17	12	24
	6	27	54	146	39	62	54	78	126	119	6	12	40	12	11	13	17	6	232	72	125	23	29	42	191
	7	10	40	121	51	76	79	96	78	280	1	17	56	19	55	30	52	4	142	36	17	29	44	24	51
	8	4	35	131	53	57	87	89	105	203	5	10	20	14	26	25	26	8	107	20	27	16	43	30	29
	9	4	13	48	18	19	46	12	11	77	1	5	9	3	14	7	6	–	43	21	11	10	14	9	7
	10	1	8	34	23	24	30	33	30	70	2	1	21	4	16	14	13	3	56	14	4	7	16	19	7
	11	1	13	61	20	36	29	26	57	101	2	10	29	20	28	12	21	18	83	12	24	13	20	28	11
5A	12	1	8	33	15	17	17	19	33	61	2	2	7	5	13	10	20	1	29	4	6	4	8	8	4
	13	4	9	53	17	18	27	30	55	74	1	6	25	9	25	13	10	11	45	11	9	9	21	17	4
	14	1	7	11	7	14	10	14	9	22	–	3	1	3	2	5	1	1	14	3	3	4	6	6	3
	15	1	3	16	6	2	5	8	10	77	–	1	5	2	3	1	4	1	33	4	10	4	7	7	4
	16	2	11	16	14	10	18	17	14	50	–	1	2	2	8	10	8	–	30	10	5	6	9	7	4
	17	2	7	31	7	19	35	29	11	49	1	–	4	9	13	5	10	1	24	12	1	7	11	11	1
	18	3	24	108	48	61	79	95	91	179	3	13	30	22	29	42	34	3	111	22	44	19	21	38	25
4B	19	–	5	19	9	19	17	15	16	69	–	3	9	5	13	4	1	4	52	8	5	5	15	11	4
	20	4	8	29	11	29	26	27	17	77	3	3	11	4	13	8	8	2	29	3	5	2	7	14	4
	21	3	11	39	12	8	11	25	36	101	–	–	15	3	2	3	4	–	47	13	10	7	3	9	10
	22	4	5	19	6	13	19	20	3	56	–	1	7	3	14	11	6	1	28	8	3	4	8	22	4
	23	3	10	16	8	31	36	23	13	51	2	3	3	3	16	13	18	2	44	9	1	12	11	10	7
	24	8	28	51	16	31	28	34	56	101	8	36	55	24	24	16	32	5	76	4	6	6	13	11	3
	25	3	23	39	23	41	20	48	27	114	5	52	35	34	52	27	56	8	160	4	9	8	17	13	1
	26	7	30	34	12	26	20	24	30	63	2	13	13	16	11	12	10	–	23	4	9	4	7	2	3
4A	27	2	8	30	4	23	25	35	3	38	2	7	5	6	10	6	8	–	11	8	1	5	13	17	2
	28	–	6	41	14	16	14	12	19	48	5	16	27	6	15	10	29	6	39	10	21	7	5	10	6
	29	9	31	85	56	67	87	83	58	181	6	35	20	27	42	49	85	1	124	43	21	23	37	47	19
3	30	7	10	27	13	31	36	48	15	74	–	6	16	10	12	7	10	1	30	5	6	5	12	9	1
	31	2	11	25	5	16	6	14	8	14	–	2	9	4	3	2	5	–	6	–	3	1	–	1	–
	32	1	9	14	10	15	10	11	8	21	–	4	12	2	5	4	5	–	14	2	–	4	3	6	–
	33	19	73	180	62	96	112	123	89	145	4	26	43	33	42	39	50	3	61	19	15	12	23	22	2

bones was a slightly greater frequency of complete or largely complete (> 50%) long bones in Period 4–5 deposits at the riverward end of the site away from the street frontage. This is not to say that there was a clear difference in the skeletal elements represented on that part of the site, only that the cattle bones seem to have been subject to less butchery and other fragmentation processes.

In order to investigate the distribution of carcass elements, they must first be quantified. The procedure chosen for this purpose is that employed in *AY* 15/1. Table 42 lists absolute numbers of skeletal elements of cattle, sheep and pigs grouped into 24 carcass components. It should be stressed that these are 'minimum' counts of discrete individual specimens, not just totals of all the fragments attributed to that part of the skeleton. Thus the high fragmentation of scapulae, for example, is taken into account by counting only separate articular ends, not blade fragments.

In Table 43, the cattle bones (using data from Table 42) have been standardised to allow for the number of times that a given bone occurs in one individual, and then converted to percentages. The values in Table 43 thus show the abundance of a given group of elements as a percentage of the total of cattle elements. If each group contained all the bones of a number of complete cattle skeletons with no bias caused by taphonomy or recovery, then the expected value for each component in Table 43 would be 11·11%.

Several overall trends are clear in Table 43. Vertebrae and phalanges are almost always under-represented. Vertebrae (counted as centra) are soft and thus particularly susceptible to destruction by gnawing and abrasion. Phalanges are more robust, but are quite small and thus liable to be poorly recovered during excavation. It was noted that first phalanges generally outnumbered the smaller second phalanges. Abundances of vertebrae and phalanges are thus unlikely to be indicative of proportions as originally deposited.

Numbers of horncores are generally low, except for a few groups such as 5, 6, 18, 22, 26 and 30, which show no concentration in any one period or part of the site. High counts for horncores do not necessarily correspond to high counts for skull (counted as jaws and atlas), and vice versa, a result which confirms that the two parts were separated early in the butchery process and were distributed separately thereafter. Values for scapula and pelvis are generally high, probably reflecting better preservation and recovery of the robust acetabulum and glenoid articulations by which these elements are quantified. Front and back legs are generally well represented, particularly the fore limb elements. Only Group 15 conspicuously lacks limb bones, this being a rather small group dominated by pieces of rib. The highest combined fore and hind limb totals are to be found in Groups 23 and 27, and Group 27 (a Period 4A pit) also gave one of the highest counts for cattle metapodials. Metapodials otherwise show a close approximation to the theoretical 'random' value of 11·11%, except for the low values in Groups 3 and 4 (both Period 5B floor levels), and Group 9 (a Period 5B pit).

There is more variation in sample content within the periods than between periods, indicating that there were no marked chronological changes in the disposal of cattle bones. Over the bone groups as a whole, there is no disproportionate representation either of those parts which would have been removed during the initial butchering of a freshly-killed

Table 43 Percentage relative abundance of cattle carcass components, using data from Table 42. The raw counts have first been standardised to compensate for the number of times that a given element occurs in a single individual, then converted to percentages. As a consequence of this procedure, the expected value for each component, assuming a random distribution of elements, is 11·1%

Period	Group	Horncores	Skull	Vertebrae	Scapulae and pelves	Forelimb	Hindlimb	Metapodials	Phalanges	Ribs
5Cf	1	3·2	10·3	7·0	25·9	8·1	16·2	9·7	6·2	13·5
	2	8·1	9·8	5·0	23·1	12·9	11·9	10·4	3·8	15·0
5B	3	9·3	9·3	6·3	21·0	12·9	11·2	5·4	6·3	18·3
	4	6·7	10·8	8·6	6·7	16·8	14·8	5·7	5·7	24·3
	5	21·8	9·9	6·3	13·8	12·7	9·3	8·7	4·3	13·2
	6	19·5	15·6	8·4	14·1	11·2	7·8	9·4	7·6	6·6
	7	7·1	11·4	6·9	18·2	13·6	11·3	11·4	4·6	15·4
	8	3·2	11·1	8·3	21·1	11·3	13·8	11·8	7·0	12·4
	9	8·9	11·6	8·5	20·1	10·6	20·5	4·5	2·1	13·2
	10	2·3	7·3	6·2	26·3	13·7	13·7	12·6	5·7	12·3
	11	1·9	9·9	9·3	19·0	17·1	11·0	8·2	9·0	14·7
5A	12	3·1	9·8	8·1	23·0	13·1	10·4	9·7	8·5	14·4
	13	8·8	7·9	9·3	18·7	9·9	11·9	11·0	10·1	12·5
	14	5·4	15·2	4·8	18·9	18·9	10·8	12·7	4·1	9·2
	15	6·2	7·5	8·0	18·7	3·1	6·2	8·3	5·2	36·8
	16	7·0	15·4	4·5	24·5	8·7	12·6	9·9	4·1	13·4
	17	5·8	8·1	7·2	10·2	13·8	20·3	21·1	2·7	10·9
	18	26·4	8·5	7·6	21·2	13·5	13·9	14·0	6·7	12·1
4B	19	–	7·9	6·0	17·8	18·8	13·4	9·9	5·3	20·9
	20	10·2	8·1	5·9	14·0	18·5	13·2	11·4	3·6	15·1
	21	8·4	12·3	8·8	16·8	5·6	6·2	11·7	8·4	21·8
	22	14·2	9·2	5·7	10·7	11·4	13·5	17·8	0·9	16·4
	23	8·3	11·1	3·3	11·1	21·7	20·0	10·6	2·8	11·1
	24	12·8	17·9	6·4	12·8	12·5	8·9	8·9	7·3	12·5
	25	4·9	15·0	3·9	19·0	16·7	9·5	13·1	3·6	14·4
	26	14·1	24·2	5·6	12·1	13·1	8·1	8·1	5·0	9·8
4A	27	6·8	10·9	8·2	6·8	19·6	17·0	19·9	0·8	9·9
	28	–	9·0	12·0	26·3	15·0	10·5	7·5	6·0	13·5
	29	7·8	10·1	5·5	22·8	13·6	14·2	11·2	3·9	11·3
3	30	14·2	8·1	4·4	13·1	15·7	14·5	16·1	2·5	11·5
	31	9·9	21·8	9·9	12·4	19·8	6·0	11·6	3·3	5·4
	32	4·9	17·5	5·4	24·3	18·3	9·7	8·9	3·2	7·9
	33	10·6	16·3	8·0	17·3	13·4	12·5	11·5	4·1	6·2

beast (e.g. head, toes) or of the bones most likely to have been retained through the butchery process to the domestic hearth (ribs, vertebrae). The groups from Period 5B house floors (Groups 3 and 4) show a high proportion of ribs, as do several other groups, but even this floor debris contains phalanges, metapodials and fragments of skull. This result is perhaps inconsistent with the existence in the town of specialised meat retailers. Had such specialist butchers supplied meat to the community, a more clear-cut division between deposits of primary butchery waste and domestic residue would be expected, such as has been noted in Roman levels elsewhere in York (24–30 Tanner Row, *AY* 15/2). However, even the small cattle of Anglo-Scandinavian York would each have produced a formidable quantity of beef for a single household, and the interpretation which best fits the available evidence is that beasts were bought in and slaughtered as required and shared amongst several households, the role of butcher being taken by whomsoever in that particular neighbourhood had a sharp knife and a rough idea of how to use it. This hypothesis is lent credibility by the unsystematic, indeed clumsy, nature of much of the butchering. A similar conclusion was reached by McCormick (1982, 128–33) with regard to Viking Dublin.

There is some evidence to the contrary, namely the mention in Domesday Book of the Shambles, in which William of Normandy's half-brother, the Count of Mortain, is said to have held two stalls (Clapham 1949, 58). If it is assumed that the term 'shambles' had the same connotations in the 11th century as it had more recently, then use of the term as a location name within York would seem to imply the existence of a butchers' street or quarter. Be that as it may, the bone debris from the tenements sampled by the Coppergate excavation seems unlikely to have been produced by any substantial and systematic butchering trade. Perhaps if butchers' stalls existed in York during the last few decades before Domesday, they were let and used on a casual basis by men who practised as butchers when the opportunity arose, but who also made a living as smiths, coopers, tanners, or any one of many trades.

Age at death

Table 44 plots the attrition stage reached by first and second molars in cattle mandibles. The absence of very young animals is quite clear. Most cattle were killed after an age at which the second molar (LM2) was well-worn, with dentine exposure on at least three-quarters of the occlusal surface, and the third molar was erupting or already in wear. Timing such dental changes is notoriously hazardous. Silver (1969, 296) gives a range of 15–18 months for the eruption of LM2 in modern cattle, and quotes 30 months for 19th century cattle, although more recent work by Payne (1984) has cast doubts on the accuracy of the 19th century figures. Furthermore, different sources differ in their definition of 'erupted' or 'in wear'. In a very detailed study, Andrews (1982, 150) found the average age for full eruption of LM2 (that is, with the posterior cusps reaching the occlusal plane) in modern cattle to be 691 days—nearly two years. For the lower third molar, Silver (ibid.) quotes 24–30 months from modern stock, four to five years from the 19th century. It would be unwise in the extreme to assume that eruption times in cattle from Anglo-Scandinavian

Table 44 Cross-tabulation of numerical tooth-wear scores (*sensu* Grant 1982) attained by lower 1st and 2nd molars of cattle mandibles from all Anglo-Scandinavian deposits. Thus, five mandibles exhibited wear stage 12 of the first molar and 7 on the second, whereas 11 exhibited stage 15 on the first molar with 14 on the second

	lower first molar											
lower second molar	8	9	10	11	12	13	14	15	16	17	18	19
1		–	–	–	–	–	–	–	–	–	–	–
2	–	1	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	1	2	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	1	–	–	–	–	–	–	–	–
7	–	–	1	–	5	–	–	–	–	–	–	–
8	–	–	–	–	1	1	–	–	–	–	–	–
9	–	–	–	–	3	–	–	–	–	–	–	–
10	–	–	–	–	2	–	1	–	–	–	–	–
11	–	–	–	–	5	2	1	1	–	–	–	–
12	–	–	–	–	1	4	4	4	–	–	–	–
13	–	–	–	–	1	1	3	1	–	–	–	–
14	–	–	–	–	–	–	–	11	–	–	–	–
15	–	–	–	–	–	–	–	7	16	1	–	–
16	–	–	–	–	–	–	–	–	3	2	1	2
17	–	–	–	–	–	–	–	–	–	–	1	–

York were the same as those for modern or 19th century cattle. Indeed, Andrews' study served to underline the variation in timing and rate of eruption of cattle teeth. The distribution in Table 44 shows no discontinuities which would give cause to suspect an annual, seasonal cull. The pattern is that of cattle mainly being slaughtered between two approximate ages. The lower end of this age bracket would appear to be at least two to two and a half years. The upper end is less easy to fix, but if LM3 is taken to have erupted at around three years of age, then few cattle were being slaughtered at more than about eight years old. Between these limits there would seem to have been little selection of more precisely-defined age groups. Attribution of mandibles to age groups is summarised in Table 45.

Turning to the epiphyses, Fig.25 plots the proportion of fused epiphyses in different age categories. Differences between the various periods are small. The proportion of fused vertebrae is lower in Periods 4 and 5A than in Periods 3 and 5B/C, possibly indicating that there were fewer fully mature cattle represented in the groups from Periods 4 and 5A.

Taking the early group of epiphyses to fuse at about twelve months, only 7–10% of cattle represented in the recovered sample were slaughtered below this age. Even allowing for the

Table 45 Mandibles grouped according to tooth eruption and attrition

Juvenile — LM1 not yet in wear
Immature — LM1 in wear, LM2 not yet in wear
Subadult — LM2 in wear, LM3 not yet in wear
Adult — LM3 in wear but not heavily worn
Elderly — LM3 showing advanced attrition (numerical score 13+)

Note that the sets of mandibles represented in this table are not the same as the sets which contribute to Tables 44, 48 and 51, so that there are small numerical inconsistencies. For example, the 'Elderly' category in this table will include cattle mandibles which bore LM3, and could thus be allocated within this table, but lacked LM1 and/or LM2, and were thus excluded from Table 44

Period	Neonatal	Juvenile	Immature	Subadult	Adult	Elderly
Cattle						
5C	–	–	–	3	4	1
5B	1	–	2	12	34	3
5A	1	–	1	6	21	–
4	–	–	4	15	21	7
3	–	2	4	11	25	2
All Anglo-Scand. deposits	3	3	16	73	158	43
Sheep						
5C	–	–	–	3	5	–
5B	–	–	4	12	18	–
5A	–	1	1	5	13	–
4	–	6	11	12	35	1
3	–	1	–	8	51	–
All Anglo-Scand. deposits	–	10	27	64	215	4
Pig						
5C	–	–	–	2	4	–
5B	–	–	7	28	15	–
5A	–	1	7	19	14	–
4	–	–	8	15	9	–
3	–	2	7	13	16	–
All Anglo-Scand. deposits	–	7	39	109	92	2

friability of calf bones militating against their recovery, this would seem to show that only small numbers of young calves were slaughtered. On the other hand, about one third of vertebrae were found to be fully fused. From modern data (e.g. Silver 1969) an age of about five to six years for fusion of the vertebral epiphyses may be suggested, so two-thirds of the cattle in these samples can be taken as younger than five or six years. Of the remaining third, the mandibular data indicate most to have been under eight years or so. The epiphysial fusion data do not permit a very detailed interpretation: such data never do. However, the two sources of information regarding age at death of cattle broadly agree. Although there does not seem to have been any precise selection of cattle of a particular age, most cattle were youngish adults when slaughtered, a result which implies a multi-purpose role for the cattle. Clearly this age distribution is atypical of the by-product of a dairy herd.

