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Environment and Living Conditions at Two Anglo-Scandinavian Sites

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Cover illustration *Lloyds Bank excavation: poles in the leather working area, possibly used as a leather stretcher.*
Photo. A. G. MacGregor

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By A. R. Hall, H. K. Kenward, D. Williams
and J. R. A. Greig

With contributions by Y. Z. Erzinclioglu, A. K. G. Jones and J. Phipps

Introduction

Excavations in the Coppergate-Pavement area, in the heart of medieval York (Fig. 24), have provided an opportunity to make large-scale investigations of richly organic Anglo-Scandinavian and medieval deposits. These are ideal for the preservation of a wide range of biological remains which can be used to make many deductions, often detailed, about urban environment and human activity during a period for which there is surprisingly little certain knowledge of everyday living conditions and way of life.

This report describes the results of investigations of plant and animal remains from 83 samples, excluding replicates, from excavations at 6–8 Pavement (on part of the present site of Lloyds Bank) and from a watching brief at 5–7 Coppergate (Fig. 25). Studies have been made of plant macrofossils, insects (principally beetles, Coleoptera, and bugs, Hemiptera) and other invertebrate remains from all of the samples, and of pollen and the soil matrix from certain samples from the Lloyds Bank site. In addition, bones of fish, birds and mammals have been studied and will be described elsewhere (*AY* 15).

This is believed to be much the largest investigation of urban archaeological deposits in which an attempt has been made to integrate the evidence from studies of a wide range of well-preserved biological material. Some limitations were, however, imposed by the nature and circumstances of the two excavations. Both had to be carried out rapidly under artificial light in the cramped conditions of cellars and were confined to small trenches. For these reasons the archaeological interpretation was difficult. Moreover, only limited consultation with environmental archaeologists was possible at 6–8 Pavement, and both excavations took place at a time when techniques for excavating and recording thick waterlogged urban deposits were at an early stage. The sampling strategy has proved, with hindsight, to have been unsuitable for systematic biological investigations. None of the authors saw the trench at 5–7 Coppergate and only J.R.A.G. saw those at Pavement.

Despite these problems, the analyses produced a wealth of new information and insights into the conditions and human activities which led to the formation of the deposits.