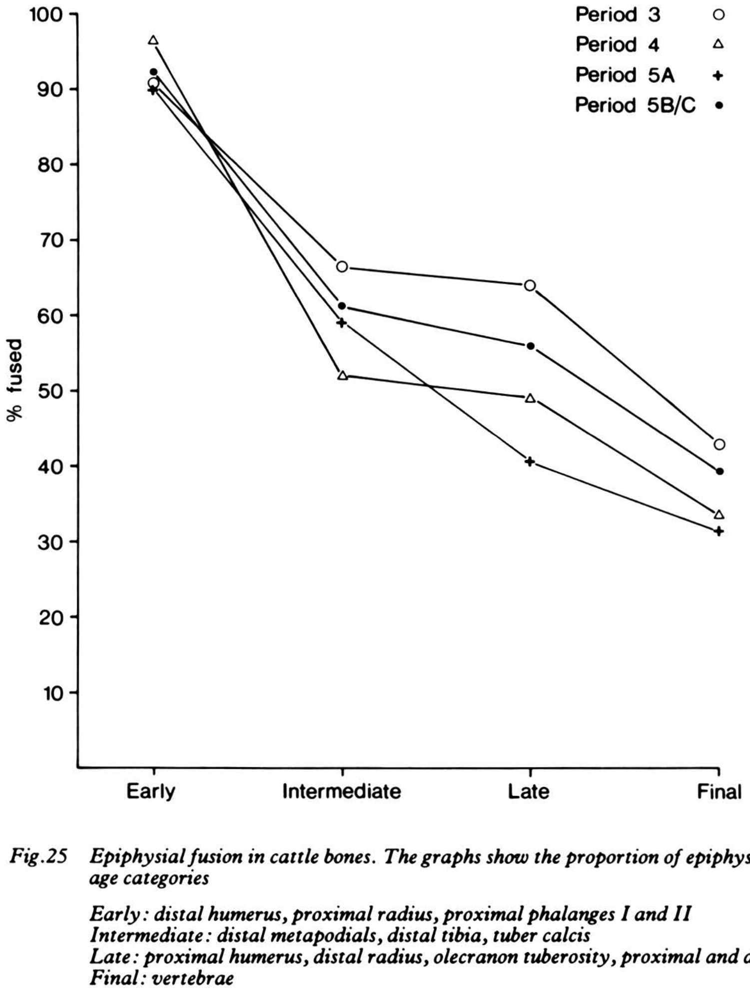


Fig.25 Epiphysial fusion in cattle bones. The graphs show the proportion of epiphyses fused or fusing in each of four age categories

Early: distal humerus, proximal radius, proximal phalanges I and II
Intermediate: distal metapodials, distal tibia, tuber calcis
Late: proximal humerus, distal radius, olecranon tuberosity, proximal and distal femur, proximal tibia
Final: vertebrae

Dairying would tend to bring to market surplus calves (mostly male) and excess or worn-out dairy stock which will be mostly female and often old, a pattern of slaughter seen in 15th–18th century groups from York (*AY* 15, in prep.). These cattle were not, on the other hand, slaughtered as soon as adult body size was attained. Even allowing for a slow rate of maturation in Anglo-Scandinavian cattle, selection for beef would have brought all but breeding animals to slaughter by their fourth or fifth year. Trow Smith (1957, 239) quotes post-medieval sources as indicating that a beef heifer of pre-Improvement type would have been ready for slaughter at three years, a steer at four to five years. The results suggest that cattle were important as a source of meat but that their role as providers of haulage and milk was also appreciated, making it worth keeping adult cattle for a couple of years beyond the 'earliest economic slaughter' point. Such an interpretation is consistent with extensive rather than intensive farming procedures, and is what might have been predicted for a system based on independent small farmers.

Disease and injury

The diagnosis of disease and injury from the traces left on bones is not a simple matter, and often the cause of some bone abnormality can only be guessed at. However, certain forms of disease and injury do leave distinctive traces on the skeleton, and a number of such disorders were noted.

To summarise the results, arthropathies, mainly attributable to osteoarthritis, were the most common conditions observed among the cattle bones. The incidence of lower-limb arthritis in archaeological cattle remains in relation to their use as draught animals has been discussed elsewhere (e.g. in O'Connor 1982a), and a similar interpretation can probably be placed upon the specimens from Coppergate. A number of cases of osteoarthritis of the hip joint were observed, and it is possible that this condition was also predisposed by the strain placed on the hind legs of a draught ox. The most frequent symptom of this disease was the presence of an area of eburnation, often with associated grooving of the bone, near the pubic margin of the acetabulum. These limb arthropathies were, for the most part, not far advanced and would not have immobilised the affected animal. Group 17, from a Period 5 pit, included a cattle occipital bone with small areas of eburnation on the occipital condyles. It is unfortunate that the rest of the neck of this individual could not be located among the fragments recovered. It is an intriguing possibility, though certainly nothing more, that the use of the horns to yoke draught oxen caused excessive strains in the neck, with resulting damage to the joint surfaces.

Several instances were noted of abnormalities of the mandibular condyle. Although the possibility of arthritis at this joint cannot be excluded, these cases all appeared to comprise developmental abnormalities, most commonly pitting or grooving near the centre of the condyle dividing the articular surface into two parts. This incipient doubling of the condyle has been discussed by Baker and Brothwell (1980, 112–14), who stress the difficulty of distinguishing between condyle abnormalities caused by disease, and what they term 'non-pathological variations from the normal'. In the absence of associated arthrosis, it seems likely that the latter interpretation can be applied to most, if not all, of the Coppergate specimens.

Patches of periostitis on metapodial shafts occurred in four specimens, and a number of causes can be proposed. The condition may have been caused by infection of the periosteum following an injury to the lower part of the limb. A similar origin is likely for a metatarsal from Group 3 which showed inflammatory enlargement of the medullary cavity with an associated draining sinus; a mild case of osteomyelitis.

A striking feature of the Anglo-Scandinavian cattle bones was the low frequency of periodontal disease and other oral disorders. Only one definite case of periodontal disease was noted, this low incidence being more akin to that seen in modern cattle than the very high frequency which was noted by Siegel (1976) in her review of archaeological bone pathology. This does not mean that the cattle suffered no oral disease, because short-lived low grade gum infections would not necessarily have advanced to a point where the bone was affected. This low frequency does, however, indicate a good state of oral health. Indeed, the cattle generally seem to have been healthy, with most symptoms limited to stress-related arthropathies.

Non-metrical traits

Two non-metrical traits were recorded systematically for cattle mandibles; the presence or absence of the second premolar (LP2), and the absence of the distal column of the third molar. The lower second premolar is occasionally congenitally absent in mandibles of many ruminant species (Andrews and Noddle 1975). Archaeological records of this trait have, in the main, been limited to noting specimens in which the premolar was absent. For the Coppergate bones, a count was also made of the number of jaws in which LP2 was present or had definitely been present despite ante- or post-mortem loss, so as to give some measure of the frequency of the trait. The results are listed in Table 46. It is not possible to argue for any difference between periods from these figures. Overall, the frequency of jaws lacking LP2 was 25 out of 368 (6·8%). By way of comparison, a survey of modern American cattle by Garlick (cited in Andrews and Noddle 1975) found a frequency of about 1%, and Meek and Gray (1911) found a frequency of 6·9% among cattle mandibles from Roman Corstopitum (Corbridge, Northumberland). A sample of 54 mandibles from post-medieval levels at 118–26 Walmgate, York, included three in which LP2 was congenitally absent, an incidence of 5·6% (p.44, *AY* 15/1), and 2nd–3rd century deposits at 24–30 Tanner Row yielded a frequency of absence of 18·5% (pp.89–90, *AY* 15/2). The aetiology of the condition is not fully understood, but it seems likely that a simple genetic anomaly may be responsible. It could be argued that such anomalies are more likely to be expressed at an unusually high or low frequency in samples drawn from a small gene-pool, where an individual sire or dam of a particular genotype will have greater influence. Thus higher frequencies might be expected in archaeological samples, representing the livestock populations of small communities, than in modern, highly exogamous, herds. Whatever the explanation or interpretation of this condition, the frequency at Coppergate agrees quite well with that observed for Corstopitum and for 118–26 Walmgate. Group 33 stands out as having a particularly high frequency (four jaws out of 22) albeit from a small sample. This Period 3 layer also yielded three of the six specimens of anomalous mandibular condyles, although a jaw-by-jaw correlation between the two conditions could not be made, owing to fragmentation of the jaws.

Sixteen lower third molars were recovered which lacked the distal column. Insufficient quantified records of this condition have been published to date to permit any interpretation, although Maltby (1979, 40) reports the condition in ten out of 76 cattle mandibles from Roman Exeter, and goes on to suggest that this abnormality may have been more common in the Roman period than it was subsequently. Andrews (quoted pers. comm. in Noddle 1980a, 404) gives the frequency of this trait in modern cattle as about 0·5%.

Table 46 Incidence of some non-metrical traits in cattle and sheep bones

LP2+ — Lower second premolar present during life
LP2– — Lower second premolar congenitally absent
>LM3 — Lower third molar lacking distal column
P+, P– — Major nutrient foramen of sheep femur present/absent at the proximal anterior locus
M+, M– — Ditto, at the midshaft posterior locus
D+, D– — Ditto, at the distal posterior locus

		Cattle mandibles			Sheep mandibles			Sheep femora					
Period	Group	LP2+	LP2–	>LM3	LP2+	LP2–	>LM3	P+	P–	M+	M–	D+	D–
5Cf	1	–	–	–	3	–	1	–	–	–	–	–	–
	2	4	1	–	7	–	–	2	–	–	1	–	–
5B	3	2	1	–	–	–	–	–	–	–	–	–	–
	4	1	–	–	1	–	–	–	–	–	–	–	–
	5	8	–	1	12	–	–	3	2	1	2	2	1
	6	16	–	–	5	–	–	–	–	–	–	–	–
	7	22	–	–	12	–	–	2	1	–	1	3	1
	8	13	2	1	5	–	–	–	–	–	1	2	2
	9	1	–	–	1	–	–	–	–	–	–	1	–
	10	2	–	–	3	–	–	–	–	–	–	–	–
	11	4	–	–	8	1	–	–	–	–	–	–	–
5A	12	3	–	1	1	–	–	1	–	–	–	–	–
	13	3	–	1	5	–	–	3	–	–	–	–	–
	14	2	–	–	1	–	–	–	–	–	–	–	–
	15	1	–	–	1	–	–	–	–	–	–	–	–
	16	5	–	–	–	–	–	–	–	–	–	–	–
	17	5	–	–	1	–	–	–	–	–	–	–	–
	18	12	1	3	9	–	–	1	–	–	–	–	–
4B	19	1	–	–	2	–	–	–	–	–	–	–	–
	20	5	–	–	2	–	–	1	–	–	–	–	–
	21	4	–	–	–	–	–	1	–	–	1	2	–
	22	–	–	–	–	–	–	1	1	1	2	2	1
	23	5	–	–	2	–	–	1	–	–	1	–	1
	24	10	–	–	22	–	–	3	–	–	2	1	–
	25	4	1	1	29	–	–	3	–	–	1	1	–
	26	6	–	1	10	2	–	3	–	–	1	–	1
4A	27	2	–	–	7	–	–	–	–	–	1	1	–
	28	–	–	–	8	–	–	2	–	–	4	3	1
	29	11	–	–	17	2	–	–	–	–	–	–	–
3	30	5	–	–	6	1	–	1	–	–	1	1	–
	31	–	–	–	–	–	–	–	–	–	–	–	–
	32	2	–	–	2	–	–	2	–	–	2	1	1
	33	18	4	–	20	–	–	3	–	–	4	1	4
All Anglo-Scand. deposits		343	25	16	391	14	3	68	9	6	54	32	46

Biometry

Measurements taken from a large series of Anglo-Scandinavian cattle and pig bones have been the subject of a detailed biometrical study, the results of which will be published elsewhere (*AY* 15, in prep.). For the purposes of this report, sufficient biometrical results have been utilised to permit an estimate to be made of the body weight and size of the cattle represented by these bones, so that comparisons may be made with material from other sites and with other cattle.

The data used for the calculations are summarised in Table 47. Two methods were used to calculate the original liveweight. The first utilised results published by Noddle (1973), based on a study of bones of cattle of known fat-free carcass weight. The second used an allometric equation obtained by Reitz and Cordier (1983) which relates a measurement on the astragalus of ungulates in general to total body weight.

Noddle (1973) explored the correlations between carcass weight and a number of different skeletal measurements, or combinations thereof. The modern dataset included bulls, cows and steers from a variety of different breeds. The correlation between weight and any one measurement was not stated in the original paper, but the diagrams presented make it clear that some measurements were much more closely correlated with weight than were others. For the present purpose, two have been chosen: the width of the distal trochlea of the humerus, and the product of the minimum medio-lateral width and corresponding antero-posterior breadth of the metatarsal diaphysis. This latter figure gives an approximation to the cross-sectional area of the metatarsal diaphysis. The results are presented in Table 47, and comparison with results presented by Noddle indicates fat-free carcass weight to have ranged between 100 and 140kg. Allowing 15% for carcass fat and assuming a dressing-out percentage of 40%, this would convert to liveweights in the range 160–225kg.

Applying Reitz and Cordier's method to the lateral length of the astragalus gives a much higher result, around 290kg. This is a newly developed procedure, applied to ungulates as a whole and not specifically to cattle. Noddle's work requires assumptions to be made about the percentage of body fat and dressing-out ratio. Neither procedure can be seen as likely to give a very accurate result, and the disparity is not really surprising.

To provide some other basis for estimation, calculations were made of shoulder height, based on lengths of metatarsals and using the conversion factor calculated by Fock (von den Driesch and Boessneck 1974). The mean reconstructed shoulder height for Anglo-Scandinavian Coppergate cattle is 1·13m (Table 47), and the range represented is from 1·03m to 1·28m. If comparison is made with modern cattle, it is clear that for a beast of shoulder height 1·10m to have a liveweight of 160kg, the animal would need to have a body conformation closer to that of a deer than an ox. One of the smallest extant British breeds (excluding the dwarfed Dexter) is the Shetland standing around 1·0–1·1m in withers height. Adult Shetland cows today weigh around 330kg, but are recorded as having weighed as little as 205kg in the early years of this century (Alderson 1976, 127–8). Kerry cattle are a little taller than Shetlands, but very 'leggy', and an adult Kerry cow will weigh about 370kg (ibid., 118–19). If Anglo-Scandinavian cattle are postulated to have had a

Table 47 Summary of main biometrical data for cattle bones. All measurements are in mm

Humerus	BFd — Medio-lateral width of the distal trochlea
Astragalus	GLl — Length of the lateral side
Metatarsal	RSH — Reconstructed shoulder height, based on maximum length × 5·45 (von den Driesch and Boessneck 1974)
	Ml × Ap — Product of minimum medio-lateral shaft breadth and antero-posterior depth at the same point (Noddle 1973)
Horncore	Circ. — Basal circumference
	Max. Bd — Maximum basal diameter
	Min. Bd — Minimum basal diameter
	Length — Length of postero-dorsal curve
	0·95 C.I. — 95% confidence interval (= Mean ± 1·96 × S.E.)

		Mean	S.D.	n	S.E.	·95 C.I.
Humerus	BFd	67·1	5·6	36	0·94	65·2–68·9
Astragalus	GLl	60·6	3·3	108	0·31	60·0–61·2
Metatarsal	RSH	1130·1	57·4	52	7·96	1115–1146
	Ml × Ap	627·0	114·3	52	15·85	596·0–658·1
Horncore	Circ.	158·9	30·5	164	2·38	154·2–163·6
	Max. Bd	54·4	11·2	165	0·87	52·7–56·1
	Min. Bd	42·3	8·3	163	0·65	41·0–43·6
	Length	182·1	53·0	59	6·90	168·6–195·6

shoulder height of 1·10–1·15m and a very lean conformation, an average liveweight in the region of 220kg would seem likely. For a heavier conformation, this average could perhaps be raised to around 270kg. In short, calculations based on the work of Noddle have produced a result which appears unreasonably low, while the equation derived by Reitz and Cordier gives a result which may be rather high.

Reconstructed shoulder heights of cattle from four English sites of 9th to 12th century date are compared in O'Connor (1982a, 20–1). All show a mean height between 1·10 and 1·20m and range from below 1·0m to 1·35m. The results from Coppergate fall into this pattern. In considering the size of cattle from early medieval Dorestad, Prummel (1983, 171–9) drew comparisons with a number of north European sites, and contrasted the mean reconstructed shoulder height of 1·16m from Dorestad with a mean of 1·10m from Hedeby (Haithabu) (Reichstein and Tiessen 1974, 26–7). To this might be added a mean of 1·06m from Mecklenburg (Müller 1984, 165). Taking published data from European cattle of 9th–12th century date as a whole, the differences between mean values from sample to sample are much smaller than the variation commonly shown within individual samples. Thus the cattle from Hedeby, Mecklenburg and Dublin (McCormick 1982, 96) were

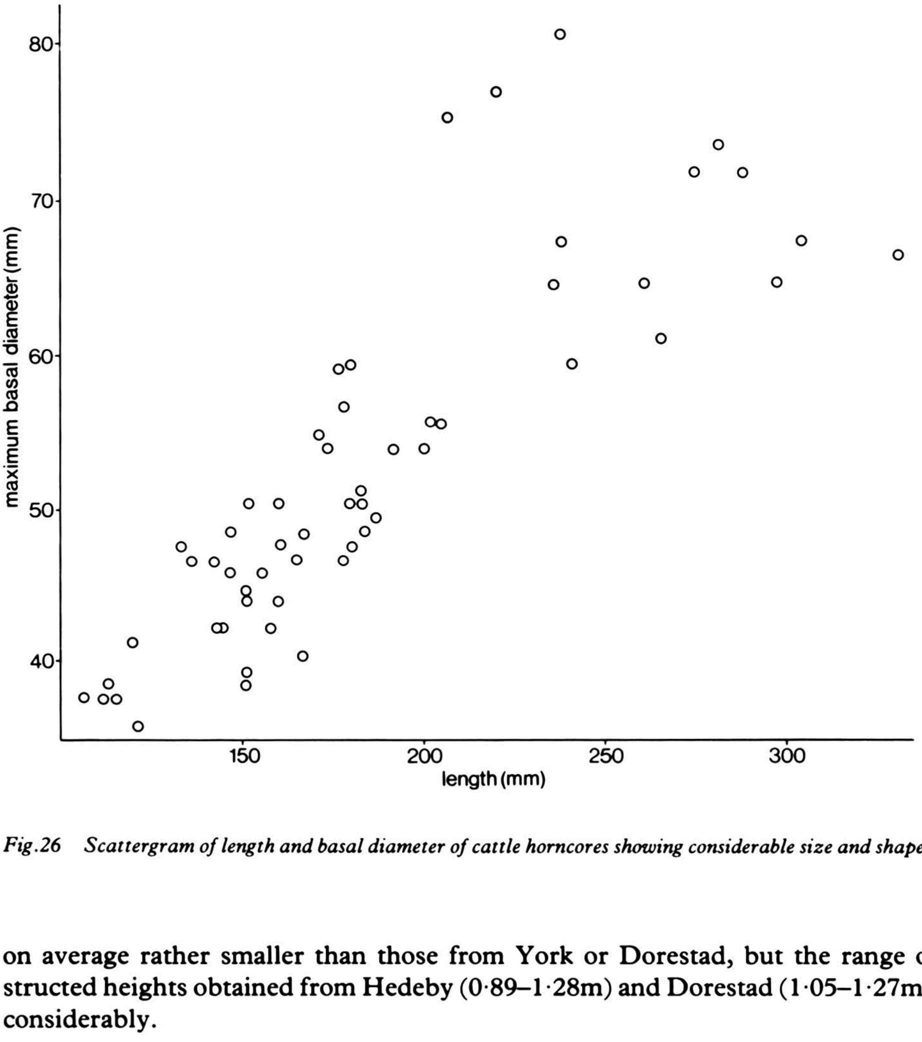


Fig.26 Scattergram of length and basal diameter of cattle horncores showing considerable size and shape variation

on average rather smaller than those from York or Dorestad, but the range of reconstructed heights obtained from Hedeby (0·89–1·28m) and Dorestad (1·05–1·27m) overlap considerably.

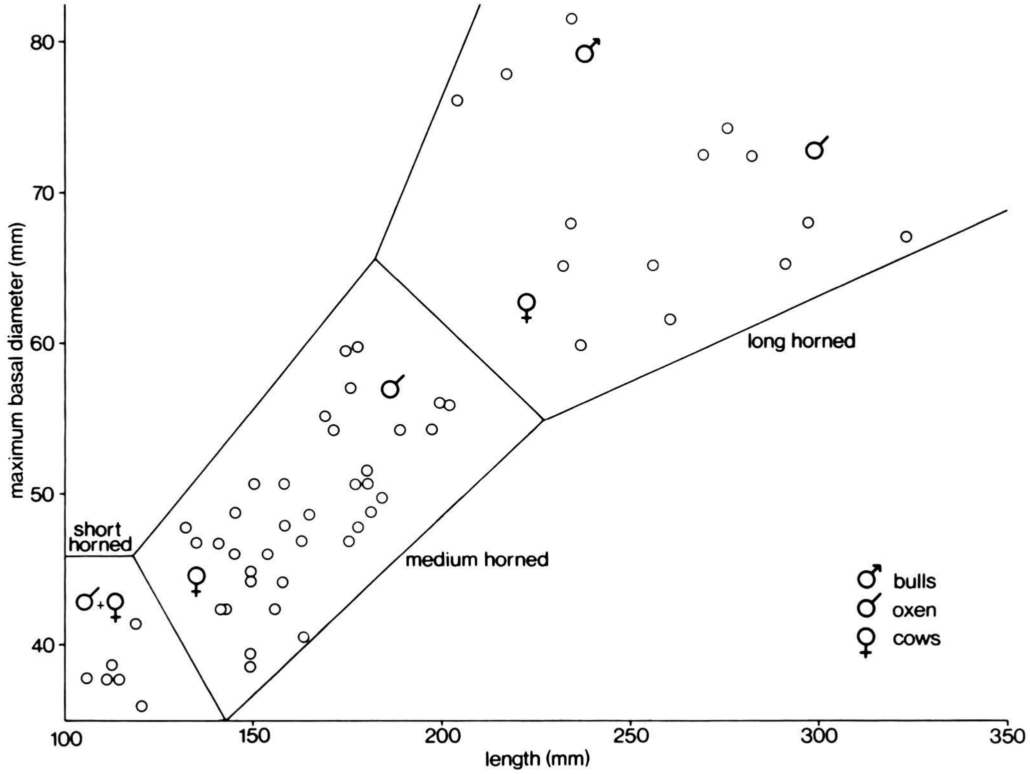
From Anglo-Scandinavian levels over the whole site, 166 at least partially measurable adult cattle horncores were recovered. The metrical data obtained from them are summarised in Table 47. Armitage and Clutton-Brock (1976) proposed a scheme for the classification and description of cattle horncores which provided parameters for terms such as 'short horned', and which described the characteristics typical of the horncores of bulls, cows and oxen. For the present purposes, the criteria of overall size, proportional length and cross-sectional shape may be defined biometrically and are used to examine this sample of horncores. The practice of chopping horncores away from the frontal bone made systematic assessment of the angle at which the horncore was attached possible in only a few cases. With regard to horncore shape, nearly all exhibited both curvature and torsion and had pointed tips. None of the specimens could be described as straight.

Armitage and Clutton-Brock (1976) stressed the importance of considering the length of horncores before attempting any subdivision by sex. Their 'small horned' category (less than 96mm in length) may be ignored for the present purposes as none of the Coppergate specimens fell into this category. Short horned cores were defined as 96–150mm in length, long horned as over 220mm long, and medium horned as between these limits. Within these size categories, bull horncores should, according to Armitage and Clutton-Brock, be distinctive for being large in overall volume but short in proportion to cross-sectional area. Cow and ox horncores are similarly proportioned, being proportionally longer than those of bulls, ox cores reaching a larger adult size than those of cows.

Of the 166 specimens measured, 57 were complete, and ranged from 105 to 330mm in length, with a marked concentration of cases between 105 and 200mm. Using the parameters given above, eighteen would be described as short horned, 23 as medium horned, and sixteen as long horned—quite a variety. In order to investigate more closely the relationship between length and gross size, Fig.26 plots maximum basal diameter against the length of the postero-dorsal curve (length) of the adult horncores. Clustering of the data is very obvious, and the interpretation very obscure. The two variables are highly correlated ($r = 0{\cdot}856, p < 0{\cdot}000$), and the values for length are heavily skewed (skew = 0·98). The most obvious 'break' in the data occurs at length = 220–230mm (corresponding to Max. Bd = 55–65mm), at the division between Armitage and Clutton-Brock's medium and long horned categories. Taking the long horned specimens in Fig.26 separately, a division into large but short bull horncores, and smaller but proportionately longer cow and ox horncores may be seen. A second break in the data at length = 130mm may be separating short and medium horned cases, in which case the medium horned cattle were cows and oxen only, with no bulls (Fig.27a). The smallest cases in Fig.26 can, on this model, be attributed to short horned cattle.

Alternative interpretations of Fig.26 are, of course, possible, and Fig.27b presents a different option. In Fig.27b, only two horncore size groups are hypothesised, following Armitage's (1982) classification scheme for post-medieval cattle. This scheme divides short and medium horned types at 220mm, with long horned cattle starting at 360mm. On this classification, 37 out of 57 cases are short horned oxen. On the interpretation shown in Fig.27a, these same 37 cases are a mixture of medium horned cows and oxen, perhaps in roughly equal numbers. On either interpretation, the only bulls in the sample are the three long (or medium) horned specimens near the top of Fig.26. The greater cross-sectional flattening attributed to bull horncores by Armitage and Clutton-Brock (1976) was not apparent in these three specimens. The ratio of minimum:maximum basal diameters varied modestly (coefficient of variation = 7·85), and this ratio showed no significant correlation either with length or basal circumference.

Whichever version of Fig.27 is accepted as the more probable, the results show a degree of heterogeneity in the cattle bones which was not apparent in other metrical data. The cattle are shown to have been similar in size to the smallest multi-purpose breeds of recent times, and the considerable variation in horncore form may indicate a diversity of phenotype greater than that seen in a single modern breed. These conclusions accord with the concept of York as a market for many separate agricultural communities scattered around

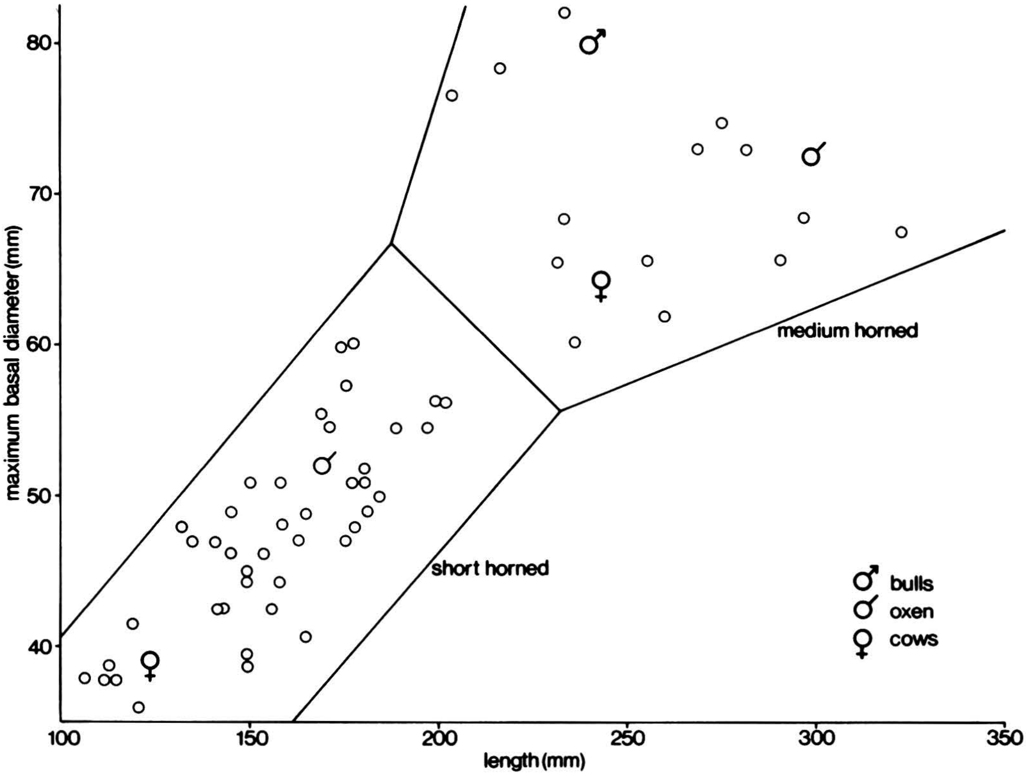


a Assuming three horncore morphotypes

Fig.27 (above and facing) Two plausible interpretations of the distribution of cases in Fig.26

the city's hinterland. Indeed, given the likelihood that the city bought cattle from throughout a wide catchment area, it would be remarkable if an archaeological sample showed great consistency of size or morphology.

There are, of course, other sources of evidence for the type and appearance of the cattle represented at Coppergate, the most obvious being their skins, in the form of leather artefacts and waste material. The large corpus of leather from Anglo-Scandinavian Coppergate will be published in *AY* 17. It is unlikely that the characteristics of the hide of a beast can be correlated with the characteristics of its skeleton. Friesian and Limousin cattle differ in surface colour, but their skeletons are remarkably alike. Furthermore it is quite possible that quantities of hides were brought into York from cattle not represented amongst the bone debris. The evidence of skins and bones cannot, therefore, be integrated closely.



b Assuming two horncore morphotypes

Sheep

Sheep bones were much less abundant than those of cattle, and if allowance is made for the relative meat yield of these two species, it is clear that sheep produced only a very small proportion of the meat supply of Anglo-Scandinavian York. Meat yield should not be equated with economic importance, however, and the use of wool as a major economic resource is well evidenced by the textile finds from Coppergate (P. Walton, *AY* 17/5).

Carcass distribution and butchery

In general, butchery marks were uncommon on sheep bones. The obvious explanation for this is that the relatively small carcass of a sheep can be taken apart by means of a knife, disarticulating the joints by cutting through ligaments. There is little need to chop through bones, and a butcher equipped with a sharp knife could joint a sheep leaving little or no trace on the skeleton. Such butchery marks as were observed were mainly knife cuts, singly or in groups, distributed about the shafts of the limb bones. Most vertebral centra were intact. The most frequent site for butchery marks was on the os innominatum, where many specimens had been chopped through perpendicular to the long axis of the ilium at its narrowest point. The lack of butchery marks may also indicate that sheep carcasses were distributed in large pieces, such as whole quarters, rather than in smaller joints.

The proportion of different sheep carcass components varied considerably between samples (Table 42), with a few consistent trends. As with the cattle, vertebrae and phalanges were consistently under-represented, a consequence of taphonomic loss, or poor recovery. Scapulae, pelves and fore limb elements were generally well represented, and the proportions of ribs varied considerably, with Period 3 groups in particular being deficient in ribs.

The numbers of sheep metapodials recovered varied considerably, and showed no obvious correlation with the abundance of any other part of the skeleton. As with the cattle bones, proportions of horncores and of skull elements were not closely correlated, and sheep horncores were therefore evidently removed early in the butchery process, probably at the point of slaughter.

Age at death

The attribution of mandibles to age categories is given in Table 45, whilst Table 48 cross-tabulates the wear stages shown by the lower first and second molars. Most sheep were slaughtered after the second molar had come into wear, but there are few very old individuals, a pattern similar to that seen for the cattle mandibles. Timing the eruption of sheep teeth is no more straightforward than it is for cattle. Figures given by Silver (1969, 297), indicate that the lower second molar is likely to have erupted around the age of twelve to eighteen months, and the lower third molar at around two years. Referring to Table 45, this would indicate a substantial minority of sheep (perhaps as many as one third) to have been killed in their second year; i.e. these are the sheep in the subadult category in Table 45. The distribution of cases in Table 48 suggests that most of the 'adult' sheep were slaughtered as third or fourth year animals, with fewer older ones. Thus it can be argued that the sheep were mainly selected for slaughter between the ages of about eighteen months and four years, with no indication of a concentration on any age group within this range.

The data obtained from epiphysial fusion are summarised in Fig.28. The results generally support the interpretation offered for the mandibles, although the presence of up to 35% unfused epiphyses in the Intermediate I group suggests that the proportion of roughly nine to eighteen months old sheep may have been under-represented by the mandibles, at least for Period 5A. Period 3 groups appear to differ in this respect, with just 10% of epiphyses unfused in this age group.

Table 48 Cross-tabulation of numerical tooth-wear stages attained by lower first and second molars of sheep mandibles from all Anglo-Scandinavian deposits

	lower first molar											
lower second molar	8	9	10	11	12	13	14	15	16	17	18	19
4	2	2	1	1	1	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	1	–	–	–	–	–	–	–	–
7	–	–	–	–	2	–	–	–	–	–	–	–
8	–	–	–	1	2	–	–	–	–	–	–	–
9	–	–	–	1	14	–	–	–	–	–	–	–
10	–	–	–	2	21	1	–	–	–	–	–	–
11	–	–	–	2	17	3	1	1	–	–	–	–
12	–	–	–	–	9	21	6	2	–	–	–	–
13	–	–	–	–	–	1	2	4	3	–	–	–
14	–	–	–	–	–	–	–	8	–	4	–	–
15	–	–	–	–	–	–	–	–	5	2	–	–
16	–	–	–	–	–	–	–	–	–	2	–	2
17	–	–	–	–	–	–	–	–	–	–	1	–

It was proposed above that the age distribution of cattle indicated that they were kept as multi-purpose animals, and the same interpretation can be offered for the sheep. Delaying slaughter to eighteen months would enable one year's wool clip to be obtained. Retaining some stock to four or five years old would permit them to be used for breeding, as well as yielding two or three years' clips. It must be stressed that these sheep are at the 'consumer' end of the system. This age distribution shows clearly that sheep were not being bred on or near the Coppergate tenements. There were no bones of perinatal lambs, no obviously culled surplus lambs of weaning age, and few bones attributable to aged breeding or milking ewes, all of which would have been expected at a 'producer' site. Clearly it was economically viable to send at least some second year sheep to slaughter, which suggests that the value of a sheep as meat was high enough not to be outweighed by the potential value of another couple of years' wool. Circumstances may have been rather different during Period 3, and the lower proportion of young sheep in Period 3 groups may reflect a lower relative value for sheep as meat during this period.

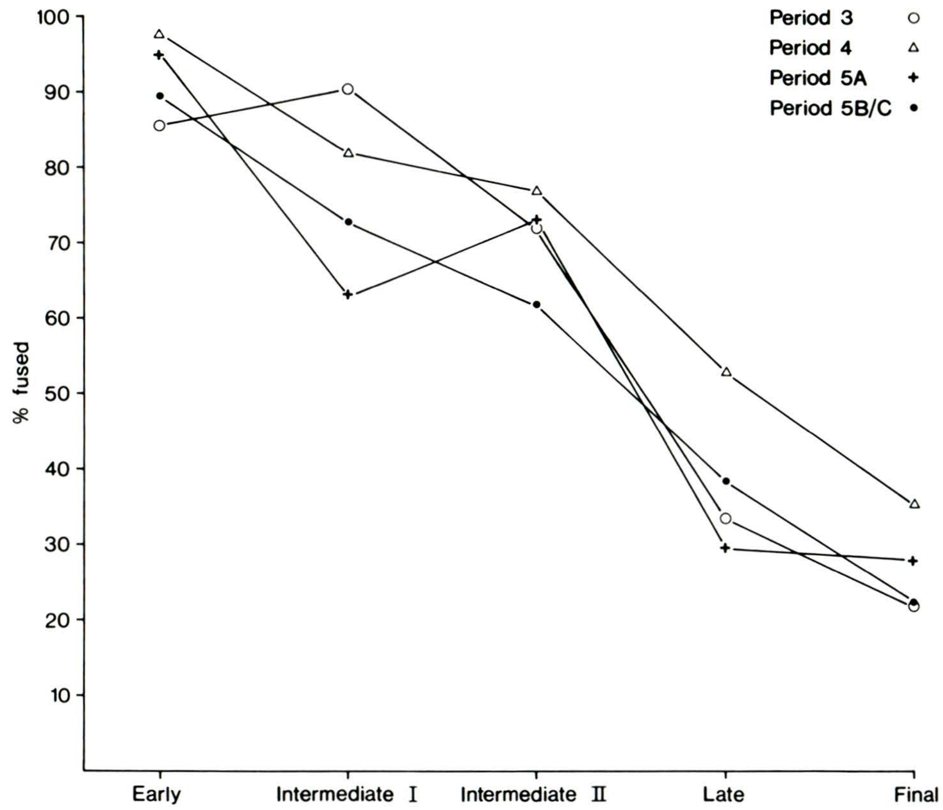


Fig.28 *Epiphysial fusion in sheep bones. The graphs show the proportion of epiphyses fused or fusing in each of five age categories*

Early: distal humerus, proximal radius
Intermediate I: proximal phalanges I and II, distal metacarpal
Intermediate II: distal tibia, distal metatarsal, olecranon tuberosity, proximal femur, tuber calcis
Late: distal radius, proximal humerus, distal femur, proximal tibia
Final: vertebrae

Disease and injury

The only disorder which was noted with any regularity in the sheep bones was the presence of exostoses around the elbow joint. These exostoses were generally on the lateral aspect of the joint, and took the form of either a strap-shaped outgrowth from the proximal end of the radius or of a narrower growth from the distal end of the humerus arising from the lateral aspect near the epiphysial line. In either case, the cause was evidently ossification of the ligaments which surround the elbow joint. The same condition has been described in sheep bones from elsewhere in York (p.24, *AY* 15/1), and the same interpretation can be offered, namely that the ossification of the ligaments is a reaction to a traumatic injury of the elbow, probably a sprain or dislocation (Baker and Brothwell 1980, 127). Thirteen instances were noted in total, making this disorder pro rata as common in sheep as were the various limb arthropathies in cattle. Three cases were noted of raised areas of dense bone on metapodial shafts, apparently a form of osteoperiostitis with no associated inflammation or infection. Again, this distinctive condition has been recorded from elsewhere in York, in greater abundance (pp.24, 42, *AY* 15/1). Specimens from late 17th to early 18th century levels at 118–26 Walmgate were thought to result from the prolonged hobbling of sheep, and the same explanation can be offered for these Anglo-Scandinavian specimens. There is a variety of reasons why a sheep might be hobbled, amongst them the need to keep a particular sheep in one place, perhaps for milking, without recourse to walls or fences, or a need to prevent a ram from mating by tying a length of rope between a front and a back leg. In unsophisticated sheep-keeping communities today, hobbling is by no means unusual, and if the observed symptoms are a consequence of prolonged hobbling, then the condition should be expected to occur routinely in archaeological samples.

An unusual horncore abnormality was noted in Period 5B deposits. A left frontal bone was found which was evidently from a four-horned sheep. To complicate matters, the posterior core had split almost to its base, giving the appearance of two and a half left cores. It is not clear whether the two parts of the posterior core would each have borne a horn sheath or whether one sheath would have covered both. It is also quite possible that the two cores on the right side of the skull were not abnormal in any way. The variability and possible causes of polycerate skulls in sheep have been discussed by Noddle (1980b), and the little that is known with any degree of certainty indicates that multiple cores or divided cores may occur in almost any population of sheep. Apart from this abnormal specimen, two other 'normal' polycerate skulls were found (Pl.Xa), and one polled specimen.

Only one definite case of periodontal disease in sheep mandibles was noted, a low frequency which matches the results from cattle jaws.

Non-metrical traits

Three non-metrical traits were recorded for the sheep bones, and the results are summarised in Table 46. The lower second premolar was congenitally absent in a lower proportion of mandibles than was noted for the cattle bones, being absent in fourteen out of 405 (3·5%). Only three abnormal lower third molars were noted, the distal column being completely missing in each case.

The location of the major nutrient foramen in the sheep femur was discussed by Noddle (1978), who drew attention to a possible relationship between breed phylogeny and the frequency of occurrence of the foramen at each of three positions. In the samples from Coppergate, the foramen was present at the proximal position in 68 out of 77 cases (88·3%), at the midshaft position in six out of 60 cases (10·0%), and in the distal position in 32 out of 78 cases (41·0%). The proximal position is by far the commonest in modern breeds, and there is some evidence that a high frequency of distal foramina is a trait of breeds originating in northern Britain (B.A. Noddle, pers. comm.). By way of comparison, post-medieval groups from 118–26 Walmgate (pp.43–4, *AY* 15/1) showed remarkably similar figures with frequencies of 87·5% at the proximal locus, 14·3% at midshaft, and 44·4% at the distal locus.

Biometry

Although all types of sheep bone were measured, most did not yield sufficient specimens to permit a detailed metrical analysis. However, enough measured metacarpals were obtained to allow some reconstruction of size and weight, and to allow comparison with results from other ancient and modern samples (principally with those in O'Connor 1982b). The metacarpal measurements are summarised in Table 49.

Variation in size was not great, and there was no evidence of size differences from period to period. Mean values for the measured variates are similar to those obtained for samples of modern Welsh Mountain and Finnish Landrace Cross sheep (O'Connor 1982b, 257). Ewes of these breeds will reach 40–50kg liveweight (Alderson 1976, 48, 86). The Anglo-Scandinavian sheep would have been lighter than this only if their carcass conformation was markedly more gracile, and there is no evidence that this was the case. In an attempt to quantify 'average size of bone' for metacarpal samples, O'Connor (1982b, 235–7) standardised the means of each of eight variates, then took the sum of the standardised means for the sample. Performing this calculation for specimens from Anglo-Scandinavian Coppergate gave a result of 163·5. This figure is close to the figures of 161 and 167 obtained respectively for Welsh Mountain and Finnish Landrace Cross wethers samples. For comparison, primitive Soay and Orkney breeds (rams and ewes) gave results around 150, whilst a modern Southdown/Kent Cross wethers sample gave 179. These figures show the Anglo-Scandinavian sheep to have been considerably larger than the most primitive extant breeds although well short of the size attained by modern commercial breeds. Values in the range 160–5 were also obtained for Saxon and early medieval samples (i.e. 9th to 12th century) from Winchester and Lincoln.

As a further test of Reitz and Cordier's allometric method (Reitz and Cordier 1983), the mean lateral length of the astragalus (25·53mm) was converted to give a liveweight of 33·2kg. This is evidently rather a low figure. A reconstruction of shoulder height based on the mean length of the metacarpal (von den Driesch and Boessneck 1974) gave a height of 0·59m. Performing the same calculation using the greatest and least recorded lengths of metacarpals gave a range of 0·54–0·65m. Such shoulder heights would be inconsistent with a body weight as low as 33kg.

A third estimate of body weight was made using a regression equation derived from radii of modern ewes and wethers of known liveweight (O'Connor 1984a, 15). The distal breadth measurements of 30 radii from Anglo-Scandinavian levels at Coppergate were substituted into this equation (weight in kg = 1·79 × distal breadth in mm − 13·3), and gave a mean estimated liveweight of 37·5kg (standard deviation 2·37). Taking all three estimates together, a typical adult liveweight of about 35–40kg is indicated.

Table 49 Summary of measurements of sheep metacarpals

Variates
1 Maximum length
2 Proximal medio-lateral breadth
3 Proximal antero-posterior depth
4 Distal bicondylar medio-lateral breadth
5 Antero-posterior depth of distal medial verticillus
6 Antero-posterior depth of lateral component of distal medial condyle
7 Minimum medio-lateral shaft breadth
8 Antero-posterior shaft depth at same point as variate 7

Variate	Mean	S.D.	n	S.E.	·95 C.I.
1	120·17	6·84	58	0·90	118·4–121·9
2	22·05	1·16	53	0·16	21·7–22·4
3	16·24	0·93	52	0·13	16·0–16·5
4	24·84	1·28	54	0·17	24·5–25·2
5	15·75	0·74	50	0·10	15·5–15·9
6	10·64	0·51	55	0·07	10·5–10·8
7	13·75	0·94	56	0·13	13·5–14·0
8	11·04	0·81	52	0·11	10·8–11·3

Anglo-Scandinavian deposits produced a total of 67 measurable sheep horncores. These were examined to see if the division into two size groups observed in sheep of the same period from Lincoln (O'Connor 1982a, 29–30) could be observed. A scattergram of the maximum and minimum basal diameters (Fig.29) shows a very wide size range and remarkably high correlation ($r = 0{\cdot}94$, $p < 0{\cdot}001$), but no clear separation into large and small cores. Examination of the correlation between other pairs of variables showed all to be closely correlated ($r > 0{\cdot}90$ in every comparison), suggesting that overall size was the main parameter of variation, with little variation in shape, at least in terms of cross-sectional

Table 50 Summary of metrical data obtained from sheep horncores

	Mean	S.D.	n	S.E.	·95 C.I.
Basal circumference	121·6	21·1	63	2·66	120·9–122·3
Max. basal diameter	43·3	7·5	66	0·93	43·1–43·5
Min. basal diameter	30·1	6·3	65	0·79	28·6–31·6
Length	164·7	63·5	18	14·97	135·4–194·0

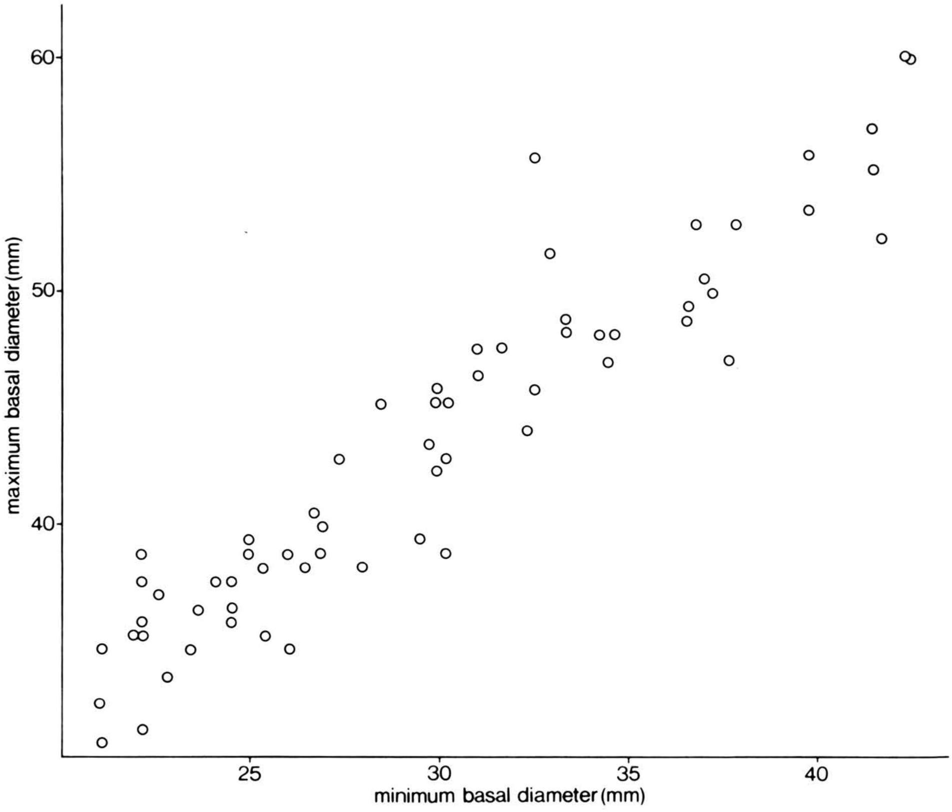


Fig.29 Scattergram of maximum and minimum basal diameters of sheep horncores

shape or proportional length. The failure to distinguish two size-groups, whether these are to be interpreted as sexual dimorphism or not, may reflect a greater variability in size and build in the York sheep than in those from Lincoln, with male/female differences being swamped by variation resulting from other factors. The metrical data obtained from sheep horncores are summarised in Table 50.

As with the cattle, so there are other sources of evidence for the outward appearance of these sheep. Walton (*AY* 17/5) describes fleece types reconstructed from wool and textile samples. The results of these analyses show quite a diversity of fleece types, with hairy and hairy medium fleeces being particularly common. Again there is the problem that the sheep represented by textile remains, in particular, may not be the same population as was sampled by the bone debris. However, the carcass weight and shoulder height estimates given here can probably be clothed in hairy to hairy medium wool, mostly white, and equipped with horns in both sexes to give a believable impression of the Anglo-Scandinavian sheep of Yorkshire.

Pigs

Pig bones were rather less frequent than those of sheep, though pigs probably supplied a greater proportion of the town's meat than did sheep. The relative abundance of pig bones was higher for Periods 5A and 5B than for Periods 3 and 4, indicating increased disposal of pig bones around the tenements compared with those of cattle and sheep, and thus a possible relative increase in the consumption of pork and bacon. The overall percentage of pig bones in Anglo-Scandinavian deposits at Coppergate is similar to that seen at other English sites (Table 40), though well below the proportion recovered at Hedeby (Haithabu) and Mecklenburg.

Carcass distribution and butchery

Little direct evidence of butchery was observed on pig bones, and the same conclusions can probably be drawn as were reached for sheep. The majority of vertebral centra were recovered intact. A minority of carcasses had been butchered by chopping through the hip, knees, shoulder and elbow joints, but the majority of specimens bore no marks of butchery or only a few indiscriminate knife cuts. Four skulls showed a possible means of slaughter, two each from Periods 3 and 5. Each bore a round hole in the frontal bone situated between the eyes, just anterior to bregma. The diameters of the holes were 25mm, 28mm and two of 30mm. These holes would seem to indicate a slaughter procedure similar to that which produced 50mm diameter holes in two cattle skulls referred to above (p.154). A tool suitable for this purpose has yet to be identified among the iron artefacts from this site (P. Ottaway, pers. comm.; also *AY* 17/6, in prep.).

The relative proportions of different pig carcass components varied considerably (Table 42). As with cattle and sheep, vertebrae were consistently under-represented, although a relatively high count for pig vertebrae was noted in Groups 6 and 29. Skull bones were the most consistently abundant, and it is quite likely that this was because the relatively robust jaws have been preserved and recovered preferentially rather than the more friable (because immature) bones of the post-cranial skeleton. The acetabulum and scapular articulation are also quite robust, and these too were well represented, quite apart from the numerous fragments of scapula blade which are not counted in Table 42. Perhaps the most striking feature of Table 42 is the high abundance of pig metapodials in some Period 5B groups, especially Groups 3 and 6, as discussed above. Evidently late 10th to early 11th century activity on the site included some butchery or distribution procedure which resulted in the accumulation of pig metapodials. Whatever this procedure, it was most marked in its effects in floor (Group 3) and backfill (Group 6) deposits in Structure 5/3, and much less so in the building immediately behind it in Tenement B, Structure 5/4. The sample from floors in Structure 5/4 (Group 4) shows a distribution of pig bones quite unlike other samples, with low counts for head and metapodial bones and high counts for leg bones and limb girdles. The pig bones in Structure 5/4 floors appear to have derived from the main meat-bearing elements of the carcass, whereas the bones in Structure 5/3 have more the character of primary butchery debris. Although the Period 5B floor levels in

Structure 5/4 contained a fairly high proportion of pig metapodials, the highest concentration was in the overlying backfill. These results cannot be interpreted as a simple difference in use between two neighbouring structures, therefore, as the contrast is really between use-phase deposits in one and post-use deposits in the other. What can be adduced is evidence that pigs were being slaughtered and butchered in or near Tenement B during Period 5B.

Age at death

Table 51 cross-tabulates attrition on lower first and second molars, and Table 45 lists the attribution of pig mandibles to age classes. Both tables show that a higher proportion of young pigs was killed than was generally the case for cattle or sheep. Nearly one quarter of the cases in Table 51 represent pigs slaughtered between the time of eruption of the first

Table 51 Cross-tabulation of numerical tooth-wear stages attained by lower first and second molars of pig mandibles from all Anglo-Scandinavian deposits

	lower first molar														
lower second molar	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	1	2	1	3	–	–	–	–	–	–	–	–	–	–
3	–	–	–	1	1	1	–	–	–	–	–	–	–	–	–
4	–	–	–	3	2	1	1	–	–	–	–	–	–	–	–
5	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
6	–	–	–	1	6	3	2	4	1	1	–	–	–	–	–
7	–	–	–	–	–	3	4	3	4	2	1	–	–	–	–
8	–	–	–	–	–	–	1	6	3	2	5	–	–	–	–
9	–	–	–	–	–	1	2	2	6	1	3	–	–	1	–
10	–	–	–	–	–	–	1	1	1	1	–	–	–	2	–
11	–	–	–	–	–	–	–	–	–	1	2	1	–	1	–
12	–	–	–	–	–	–	–	–	–	–	2	2	2	2	–
13	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–
14	–	–	–	–	–	–	–	–	–	–	2	–	1	1	1
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

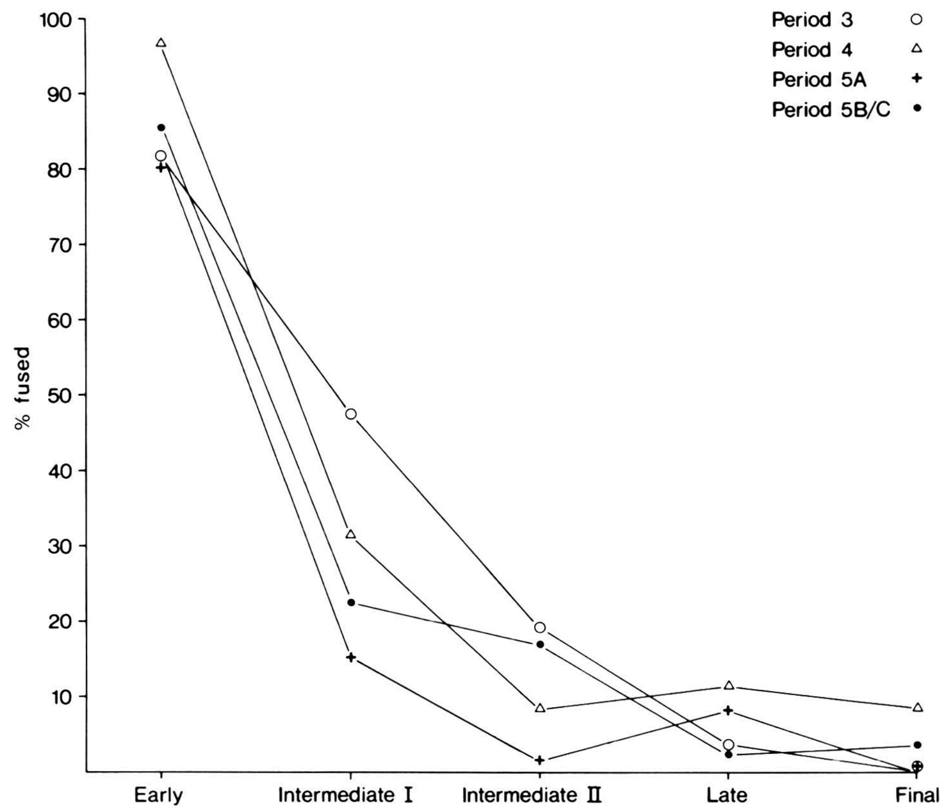


Fig.30 *Epiphysial fusion in pig bones. Graphs show the proportion of epiphyses fused or fusing in each of five age categories*

Early: distal humerus, proximal radius
Intermediate I: distal metacarpal, distal tibia
Intermediate II: distal metatarsal, tuber calcis
Late: proximal humerus, distal radius, olecranon tuberosity, proximal and distal femur, proximal tibia
Final: vertebrae

molar and the coming into wear of the second molar; that is, between six to twelve months and eighteen to 24 months. The remaining three quarters are mainly concentrated into the time represented by the early stages of wear of the second molar, about two to three years of age. Thus most pigs were slaughtered between about nine months and three years of age, a result entirely consistent with slaughtering for prime pork carcasses, given that these would have been fairly slow-maturing pigs. The epiphysial fusion data (Fig.30) give results consistent with the dentition, and the concentration on one to three year old pigs would seem to have been the same in all periods.

Although perinatal pigs were not represented in the hand-collected groups in Table 45, a number of specimens of perinatal and foetal pig bones were recovered from bulk-sieved soil samples from Anglo-Scandinavian levels. The presence of such immature piglets strongly suggests that at least some pig breeding was taking place at the site or very near by. This possibility is further discussed below (p.183).

Lauwerier (1983) raised the possibility of identifying seasonal culling in pigs from a detailed examination of age at death, assuming a spring farrowing. Table 51 indicates that the beginning of the 'preferred slaughter age' coincided with the eruption and coming into wear of the lower first molar. Silver (1969) times this event at about four to six months in modern pigs, and quotes twelve months for 18th century sources. Notwithstanding the latter figure, Bull and Payne (1982, 56) quote a variety of sources for eruption times in wild and domestic pigs which centre around six months for the lower first molar. If six months is accepted as the beginning of the slaughter period, and if a spring farrowing is assumed, then the youngest pigs slaughtered were those just coming to their first autumn. There is, however, no evidence for a routine autumn culling of second or third year pigs.

Sex ratios

The pronounced sexual dimorphism in the canine teeth of pigs allowed an examination of whether either sex was particularly selected for slaughter in any one age group. Theory would predict the keeping of more adult females than males, immature males mostly being slaughtered for meat whilst some mature sows would be kept for breeding. However, of adult mandibles to which sex could be attributed, 22 were male and eighteen female. Among two to three year old mandibles, the ratio was 23 males to 20 females. The results showed that males and females were about equally likely to be slaughtered at any age, and that roughly equal numbers of males and females were slaughtered overall. A wider examination of the spatial distribution of pig mandibles subdivided by age and sex showed some disparity in the occurrence of males and females, notably a concentration of adult females in deposits at the riverward end of the site, furthest from the built-up Coppergate street frontage. This observation was based on small numbers of mandibles, however, and can not be seen as significant in terms of human activity on the site.

Disease and injury

Few specimens of pathological interest were noted among the pig bones. Only one case of crowding and rotation of the teeth was found. Such rotation is usually attributable to stunted development of the maxilla, which may be a symptom of malnutrition (McCance et al. 1961), or may be a consequence of selective breeding, as in modern pigs. That only one case was noted suggests that neither causal factor was a feature of pig husbandry during the period represented. Two cases were found of an infection involving the skeleton. One was a superficial ulceration of a metapodial shaft, possibly as the result of a penetrating wound, whilst the other involved the medullary cavity of an ulna. Generally, the low incidence of disease and injury among the pig bones matches the results from cattle and sheep bones.

Biometry

The mainly immature and fragmentary nature of the pig bones has effectively precluded detailed biometrical analysis. However, by using the regression factors obtained for wild and domestic pigs by Teichert (1969), it has been possible to make some reconstruction of body size. From all Anglo-Scandinavian deposits, thirteen astragali and four calcanea gave a mean reconstructed shoulder height of 0·69m, with a range from 0·64 to 0·76m. Considering the reconstructed heights individually, there was some hint of bimodality, with seven cases between 0·64 and 0·67m, and the remaining ten all over 0·69m. The simple interpretation would be to suggest that the smaller individuals were females, and the larger ones males, probably both boars and barrows. Comparison with figures given by Teichert (1969) and Prummel (1983, 215–16) for other archaeological groups shows the pigs from Coppergate to have been much the same size as domestic pigs from elsewhere in medieval Europe. None of the wild pig bones recovered from Anglo-Scandinavian Coppergate could be used to give a comparable size estimate, but it was evident that the wild pigs were sufficiently larger than domestic pigs for there not to have been confusion in identification (Pl.Xb).

Town pigs or country pigs?

Of the larger domestic animals, pigs are particularly well suited to being fattened, or even bred, within towns, and the possibility that pigs were kept in the 'yard' areas at Coppergate deserves attention. In fact, any conclusions must depend as much on intuition as on hard evidence. Bones of foetal and perinatal pigs were recovered from Period 4 and 5 deposits in modest numbers, and this at least implies the presence within this part of the town of farrowing sows. One soil sample (from context 34397, a fill of a Period 4B pit) yielded a suite of nematode ova indicative of a degree of contamination with pig faeces. Otherwise, the argument proceeds on an informed assessment of likelihood. Pigs were commonly kept in towns in more recent times, and are not particularly demanding of space. Modern accounts of 'low-tech' pig farming vary in their recommendations, but sources such as Blake (1956, 58) and Trevisick (1978, 60–4) indicate that a farrowing sow and her litter can be housed in as little as five to ten square metres, and a similar area would be adequate for one or two young pigs being fattened for slaughter. Adult boars, however, are another matter, and it seems a reasonable conclusion that households occasionally obtained a sow in pig from rural communities which ran breeding herds of pigs on uncultivated land. For farrowing or fattening, the areas behind the Coppergate houses would have been amply spacious, with post and wattle fencing and hurdling being ideal for the construction of temporary pens as and where necessary.

Other mammals

The scarcity of bones of other mammal species has already been commented on. The frequency of horse bones was highest in Period 3 and 4 groups. The bones were nearly all those of adult horses of small stature. Two complete metacarpals from Period 3 deposits indicate a shoulder height of about 1·4m (nearly 14 hands), and there were no specimens of particularly large or small horses. Horse bones appear to have been butchered and disposed of in much the same way as cattle bones. Many specimens bore marks of butchery, including humeri and radii which had been split in half axially. Although horse bones were distributed generally throughout the site, a survey of the occurrence of species in over 500 small context groups has shown a concentration of horse at the riverward end of the site, furthest from the street frontage. The relative frequency of horse in this area was 0·35, compared with 0·08 for the rest of the site (Scott 1984). The evidence clearly indicates that horse formed an occasional minor part of the diet and that the bones became part of the general urban refuse. That being so, it is possible that the scarcity of horse bones genuinely reflects the status of the species in Anglo-Scandinavian York, an occasional means of draught traction as an alternative to the more commonly-used cattle, as well as a means of individual transport, as indicated by spurs and harness-fittings recovered from contemporaneous levels (*AY* 17/6 in prep.).

Goat bones were uncommon. Though there are problems in distinguishing goat bones from those of sheep (discussed by Boessneck 1969; Spahn 1978; amongst others), it is fair to say that reliable non-metrical criteria for the separation of the two species can be found on most parts of the skeleton, and that in British post-Roman assemblages, at least, the greater robusticity of goat bones makes their identification at least possible, if not straightforward. The fact that over one-third of the goat bones from this site were horncores need not indicate that goat post-cranial elements were misidentified. Accumulations of goat horncores, apparently as waste from the collection of horn, have been noted on a number of medieval sites in York (p.20, *AY* 15/1; pp.81,118, *AY* 15/2), and careful examination of easily identified caprine elements, such as the metapodials, has shown that these accumulations genuinely represented selective collection of goat horncores, not merely a failure to recognise goat post-cranial elements. Most parts of the goat skeleton are represented amongst the goat bones identified from 16–22 Coppergate, and it is thought that few, if any, goat specimens have been misidentified as sheep, or vice versa. It seems that small numbers of goats were kept in the York area for dairying and that they formed a minor part of the diet, much as did horses.

A total of 32 measurable adult goat horncores were recovered, and the metrical data obtained from them are summarised in Table 52. Other goat horncore samples from York have shown a clear separation of presumed males (large) from presumed females (small),

Table 52 Summary of metrical data obtained from goat horncores

	Mean	S.D.	n	S.E.	·95 C.I.
Basal circumference	128·0	30·2	29	5·60	117·0–139·0
Max. basal diameter	147·2	12·5	30	2·28	42·7–51·7
Min. basal diameter	31·1	6·2	29	1·53	28·1–34·1
Length	229·5	53·7	19	12·32	205·4–253·6

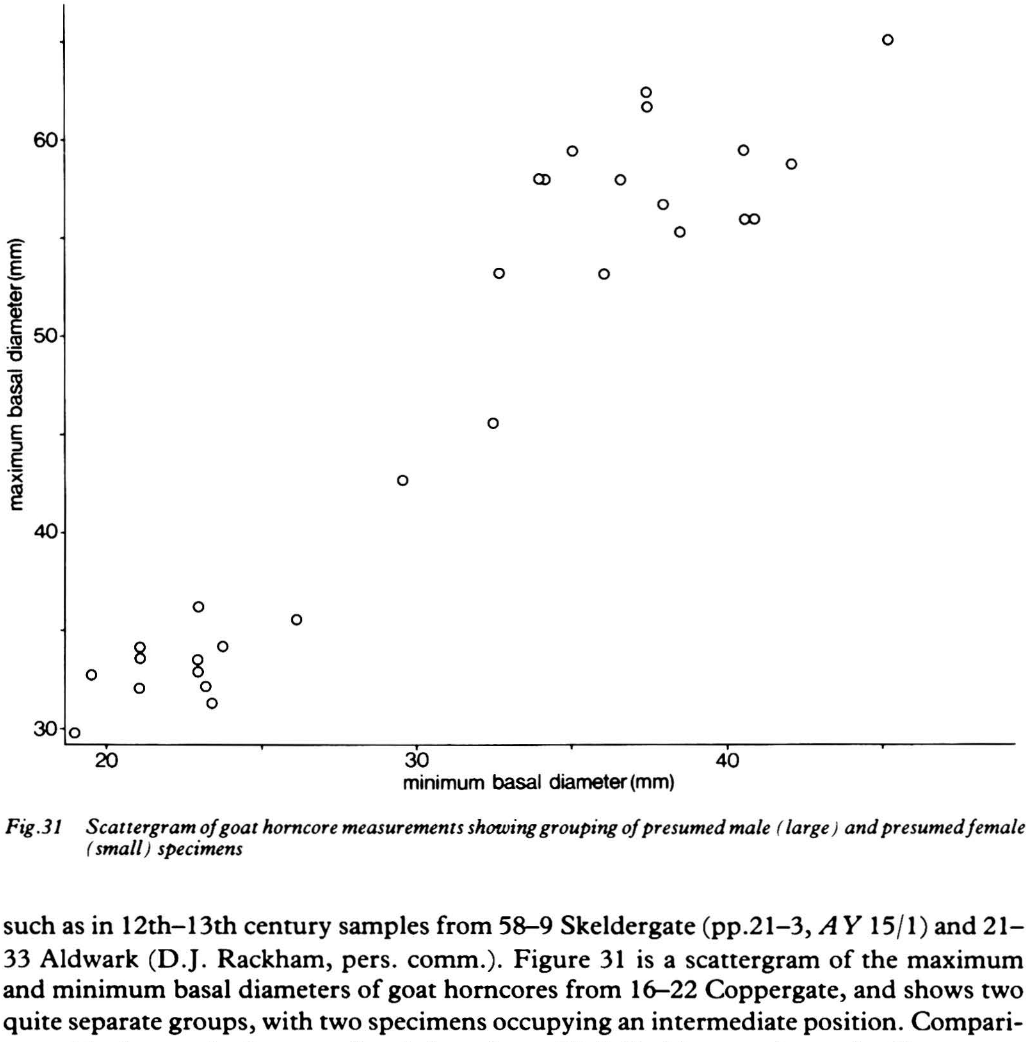


Fig.31 Scattergram of goat horncore measurements showing grouping of presumed male (large) and presumed female (small) specimens

such as in 12th–13th century samples from 58–9 Skeldergate (pp.21–3, *AY* 15/1) and 21–33 Aldwark (D.J. Rackham, pers. comm.). Figure 31 is a scattergram of the maximum and minimum basal diameters of goat horncores from 16–22 Coppergate, and shows two quite separate groups, with two specimens occupying an intermediate position. Comparison with the results from medieval deposits at 58–9 Skeldergate shows the Coppergate 'males' to be larger on average than the Skeldergate 'males', with the two intermediate specimens in Fig.31 falling into the lower part of the range of 'male' horncores from Skeldergate. Counting these two specimens as male gives a ratio of seventeen males to twelve females in Fig.31.

Deer were represented by numerous pieces of worked red deer antler, and a few bones each of red deer and roe deer. The worked antler fragments were waste from the manufacture of artefacts, probably mostly combs of which many examples were recovered from the site (*AY* 17, in prep.; O'Connor 1984b). It is clear from the assemblages at 16–22 Coppergate that red deer was far more important as a source of antler than as potential meat. Some of the antler bases had skull bone attached, but the majority were collected as shed antlers during the winter months. Such a lack of exploitation for meat suggests that the supply of meat from domestic species was both adequate and reliable. Worked antler fragments were not evenly distributed throughout Anglo-Scandinavian deposits, a point which is discussed in more detail below (p.191, Table 54).

Cat bones were present in many samples, but were never abundant. Only one specimen, a very robust humerus shaft, was attributable to wild cat. The remaining specimens were all of rather small domestic cats, with a high proportion of immature individuals. Cats were probably tolerated but not tended to any extent, hence the high mortality of young ones. Evidence from other bone assemblages from Coppergate suggests that cat skins were routinely collected. Bones from soil samples dated to Periods 4 and 5 included groups of cat phalanges, apparently divorced from the rest of the cat, and deposits not otherwise included in this analysis have yielded four specimens of cat skulls with repeated parallel knife cuts immediately above and between the eyes, which would seem to indicate that the cats had been skinned.

A survey of the bones recovered from Anglo-Scandinavian deposits not otherwise included in this analysis (Scott 1984) showed an intriguing disparity in the distribution of cat bones, which were much more frequent in Period 4 and 5 deposits within Tenements A and B than in the other tenements. The cat bones were not sufficiently concentrated for this distribution to be explained in terms of the systematic collection of cat skins in one of the tenements. If live cats, and thus by association their bones, were creatures of the hearth and home, this observation may only indicate a greater use of Tenements A and B for domestic occupation. The evidence is far from categorical, however, and this disparity in distribution is hard to explain.

Dog bones were generally more abundant than cat bones, although this may in part be an artefact of recovery. A considerable size range was represented, from animals rather smaller than a fox to very large dogs which were certainly big enough to be wolf, but which cannot with certainty be ascribed to that species (Pl.VIIIa and b). The large specimens concerned were two metapodials and a damaged radius. Despite a search of the literature and examination of specimens in the British Museum (Natural History), it was not possible to reach a firm identification of these specimens. Since there was no other evidence for the presence of wolf, the large specimens were presumed to have been large dogs. Intact limb bones were few, but four specimens could be used to reconstruct shoulder height using the regression equations published by Harcourt (1974). These four specimens gave reconstructed shoulder heights of 0·52m, 0·56m, 0·59m and 0·70m. Examination of the dog bones as a whole showed the majority to belong to dogs of 'collie-size' or a little larger. These would have stood about 0·5–0·6m at the shoulder. The remaining specimens were divided between small, 'terrier-size' dogs, and the few very large bones referred to above. One of the latter group, a third metacarpal, was 87·4mm in length. For comparison, other third metacarpals measured 49·0mm, 52·2mm and 48·1mm. A third metatarsal of 97·8mm contrasts similarly with others of 73·7mm and 68·4mm. The possibility of wolf being present in these assemblages cannot be ruled out, but, lacking a complete skull or mandible, this cannot be proven. It seems highly probable that wolves were present in the York area during the Anglo-Scandinavian period, but the obvious problems of identification make it difficult to prove this point.

The dog bones were mainly those of adults, with few indications of disease or injury. This would indicate a well-tended existence, reflecting a valued role in the community. The large dogs could be seen as hunting dogs, although in view of the scarcity of bones from game species, one wonders what they were hunting. Given the close proximity in which the people of Anglo-Scandinavian Coppergate were living, dogs may also have fulfilled a role as guard dogs and defenders of territory.

Other mammals were poorly represented. Brown hare was noted in several groups, but was evidently only a minor element in the diet, taken for food when opportunity arose but not hunted systematically. Fox was represented by a single canine tooth, and would appear not to have been a regular scavenger around the site. Two groups yielded third phalanges of brown bear (Pl.XIa), and more bear third phalanges have been recovered from soil samples. The status of bear in northern England during the Anglo-Scandinavian period is not known with any certainty (Corbet 1974). Small number of bears may still have been found in the area, depending on the degree of woodland clearance effected during the Roman period. The phalanges, found in the absence of any other bear bones, are most likely to have arrived on the site attached to imported bear skins. Whether the skins were imported from elsewhere in Britain, or from Scandinavia or somewhere else in Europe, cannot be determined. An otter (*Lutra lutra* L.) humerus from a Period 3 deposit (Pl.XIb) constitutes the only archaeological record to date from York of a species which must have been more common in the Anglo-Scandinavian period than at present, and which may also have been valued for its fur.

To underline the poor representation of wild mammals compared with the domestic species, a survey of the occurrence of species in 520 mostly small context groups (Scott 1984) showed cattle to be present in 97·5% of the contexts examined, and hare in only 2·9%. Even if allowance is made for recovery bias favouring the relatively large bones of cattle, this result still shows one of the commonest of the wild mammals to have been relatively very scarce.

Mammal and amphibian bones from soil samples

Archaeological deposits at 16–22 Coppergate, most especially those relating to the Anglo-Scandinavian period, were extensively sampled so as to allow recovery of plant and animal fossils not recoverable by collection during excavation. Invertebrate and plant fossils will be described and discussed in *AY* 14, and fish bones from soil samples are described in more detail below (p.195). Some identifiable bird bones were recovered from soil samples, and these have been included in a detailed study of bird bones from seven sites in York (Allison 1985; see also below p.193). However, the great majority of bird bones recovered by sieving comprised fragmented bones attributable to domestic fowl, and these bones added very little to the information gained from hand-collected bird bones. Accordingly, this section of the report is concerned with the bones of amphibians and the smaller mammals recovered from soil samples, and with their interpretation in terms of past environmental conditions and depositional history.

Samples of unsorted sediment were processed by wet-sieving, following procedures described by Kenward et al. (1980) and Jones (1983). Samples comprised 20–100kg of sediment, and were wet-sieved on a mesh of 1mm aperture. The residue was air-dried, then dry-sieved to 2mm aperture. The 1–2mm fraction was retained as a check on recovery but not usually sorted, whilst the 2+mm fraction was sorted by eye for all categories of biological and 'cultural' finds. Small mammal bones were identified with the aid of a binocular microscope, and by reference to collections held at the Environmental Archaeology Unit, University of York, and to Corbet and Southern (1977) and Gaffrey (1953). To allow comparisons of bone concentration between periods, the mammal and amphibian bone greater than 2mm recovered from each sample was weighed, as was the fraction which could be identified.

Table 53 summarises the main statistics of soil sieved and bone recovered, subdividing the results by period. In all, 234 samples of Anglo-Scandinavian date yielded identifiable bone, and it is this total, or the subtotal for the appropriate period, which is used as the basis for calculations of average weights and concentrations. Periods 3 (59 samples) and 4B (83 samples) were best represented, though even Periods 4A (10) and 5Cr (15) produced enough samples to be included in this comparison. Only Period 5Cf (2 samples) and a single sample phased as Period 4/5 have had to be excluded from Table 53.

The total of 234 samples represents a little less than 10% of all numbered soil samples from the Coppergate site, the remaining 90% comprising samples processed for purposes

Table 53 Main statistics quantifying the amount of sediment sieved and numbers of mammal and amphibian taxa recovered. All weights are in kilograms. Note that a total of three samples attributed to Periods 4/5 and 5Cf have been omitted from this analysis

Ns—Number of samples yielding identifiable bone
Ws—Weight of soil sieved
Ws/Ns—Average weight per sample
Wb—Weight of bone recovered
Wb/Ns—Average weight of bone per sample
Wi—Weight of bone identified
Wi/Ns—Average weight of bone identified per sample
Nt—Total of mammal + amphibian taxa identified
T/S—Average number of taxa per sample

Period	Ns	Ws	Ws/Ns	Wb	Wb/Ns	Wi	Wi/Ns	Nt	T/S
5Cr	15	584	38·9	3·55	0·24	1·58	0·11	10	4·10
5B	41	2277	55·5	11·09	0·27	6·50	0·16	15	4·02
5A	23	1067	46·4	5·53	0·24	2·42	0·11	10	3·74
4B	83	3646	43·9	20·55	0·25	11·21	0·14	14	3·46
4A	10	464	46·4	3·55	0·36	1·81	0·18	7	3·40
3	59	2780	47·1	24·62	0·42	12·31	0·21	19	4·46

other than the recovery of small bones, or which yielded no identifiable mammal or amphibian bones, or which were not of definite Anglo-Scandinavian date. In all, mammal or amphibian bones were recorded from 375 'bulk' samples, of which 234 were phased as definitely of Anglo-Scandinavian date.

The method of quantification which will be used in comparisons of the occurrence of different species within periods is an analysis of frequency; that is, noting the proportion of the samples examined in which the taxon occurred. For comparisons to be valid, several criteria have to be satisfied, though the heterogeneity of archaeological deposits and the non-random selection of sampling points in the first place would invalidate any attempt to be truly rigorous at this stage in the analysis. The main concern is that average sample size should not vary greatly between periods. If, for example, Period 5B samples were on average twice the size of Period 3 samples, then 5B samples as a whole might be expected to show a greater overall species diversity than those from Period 3. Table 53 shows the average weight of samples to have been much the same in all periods, the small differences in average sample weights scarcely being enough to have caused major discrepancies in species frequency. The average weight of bone identified varied from period to period, being rather higher in Period 3 than in later samples. However, the weight of identified bone as recorded in Table 53 is essentially the weight of cattle, sheep and pig bone fragments, whereas the examination of species occurrence is largely concerned with the smaller vertebrates. Thus the greater average weight of identified bone in Period 3 samples may not reflect any change in the overall incidence of the smaller vertebrates.

Bearing all of this in mind, the frequency of mammal and amphibian taxa is listed in Table 54. Apart from cattle, sheep and pig bone fragments, frog was the most common taxon, being present in about one-third of all samples. Given the proximity of the River Foss, and evidence (*AY* 14, in prep.) for the existence of damp, marshy areas nearby, the regular appearance of frogs in all periods and all types of deposit is hardly a surprise. The accumulation of organic debris around the settlement probably attracted flies and other invertebrates in some quantity, and frogs would have been well fed. In contrast, toad was only present in three samples, all of them of Period 3 date. Human occupation of the site was less intensive in Period 3. Perhaps the laying-out of tenements and construction of buildings in Periods 4A and 4B changed, or at least disturbed, the environment sufficiently to discourage toads (Arnold and Burton 1978). In passing, it may be noted that toads were present in small numbers in post-Anglo-Scandinavian deposits at 16–22 Coppergate and 24–30 Tanner Row (pp.106–7, *AY* 15/2), in both cases associated with phases of refuse disposal on otherwise unoccupied land rather than with intensive occupation.

Turning to the small mammals, rats and house mice were evidently common throughout the Anglo-Scandinavian era, although the frequency of black rat is markedly higher in Period 3 and 5Cr samples than in the rest. This could tentatively be interpreted as showing that rats exploited the fringes of settlement rather than sharing buildings with their human occupants, as would the more markedly commensal house mouse (Brothwell 1981; Tchernov 1984). The relatively sparse occupation in Period 3 has already been commented on, and Period 5Cr deposits were located at the riverward end of the site, away from the

Table 54 The frequency of occurrence of mammal and amphibian taxa in sieved samples of Anglo-Scandinavian date

The total number of samples given is the total from which identifiable mammal or amphibian bones were recovered. The upper section of the table gives the number of samples in which each taxon was recorded, subdivided by period. The lower section gives the relative frequency of selected taxa, using the total of samples in which identifiable mammal or amphibian bones were recorded (234) as the basis for calculation. Note the concentration of rats in samples of Periods 3 and 5Cr, and the scarcity of red deer in Periods 5B–C

Period		3	4A	4B	4/5	5A	5B	5Cf	5Cr
Total number of samples		59	10	83	1	23	41	2	15
Common shrew	*Sorex araneus* L.	5	–	–	–	–	2	–	–
Water shrew	*Neomys fodiens* (Pennant)	2	–	–	–	–	–	–	–
Rabbit	*Oryctolagus cuniculus* (L.)	–	–	–	–	–	1	–	–
Hare	*Lepus* c.f. *europaeus* Pallas	2	–	–	–	1	–	–	–
Red squirrel	*Sciurus vulgaris* L.	–	–	–	–	–	2	–	1
Bank vole	*Clethrionomys glareolus* (Schreb.)	1	–	–	–	–	–	–	–
Field vole	*Microtus agrestis* (L.)	3	–	–	–	–	1	–	1
Water vole	*Arvicola terrestris* (L.)	2	–	–	–	–	–	1	–
Wood mouse	*Apodemus* sp(p).	4	–	1	–	2	–	–	–
House mouse	*Mus* sp.	17	2	18	1	7	14	2	3
Black rat	*Rattus rattus* (L.)	11	–	3	–	–	1	1	3
Dog	*Canis* sp. domestic	3	2	4	1	2	2	1	1
Fox	*Vulpes vulpes* (L.)	–	–	1	–	–	–	–	–
Brown bear	*Ursus arctos* L.	–	–	1	–	–	–	–	–
Polecat	*Mustela putorius* L.	–	–	1	–	–	–	–	–
Cat	*Felis* sp. domestic	11	–	13	–	3	9	–	5
Horse	*Equus* sp. domestic	4	1	2	–	–	2	1	–
Pig	*Sus* sp. domestic	49	9	70	1	20	39	2	12
Red deer	*Cervus elaphus* L.	5	–	8	–	1	1	–	–
Roe deer	*Capreolus capreolus* (L.)	1	–	–	–	–	–	–	–
Cattle	*Bos* sp. domestic	55	10	75	1	22	35	1	14
Goat	*Capra* sp. domestic	–	–	–	–	–	1	–	–
Sheep	*Ovis* sp. domestic	57	10	73	1	21	39	2	14
Common toad	*Bufo bufo* L.	3	–	–	–	–	–	–	–
Common frog	*Rana temporaria* L.	28	2	18	1	7	18	1	7
Relative frequency									
Common shrew		0·08		–		–	0·05		–
Wood mouse + voles		0·17		0·01		0·09	0·02		0·07
House mouse		0·29		0·22		0·30	0·34		0·20
Black rat		0·19		0·04		–	0·02		0·20
Dog		0·05		0·05		0·09	0·05		0·07
Cat		0·19		0·16		0·13	0·22		0·33
Red deer (= antler fragments)		0·08		0·10		0·04	0·02		–
Common frog		0·47		0·22		0·30	0·44		0·47

built-up street frontage. Periods 4B and 5B encompass the phases of most intensive settlement, and rat bones were scarce in samples of these periods, even from the rear of the site, though house mouse bones were common. Of the three records of rat from Period 4B samples, one was from a floor deposit in the post and wattle building sequence on Tenement C, and another from an alleyway beside this building. The third was from a pit towards the rear of the site. These results perhaps show a difference in niche exploitation between these two commensal rodents, the house mouse infesting domestic buildings and workshops whilst the rats lived a little apart from the human inhabitants. Whether this was a behavioural adaptation on the part of the rats or intolerance on the part of the humans is a debatable point. Perhaps the distaste and intolerance was mutually felt.

Period 3 samples as a whole show a greater diversity of small mammal bones than do later samples. Shrews, voles and wood mice were more frequent in Period 3 samples, with seventeen records in 59 samples, compared with eight records in 175 samples for all other periods (chi-squared $= 27{\cdot}2$ at 1 degree of freedom; $p < 0{\cdot}001$). This probably reflects the relatively unintensive nature of human exploitation of the site during this period, which was also reflected in the distribution of toad bones.

This greater diversity in Period 3 samples is largely a consequence of the presence of a few samples which yielded many taxa, rather than a higher average diversity throughout Period 3 samples. The modal number of taxa in Period 3 samples lies between three and four, as it does in all the other sample groups. However, of the 59 Period 3 samples, seventeen (29%) yielded six or more mammal and amphibian taxa, compared with 5% in Period 4B, 4% in 5A, and 8% in 5B. Interestingly enough, Period 5A samples do not show any increase in diversity, even though this was a period during which the site appears to have been cleared and redeveloped. Although the site may have provided suitable habitats for shrews and voles during Period 5A, recolonisation seems not to have been successful. If Period 5A involved substantial dumping and reworking of earlier deposits, this would not be surprising.

Three records of red squirrel were all of foot bones, either metapodials or phalanges, suggesting the collection and working of squirrel pelts. There is a parallel from a 14th century pit at The Bedern, York (*AY* 15, in prep.), which contained hundreds of foot bones of red squirrel, mixed with food debris. The records of red deer are of an industrial nature as well. As in the hand-collected assemblages, this species was represented by fragments of antler, most of them clearly waste debitage from the working of antlers into artefacts. It is notable that antler fragments were quite frequent in Period 3 and 4B samples, but scarce in 5A, 5B and 5Cr. This would seem to indicate that antler working at the site more or less ceased when the post and wattle buildings of Period 4B were replaced by the sunken, plank-built structures of 5B. The few pieces of antler in Period 5A and 5B samples could be residual from Period 4B deposits.

Overall, the mammal and amphibian bones from soil samples have served two purposes. Small fragments of bones of large species such as red deer and sheep have supplemented the hand-collected assemblages, and the identifications of the smaller species will make a contribution to the reconstruction of living conditions around the site. A few questions remain for future study. Does the relatively high frequency of rats in Period 3 indicate continuity with Roman rat populations rather than re-introduction? Results to date show black rat to have been present in York since the late 2nd century (pp.105–7, *AY* 15/2; Rackham 1979), though there is a gap in the record for the 4th to early 9th centuries. Either rats persisted in the York area through the Anglian period, or were re-introduced by Scandinavian settlers in the late 9th century. In the latter case, it would be surprising to find rats quite so frequently in samples dated to the earliest period of Anglo-Scandinavian settlement, though resolution of this question will have to await examination of a substantial assemblage of sieved bones of Anglian date. Samples in hand from Anglian occupation at 46–54 Fishergate should complete the chronological sequence.

The status of common shrew in York since Roman times is quietly intriguing. The species was present in two samples dated to Period 5B, when there was considerable human occupation of the site, and has also been recorded in association with timber buildings and intensive human activity in 2nd–3rd century deposits at 24–30 Tanner Row (pp.106–7, *AY* 15/2). Perhaps common shrews found suitable habitats and food around the city during the Anglo-Scandinavian period. The species feeds mainly on earthworms, beetles, and a range of other invertebrates (Rudge 1968), and will live successfully in almost any type of habitat provided that some low ground cover is available (Corbet and Southern 1977, 60). If refuse deposits in yards and alleyways provided suitable cover, it seems likely that ample invertebrate prey would have been available, and common shrew may well have lived in close proximity to the human population, much as did the house mouse.

The remaining question is a methodological one. Certainly the taking of large soil samples and recovery of bones from them has proved to be a worthwhile exercise, but identifying and recording these bones was extremely time-consuming. The numerous small, but identifiable, fragments of cattle, sheep and pig bones comprised much the majority of the data recorded, but this information has been of little value in the final analysis. The recording of bones from soil samples sieved on a 1mm mesh or smaller could be greatly expedited if specimens of bones of the major species were only quantified on a subjective scale of abundance (e.g. few, some, many), and recording concentrated on the bones of small-sized taxa not represented in the hand-collected assemblage or in samples sieved on a coarser mesh. Adopting such a procedure could allow more samples to be examined in the time available. 16–22 Coppergate was the first site in York to have been subjected to an intensive sieving programme, and to have streamlined procedures in this way for Coppergate would have been inappropriate. However, in the light of what has been learned from the sieving programmes at Coppergate and 24–30 Tanner Row (*AY* 15/2), perhaps in future the recording of bones from bulk samples should be targeted towards the smaller vertebrates. The question of optimising the recovery of taxon diversity by sample size selection is further discussed in O'Connor (1987b), and a case study based on results from the 1985–6 excavations at 46–54 Fishergate is given in O'Connor (1988).

Birds

Bird bones from the deposits at 16–22 Coppergate and elsewhere in York have been made the subject of a major study prepared as a doctoral thesis (Allison 1985). This section of the report is largely based on Allison's work, with additional records made by S. A. Scott and the author.

Comparisons of the abundance of taxa from different periods are complicated by two factors. First, recovery by hand will have biased the results to some extent against the smaller species, and, second, the numbers of bird bones recovered from Period 5B was much greater than from Periods 3 to 5A (because more bones of all classes were recorded from 5B deposits), thus inflating the number of taxa represented and the apparent diversity. With these caveats borne in mind, Table 55 lists the taxa present and gives the number of fragments of each recovered from the main periods of occupation. The abundance of fowl and goose (*sensu Anser anser* L. f. domestic) bones is remarkably consistent, and the main difference between periods is the much larger number of taxa recovered from deposits of Period 5B. Even allowing for the greater quantity of bird bones recovered from this period, it would probably be correct to conclude that the late 10th–early 11th century saw an increase in the diversity of birds being brought on to the site, probably mostly for food.

Fowl obviously outnumbered geese at all periods, although their respective meat yields were probably about the same, allowing that one goose will give at least as much meat as three fowls. The abundance of comminuted egg-shell and fragments of egg-shell membrane recovered from soil samples indicates that eggs were an important product, and a minority of this shell is clearly derived from goose eggs. Of the wild species, wild geese were evidently routinely taken, in particular barnacle goose. Golden plover bones were frequent in groups from Periods 4 and 5A, but less so in Period 5B, a difference which might reflect a change in exploitation. Overall, the species show a concentration on wetland areas, with some woodland birds (wood pigeon, woodcock), moorland species (golden plover, black grouse) and two cliff-nesting coastal birds (guillemot, razorbill). These last two species would only have been available during the summer, at a distance of some 50km (30 miles) from York.

Guillemot and razorbill bones have also been recovered from post-Anglo-Scandinavian deposits at Coppergate (O'Connor 1986), from 12th–13th century deposits at Tanner Row (pp.100–1, *AY* 15/2), and from 11th–13th century deposits at the Lurk Lane and Eastgate sites in Beverley (S.A. Scott, pers. comm.). The two Period 5B/C specimens from Coppergate constitute the only pre-Conquest specimens from York or Beverley to date. All other records are clearly post-Conquest, and none is definitely later than early 13th century in date. The auks are always in association with assemblages interpretable as food debris. Thus we have a fairly short-lived exploitation of these two species, apparently for food. Why did this exploitation cease? Both auks are common today on the Yorkshire coast, and it seems highly unlikely that both species suddenly died out. It is possible, therefore, that the exploitation of auks ceased because of a change in tastes precipitating a change in the demands generated by the urban market.

Table 55 Numbers of hand-collected fragments attributed to bird taxa. Specimens from the 33 phased groups are allocated to period, and additional taxa recovered from other Anglo-Scandinavian deposits are listed separately

Note that identifications made only to family or order are not included in this table, and the totals for each period are thus less than the total counts of bird bones given in Tables 39 and 40

	Period	3	4A	4B	5A	5B	5C
Mute swan	*Cygnus olor* (Gmelin)	–	–	–	–	1	–
Goose sp(p).	*Anser/Branta* sp(p).	–	–	–	5	17	2
Pink-footed goose	*Anser brachyrhynchus* (Baillon)	–	–	–	1	1	–
White-fronted goose	*A. albifrons* (Scopoli)	–	–	8	–	–	1
Domestic/greylag goose	*A. anser* L.	13	25	48	42	220	15
Barnacle goose	*Branta leucopsis* (Bechstein)	–	–	2	6	13	7
Brent goose	*B. bernicla* (L.)	–	2	–	–	3	–
Duck sp(p).	*Anas/Aythya* sp(p).	–	–	–	–	1	–
Mallard	*Anas platyrhynchos* L.	1	–	–	4	8	–
White-tailed eagle	*Haliaeetus albicilla* (L.)	–	–	–	–	–	1
Goshawk	*Accipiter gentilis* (L.)	–	–	–	1	–	–
Black grouse	*Lyrurus tetrix* (L.)	–	–	–	5	4	–
Domestic fowl	*Gallus* sp. domestic	40	67	240	140	730	50
Crane	*Grus grus* (L.)	–	–	–	–	6	–
Plover	*Pluvialis* sp(p).	–	–	–	–	3	–
Golden plover	*P. apricaria* (L.)	–	–	13	9	6	–
Grey plover	*P. squatarola* (L.)	–	–	–	–	3	–
Woodcock	*Scolopax rusticola* L.	–	–	–	–	1	–
Guillemot	*Uria aalge* (Pontoppidan)	–	–	–	–	1	–
Razorbill	*Alca torda* L.	–	–	–	–	–	1
Dove sp(p).	*Columba* sp(p).	–	–	–	–	6	–
Wood pigeon	*C. palumbus* L.	4	1	–	3	3	–
Jackdaw	*Corvus monedula* L.	–	–	–	2	–	–
Raven	*C. corax* L.	1	1	–	1	5	–
Further species recovered from other Anglo-Scandinavian deposits							
Whooper swan	*Cygnus cygnus* L.						
Teal	*Anas crecca* L.						
Tufted duck	*Aythya fuligula* (L.)						
Red kite	*Milvus milvus* (L.)						
Buzzard	*Buteo buteo* (L.)						
Sparrowhawk	*Accipiter nisus* (L.)						
Coot	*Fulica atra* L.						
Short-eared owl	*Asio flammeus* (Pontoppidan)						

Of the other bird species, some would only have been available during the winter, notably various geese. Jackdaw and raven can be seen as likely scavengers on urban refuse, and the goshawk might have been kept as a hawking bird. Certainly goshawks were highly regarded by hunters later in the medieval period, but the species is still seen wild in the York area today, and may formerly have been more common when woodland was more widespread. Its status in the Anglo-Scandinavian period must therefore remain uncertain.

Similarly, questions hang over the status of the white-tailed eagle at 16–22 Coppergate, as at other European sites. Six out of the eight specimens from Anglo-Scandinavian and medieval deposits at Coppergate are bones of the wing, a preponderance similar to that found at Hedeby (Haithabu) and elsewhere (Reichstein 1974). The argument that eagle pinion feathers were being traded for fletching is persuasive given that finds of eagle wing bones generally outnumber bones from the rest of the body by a considerable margin. In the context of modern Yorkshire, it is much easier to see these eagle bones as a consequence of trade from Scandinavia than as autochthonous fossils of a native species. However, other species have ceased to breed in Yorkshire during the last 1000 years, the crane being the obvious example, and the question of the status of white-tailed eagle in post-Roman England must remain open until further data are available, preferably with some supporting literary or artefactual evidence.

Apart from the razorbill and guillemot, the species represented are those which are found at most medieval sites in lowland England. Wild birds were probably only taken as an occasional addition to the diet and, like the wild mammals, were not a significant component of the urban meat supply except in so far as they contributed variety. Hens and geese were probably kept around the houses, and were exploited for eggs as well as meat.

The species interpreted as urban scavengers are not those seen around cities today. Gulls and feral pigeons are the predominant commensal birds in most major towns in England at the present time, whereas archaeological records show this niche to have been filled in the past by corvid species, and perhaps kite and buzzard. Bones of raven are regularly found in urban archaeological deposits at least to the end of the medieval period, and it is clear that the change in urban bird species occurred comparatively recently. Why kites and ravens should suddenly have become much less successful in this niche is far from clear, and the answer may have as much to do with habitat loss in the rural hinterland as with deliberate persecution within the town.

Fish

Fish bones from archaeological deposits at 16–22 Coppergate will form part of the raw material for a study of fish bones from sites of all periods in York, to be reported elsewhere in *AY* 15. The account which follows is an extended summary, based on identifications made by A.K.G. Jones.

Small numbers of fish bones were recovered by hand-collection. Obviously, these specimens will represent only a very small percentage of the fish bones originally present in the deposits and will be heavily biased towards the larger taxa. The majority were identifiable as cod or salmon bones, though Period 3 deposits yielded several fragments of bony plates (scutes) from the skin of sturgeon.

The wet-sieving process, described above (p.188), produced very large numbers of fish bones from deposits of all periods, and all types of deposit or feature. These bones were identified as far as possible to skeletal element and taxon, measurements were taken where

Table 56 Relative frequency of fish taxa from sieved samples dated to the Anglo-Scandinavian period

As for the mammals (Table 54), relative frequency is based on the number of samples for each period in which fish bones were identified. Relative frequencies given for attributions to family only include specimens identified to family level, not specimens identified to genera or species within that family. Note that the corpus of samples used in the analysis of fish bones was not the same as that used in the analysis of other small vertebrates (Table 54)

Period		3	4A	4B	5A	5B	5Cr
Number of samples		50	9	57	24	39	10
Thornback ray	*Raja clavata* L.	–	–	–	–	0·03	0·10
Sturgeon	*Acipenser sturio* L.	–	–	0·02	–	–	–
Herring family	Clupeidae	0·02	0·11	0·04	0·04	–	–
Shad species	*Alosa* sp(p).	0·10	–	0·04	–	–	–
?Sprat	?*Sprattus sprattus* (L.)	0·02	–	–	–	–	–
Herring	*Clupea harengus* L.	0·54	0·56	0·81	0·88	0·77	0·70
Grayling	*Thymallus thymallus* (L.)	0·02	–	0·16	–	–	–
Salmon family	Salmonidae	0·22	–	0·33	0·25	0·21	0·20
Salmon	*Salmo salar* L.	0·26	–	0·39	0·38	0·13	0·20
Trout	*S. trutta* L.	0·14	–	0·14	0·21	0·08	0·10
Smelt	*Osmerus eperlanus* (L.)	0·14	–	0·40	0·25	0·13	0·30
Pike	*Esox lucius* L.	0·26	0·33	0·54	0·67	0·41	0·30
Carp family	Cyprinidae	0·74	0·89	0·93	0·75	0·56	0·60
Barbel	*Barbus barbus* L.	–	–	0·02	–	–	–
?Gudgeon	?*Gobio gobio* L.	–	–	0·02	–	–	0·10
?Tench	?*Tinca tinca* (L.)	0·02	–	0·05	–	–	–
?Bream	?*Abramis brama* (L.)	–	–	0·02	–	–	–
?Roach	?*Rutilus rutilus* (L.)	0·10	–	0·25	0·21	0·10	0·10
Roach		0·06	0·11	0·26	0·08	0·05	–
?Rudd	?*Scardinius erythropthalmus* (L.)	–	–	0·02	–	–	–
?Chub	?*Leuciscus cephalus* (L.)	0·04	–	0·16	0·08	–	–
Chub		–	0·11	0·05	–	–	–
?Dace	?*L. leuciscus* (L.)	0·06	–	0·11	0·08	0·05	–
Dace		0·02	–	–	–	–	–
Eel	*Anguilla anguilla* (L.)	0·80	0·56	0·91	0·88	0·72	0·80
Cod family	Gadidae	–	–	0·05	–	0·08	0·50
Whiting	*Merlangius merlangus* (L.)	–	–	0·02	–	–	–
Cod	*Gadus morhua* L.	–	0·11	0·05	–	0·28	0·50
Haddock	*Melanogrammus aeglefinus* (L.)	–	–	–	–	–	0·10
Burbot	*Lota lota* (L.)	0·06	0·11	0·14	–	0·03	–
Perch family	Percidae	–	0·11	0·09	–	–	–
Perch	*Perca fluviatilis* L.	0·06	0·22	0·33	0·25	0·13	0·10
Horse mackerel	*Trachurus trachurus* (L.)	0·04	–	–	–	–	0·20
Mackerel	*Scomber scombrus* L.	–	0·11	–	–	–	0·20
3-spined Stickleback	*Gasterosteus aculeatus* L.	0·02	–	0·04	–	–	–
Flatfish	Pleuronectidae	0·10	–	0·26	0·13	0·05	–
?Flounder	?*Platichthys flesus* (L.)	0·02	–	0·04	–	0·03	–
Flounder		–	–	0·05	0·04	–	–
Unidentified fish	Pisces	0·76	0·67	0·91	0·92	0·67	0·70

appropriate, and notes were made of any evidence of disease, butchering or gnawing damage. The data are held on the University of York VAX cluster mainframe computer.

An analysis of taxon frequency has been used in order to examine the occurrence of different taxa. Objections to the use of abundance quantification techniques have been given in an earlier section of this report (p.149), and abundance quantification of fish bones, in particular, is further complicated by the problem of the 'visibility' of different taxa. Thus whilst an eel may be recognisably represented in a sample by any one of 100 or more bones, many species of Cyprinidae can only be reliably distinguished on the basis of their pharyngeal teeth. The Cyprinidae are thus inherently less 'visible' than, for example, eels or herrings, and to have quantified the fish in terms of numbers of bones would have led to the data being swamped by very large numbers of eel and herring bones. Furthermore, there is the problem of fish bone destruction by scavenging animals, or during consumption of the fish by the human population. Even if marauding dogs and cats depleted the deposited assemblage in an unbiased manner, with no preferential selection of certain species, the same is unlikely to be true of human consumption. Some fish can be eaten 'bones and all', with destruction of most of their vertebrae through chewing and digestion: Jones (1986) has demonstrated this taphonomic pathway with herring bones, and the present author has found eel vertebrae to be quite edible. This problem of bone samples being biased by preferential human consumption scarcely arises with mammals and birds, but is clearly important when considering fish bone samples from occupation sites.

In Table 56, the incidence of different taxa in samples allocated to Periods 3, 4A, 5A, 5B and 5Cr is given in terms of relative frequency. Periods 4A and 5Cr are represented by rather few samples, and Period 5Cf (four samples) has been excluded from the analysis. A few taxa are conspicuously frequent in all periods, notably herrings, Salmonidae, pike, Cyprinidae, and eels. Herrings and eels were clearly an important and heavily exploited resource throughout the Anglo-Scandinavian settlement, but with some other taxa it is possible to see a change in exploitation through the period of time represented. Although the number of samples examined from Periods 5B and 5Cr was relatively few, the data show a convincing decline in the frequency of salmonid and cyprinid taxa in Periods 5B and 5Cr, compared with Periods 3, 4 and 5A. In parallel with this there is an increase in the frequency of cod and other gadid bones, reflecting, perhaps, a shift in exploitation in the early 11th century from the local rivers to the open sea. Although fish bones were particularly concentrated in some types of deposit (such as refuse pit fills), there was no discernible spatial variation in the distribution of particular species.

Although most of the taxa listed in Table 56 are familiar enough, a few merit comment. Sturgeon are salt water fish which migrate into rivers to spawn. Though rare in British waters today, there are historical records of sturgeon in the Rivers Trent, Don and Ouse (at Goole) (Bunting et al. 1974). Shads similarly spend much of the year in salt water, moving into the tidally-influenced lower reaches of rivers to spawn. The specimens from Coppergate could not be identified to species with any degree of certainty. Burbot is the only freshwater member of the cod family (Gadidae), living in clear rivers and lakes and occasionally in brackish water. Though now probably extinct in Britain, burbot was recorded from rivers in the York area into the 20th century (Clegg 1977), and was also present in Roman deposits at 24–30 Tanner Row (*AY* 15/2).

The range of taxa represented shows exploitation of riverine, estuarine and marine waters, though the contribution made by each habitat is difficult to quantify. Although herrings are essentially marine fish, they shoal in inshore and estuarine waters during summer months. Given the heavy exploitation of herrings, but not of other marine taxa, in Periods 3, 4A and 4B, it is possible that herrings were caught in the Humber or even the lower reaches of the Ouse. An alternative explanation would be that the herrings were not caught locally at all, but were imported from elsewhere.

A number of other taxa listed in Table 56 were possibly or probably taken in estuarine waters, including sturgeon, shad, salmon, trout, smelt, eel and flounder. Although eels and flounders will tolerate a moderate degree of water turbidity or pollution, the other estuarine species would seem to indicate that the Humber and lower reaches of the Ouse were better oxygenated in the Anglo-Scandinavian period than is the case today. Similarly, the presence of grayling and burbot amongst the freshwater fish points to clean water conditions. The frequency of shad, grayling and burbot falls off after Period 4B, and this may indicate a decline in water quality during the last quarter of the 10th century. If the Ouse and Foss were becoming polluted around York, perhaps as a consequence of urban refuse being dumped into the rivers, there would have been a deleterious effect downstream as well. If the change in exploitation of fish species does indicate some fouling of the rivers, its effect should not be exaggerated. The rivers were still capable of yielding quantities of pike and other freshwater taxa, and smelt were evidently still available in the estuary.

In conclusion, it must be said that the diversity of taxa in Table 56 represents fairly unselective exploitation of resources. There is a much greater variety of fish represented than would be utilised by an English urban community today, a fact which reflects the difference between what one might *choose* to eat (herrings, cod, haddock) and what *can* be eaten if necessary (roach, chub, horse mackerel). Fish exploitation in the Anglo-Scandinavian period appears to have been fairly opportunistic, though we may perhaps see the beginnings of more selective exploitation by Periods 5B and 5C in the increasing frequency of cod and other gadid taxa.

Discussion

Period-to-period differences in these bone groups are small and for the most part subtle. The predominance of cattle bones is most marked in Period 3, with increased proportions of pig and bird bones in Periods 5A and 5B (Table 40). In terms of the overall relative abundance of species, groups from Period 5A more closely resemble those in 5B than those in Period 4. However, the relative abundance of bird taxa points to a closer similarity between Period 4 and 5A deposits, the abundance of golden plover bones being higher in Period 4 and 5A deposits than in 5B deposits. The distribution of worked red deer antler in soil samples is also consistent with some derivation of Period 5A material from 4B deposits. This is certainly what is indicated by the archaeology of these deposits, Period 5A constituting a short-lived phase of re-organisation of the site, with redeposition of cultural material associated with the post and wattle structures of Period 4B.

Bone assemblages from Lincoln which span approximately the same period of time (Table 40; see also O'Connor 1982a) show a marked increase in the proportion of sheep bones after the mid 10th century, with a corresponding decline in the proportion of cattle bones. This change was not apparent at Coppergate, where the proportion of sheep bones was generally lower in Anglo-Scandinavian levels than was the case at Flaxengate. Table 40 shows the proportion of sheep bones at Coppergate to be consistently lower than at contemporaneous English sites selected for comparison, and the Continental examples show ratios of cattle:sheep:pig to vary considerably. Answers to the question 'why were there more sheep at Lincoln than at York?' probably centre on differences between the agricultural hinterlands of the two towns. Although quite well-drained today, the Vale of York is a consistently flat, low-lying area, still subject to seasonal inundation from its several rivers. Even with the modern emphasis on arable farming, one of the main crops of the Vale is grass, and beef and dairy herds are a prominent feature of the landscape. The Wolds, an area of chalk upland, with thin, fast-draining soils, lie some 20km (12 miles) to the east, and there are light soils on Magnesian Limestone 15km (8 miles) to the west. Thus, in the virtual absence of hard evidence, it could be predicted that the Vale of York in the Anglo-Scandinavian period would have been good beef country, with sheep being important on the thinner, drier chalk and limestone soils some distance from the city. For comparison, Lincoln is sited on a Magnesian Limestone escarpment, with a flat alluvial plain to the west and rolling chalk hills within a few miles of the city to the east. Although equating damp grasslands with cattle and dry meadows with sheep may be an over-simplification (consider, for a contrary example, the long history of sheep farming on the soggy Romney Marsh in Kent), differences in the availability of different types of pasturage in the immediate environs of York and Lincoln may well account for the greater importance of sheep at Lincoln, not forgetting that these sheep were probably raised for wool and milk rather than for meat.

If the stockmen who supplied Anglo-Scandinavian York were mainly raising beef, we may assume that this was under an extensive rather than intensive regime, and therefore that at least some of the beasts whose bones were deposited at Coppergate were raised and fattened an appreciable distance from the city. However, there is some evidence that pigs, fowls and geese were kept within the city, and the eels which are prevalent among the fish bones from Anglo-Scandinavian levels could have been obtained within or close to York. Thus the population of the city had some meat supply of their own and were not wholly dependent upon the hinterland farms, although it is unlikely that backyard pigs and buckets of eels would have been adequate for the city's needs had supplies from the Vale been disrupted by climatic or social factors.

The relatively small numbers of goat bones recovered would seem to indicate that individual households could purchase or barter much of their dairy requirements from specialist producers. If families had to depend upon their own resources for a supply of milk and cheese, then some evidence for the widespread keeping of goats in or near the city might have been expected. Even postulating low milk productivity for cattle at this date, a single cow kept for milking would have required considerable food and space, and would have produced quantities of milk which would stretch the capacity and ingenuity of a single household, quite apart from the inconvenience of getting the cow in calf regularly to keep her in milk. Given the greater convenience of the all-consuming, modestly productive goat, the lack of goat bones in Anglo-Scandinavian levels implies that dairy production was not on a house-by-house basis, but rather that a few suppliers traded milk and cheese in quantity. All of this presupposes that dairy products were consumed: in fact there is no direct evidence to this effect, though it would be absurd to assume otherwise.

If diversity of diet is equated with status, through the availability of disposable wealth for the purchase of exotic or high-priced foods, then the inhabitants of the Coppergate tenements do not appear to have been from the more prosperous section of society. The meat component of their diet, as evidenced by the bones, was dominated by beef, itself not specifically raised as a source of meat, with little use of hunted or fished game to provide variety. That is not to say that there is any evidence of poverty. The joints of beef and pork represented include the prime meat cuts as well as the poorer joints of the carcass: the diet encompassed rump steak as well as pigs' trotters. Such attempts to postulate social status from dietary remains beg a number of questions, not least whether Anglo-Scandinavian York was socially stratified. Given certain reasonable assumptions, however, the evidence for an adequate though not diverse meat diet could be equated with a stratum of society certainly not poor, though lacking the wealth, and perhaps the social outlook, to purchase exotic 'luxury' foods to vary their diet.

That being said, the lack of excavated high-status urban sites of directly comparable date and with a strong Anglo-Scandinavian element makes it impossible to state with certainty whether the low diversity seen at Coppergate is typical of this site, or of Anglo-Scandinavian urban occupation in general. Bone assemblages from late 9th to early 11th century deposits at Flaxengate, Lincoln, were not conspicuously more diverse in the range of taxa represented, nor were assemblages from Hedeby (Table 40). In describing the Coppergate assemblages as showing low diversity, comparison is being made with Roman (*AY* 15/2) and 15th–17th century assemblages from York, and such comparisons may have little validity.

The discussion thus far has populated the city with a few pigs, hens and geese, and perhaps the odd goat. To these must be added the resident birds and the smaller animals evidenced in the bones recovered by sieving. Some caution must be exercised when examining the list of bird species in Table 55, as those which *could* have lived in the city *need not* have done so. However, it seems reasonable to suggest that jackdaw and raven were residents, as the former is a common town bird today and the latter has been within historical record. The coot specimens and at least some of the mallard bones probably derived from birds which lived on York's two rivers. Comparing this list with the birds of modern York, the only remarkable absence is the gulls (Laridae), in particular black-headed gull. This result rather implies that by the Anglo-Scandinavian period the smaller gull species, at least in this part of England, had not yet adopted their modern behavioural pattern of exploiting human settlements as a source of food. The main scavengers at Coppergate seem to have been corvids rather than gulls.

Of the smaller vertebrates, frogs were evidently a regular feature of everyday life, being buried in rubbish tips, hopping into cess pits, and generally becoming incorporated into surface deposits. House mouse was much the most common rodent, probably common enough to require precautions to be taken when storing food, and black rat was evidently present in some numbers, though perhaps not so closely associated with peoples' houses.

Comparing these results from Anglo-Scandinavian Coppergate with those from a variety of other sites in England, there is nothing in the Coppergate results which can be pointed to as possibly distinctively Scandinavian. The proportion of cattle bones is particularly high, but it is argued above that this can be explained in terms of available pasturage. The cattle themselves are not unusually large or small, nor do they have especially distinctive characteristics of horncore morphology. Such few comparative data as are currently available suggests that the frequencies of non-metrical dental anomalies observed at Coppergate are not unusual. The sheep are quite large in comparison with a range of Saxon and medieval samples, but there is no reason to suspect the introduction of Scandinavian stock. Given the uncertainties surrounding the degree of ethnic Scandinavian influence in York's population through the Anglo-Scandinavian period, and the likelihood that most of the livestock which were slaughtered and butchered in the city were brought in from a large catchment area, it is difficult to see what distinctively Scandinavian characteristics might have been expected of this assemblage.

At the present point in studies of bones from York, results from Anglo-Scandinavian groups stand somewhat alone. Work in hand or in prospect will produce data for comparison from Anglian and medieval deposits which will set the results described here in their proper context. Further examination of Anglo-Scandinavian groups could also be justified if the bones were from excavations in a different part of the city. For the present, the bones from Coppergate have provided a good sample of livestock and human activities in an artisans' quarter of the Anglo-Scandinavian town, and have raised a number of questions to be borne in mind when future research is planned.

Acknowledgements

The study of the bones described in this report was undertaken at the University of York under a contract funded by English Heritage who also provided a grant for its publication. The excavation from which they came was made possible through the generous co-operation of York City Council, the site owners, and the financial support of the Department of the Environment and a number of generous benefactors and donors.

The author is grateful to Richard Hall, the director of the excavation, for contributing a part of this fascicule and for patiently setting the bones in their archaeological context. The many drafts of this text have benefited from comments and suggestions made by colleagues in the Environmental Archaeology Unit, of whom the author wishes to thank Enid Allison and Andrew Jones in particular for their contributions of data. Sebastian Payne (Ancient Monuments Laboratory) made numerous helpful suggestions, and Juliet Clutton-Brock (British Museum (Natural History)) gave her experienced opinion on the large canid specimens. Many others helped in diverse ways, and join those in being thanked, and absolved of any responsibility for any remaining flaws or shortcomings.

Figures for this fascicule were drawn by Glenys Boyles (Figs.24, 26–7, 29, 31), and by T. Finnemore (Fig.21) and P. Stott (Figs. 23, 25, 28,30); the distribution plans (Fig.22) were prepared by Kaye Haworth. The photographs were taken by R. Hunter (Pls.VIIIa and b, IXa and b, Xa), M.S. Duffy (Pl.Xb, XIa) and K. Buck (Pl.XIb). The summary was translated into French by Mr B. Randoin and into German by Mrs K. Aberg and the report has been under the editorial supervision of Wendy Sherlock.

Summary

Results are presented from a study of 33 groups of hand-collected bones dated to the mid 9th–mid 11th century and directly associated with Anglo-Scandinavian structures and activity on the 16–22 Coppergate site. A preponderance of cattle bones was found, with lesser quantities of sheep and pig, and low frequencies of wild species. It is argued that most of the groups of bones examined are a mixture of debris from the butchering of stock and from domestic activity. The predominance of cattle is most marked in the earliest groups (mid 9th–early 10th century), with the latest groups (late 10th–mid 11th century) being characterised by an increased diversity of wild birds and a higher proportion of pig bones. In all, 32 bird taxa were recorded, with domestic fowl and goose predominating. Most of the wild birds were clearly species which were taken for food or which scavenged among the urban refuse.

Recovery of bones by sieving gave substantial samples of fish bones, which showed a heavy concentration on eel and herring, with more offshore marine taxa towards the end of the period. Of the mammalian and amphibian taxa, frog was particularly common, although not present in hand-collected groups, with black rat and house mouse consistently present. Other small mammals were only common in samples which were dated to the earliest period of Anglo-Scandinavian settlement. Comparison is made with bone assemblages from other sites in northern Europe, and it is concluded that no distinctly Scandinavian traits can be determined in the results.

Résumé

Ce rapport présente les résultats de l'étude de 33 groupes d'ossements ramassés à la main datés du milieu du 9e siècle au milieu du 11e siècle, directement associés aux structures et aux activités anglo-scandinaves du site du 16–22 Coppergate. Le gros bétail représente la grande majorité de ces ensembles avec une plus faible représentation du mouton et du porc, les espèces sauvages sont très faiblement représentées. On en déduit que la plupart des groupes étudiés sont constitués d'un mélange de débris provenant de l'abattage du bétail et d'activités domestiques. La prédominance du gros bétail est plus marquée dans les groupes les plus anciens (milieu 9e–début 10e siècle), alors que les groupes les plus tardifs (fin 10e–milieu 11e siècle) sont caractérisés par une diversité croissante d'oiseaux sauvages et une plus forte proportion d'ossements de porc. En tout, 32 taxons d'oiseaux ont été enregistrés, avec une domination de volaille domestique et d'oie. La plupart des oiseaux sauvages sont des espèces utilisées pour la nourriture ou qui vivaient sur les rejets urbains.

Le ramassage d'ossements par tamisage a fourni un échantillonage substanciel d'ossements de poissons, qui a montré une lourde concentration d'anguille et de hareng, avec une plus grande proportion de taxons de haute mer vers la fin de la période. Parmi les taxons de mammifères et d'amphibiens, la grenouille est particulièrement courante, bien qu'absente des groupes d'ossements ramassés à la main, avec le rat noir et la souris qui sont toujours présents. D'autres petits mammifères ne sont communs que dans les échantillons datés de la période la plus ancienne de l'établissement anglo-scandinave. La comparaison effectuée avec d'autres sites de l'Europe du nord conduit à la conclusion que l'on ne peut dégager de ces résultats aucun trait spécifiquement scandinave.

Zusammenfassung

Die Auswertungsergebnisse 33 handgelesener Knochengruppierungen mit Datierungen von der Mitte des 9.Jahrhunderts bis in die Mitte des 11.Jahrhunderts und direkter Zuordnung zu Gebäuden und Aktivität aus anglo-skandinavischer Zeit auf der Grabungsstelle 16–22 Coppergate werden vorgelegt.

Der Hauptanteil der Funde bestand aus Rinderknochen mit geringen Mengen an Schaf- und Schweineknochen und sehr geringem Auftreten von Wildknochen. Es wird gefolgert, daß der größte Teil der ausgewerteten Knochengruppen ein Gemisch aus häuslichem und Schlachtereiabfall darstellt. Das Übergewicht der Rinderknochen ist besonders augenfällig in den ältesten Gruppierungen, deren Datierungen von der Mitte des 9. bis in das frühe 10.Jahrhundert reichen. Die jüngeren Gruppierungen dagegen, von späten 10. Jahrhundert bis zur Mitte des 11. Jahrhunderts datierend, zeichnen sich durch eine ansteigende Vielfalt im Vorkommen der Wildvögel und einem höheren Anteil an Schweineknochen aus. Im Ganzen wurden 32 Vogelarten festgestellt, bei denen die Haushühner und Gänse vorherrschten. Die meisten der Wildvögel gehörten eindeutig zum Federwild oder zu jenen Vogelarten, die im städtischen Abfall ihr Futter suchen.

Die Sicherstellung von Knochenfunden aus gesiebtem Material ergab umfangreiche Fischgrätengruppierungen, bei denen das Schwergewicht bei Aal- und Herringsgräten lag. Hochseefische traten häufiger gegen Ende des untersuchten Zeitraumes auf. Unter den zu den Säugetieren und Amphibien zählenden Familien war der Frosch besonders häufig; er ist jedoch für die handgelesenen Gruppierungen nicht belegt. Die Hausratte und die Hausmaus waren gleichbleibend vertreten. Andere Kleinsäuger kamen nur in Gruppierungen, die aus der frühesten Zeit der anglo-skandinavischen Siedlung stammten, häufig vor. Vergleiche mit Knochensammlungen aus anderen Fundstätten in Nordeuropa werden angestellt und sie zeigen, daß in den Auswertungen keine spezifisch skandinavischen Besonderheiten aufzuweisen sind.

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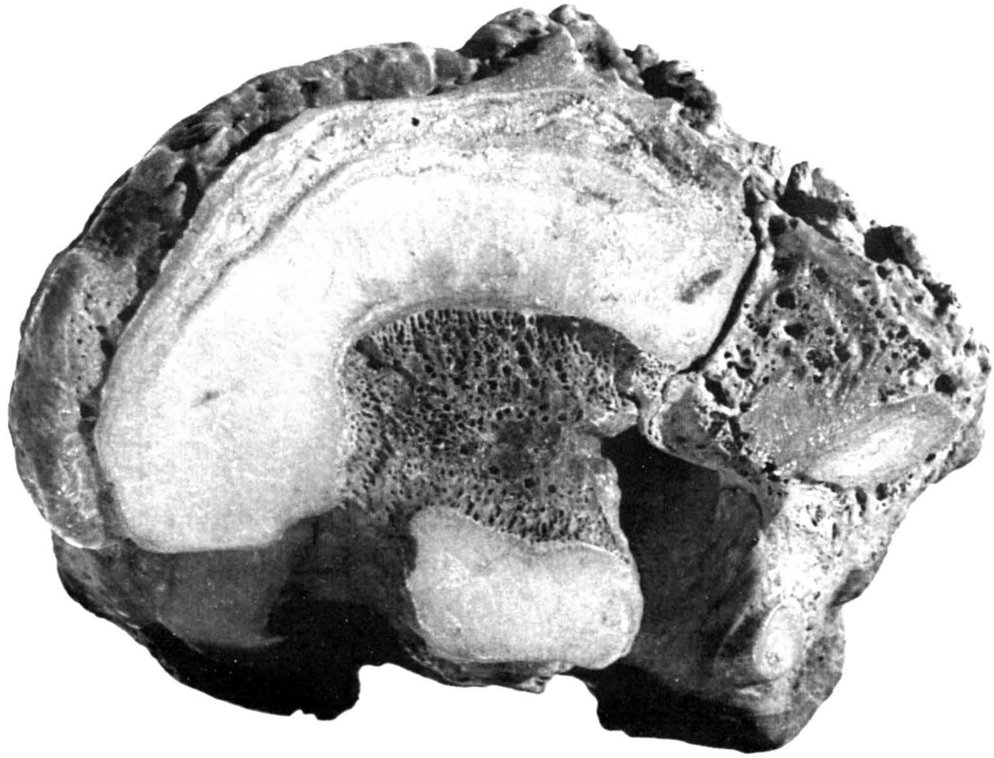
Plate VIIIa Palatal view of a dog skull, showing the relatively long muzzle with well-spaced teeth typical of the larger dogs from Coppergate. Max. length 200mm

Plate VIIIb Two metapodials from a large canid, not definitely attributable either to domestic dog or wolf. Max. length: (i) 88mm; (ii) 100mm



a Distal view

b Lateral view

Plate IX Fused tarsals of a horse. An arthropathy has immobilised the joint by ossification of periarticular soft tissues, but there is little involvement of the articular surfaces

Plate Xa   Right frontal bone of a sheep, showing the bases of two well-developed horncores—a 'four-horned' sheep

Plate Xb   Lower canine of a male wild boar. Chord length 132mm

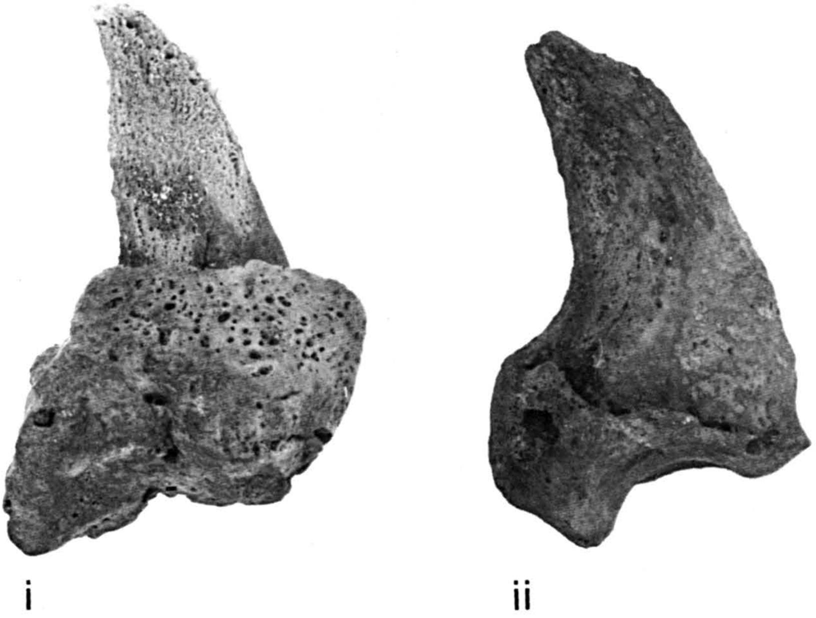


Plate XIa Two third phalanges of brown bear, (i) showing some pathological degeneration of the articular surface. Max. length: (i) 41mm; (ii) 37mm

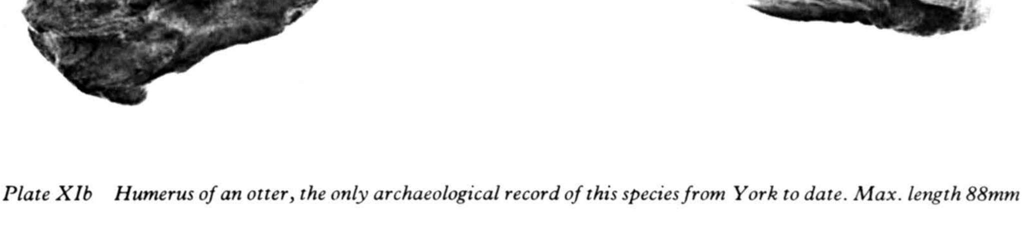


Plate XIb Humerus of an otter, the only archaeological record of this species from York to date. Max. length 88mm

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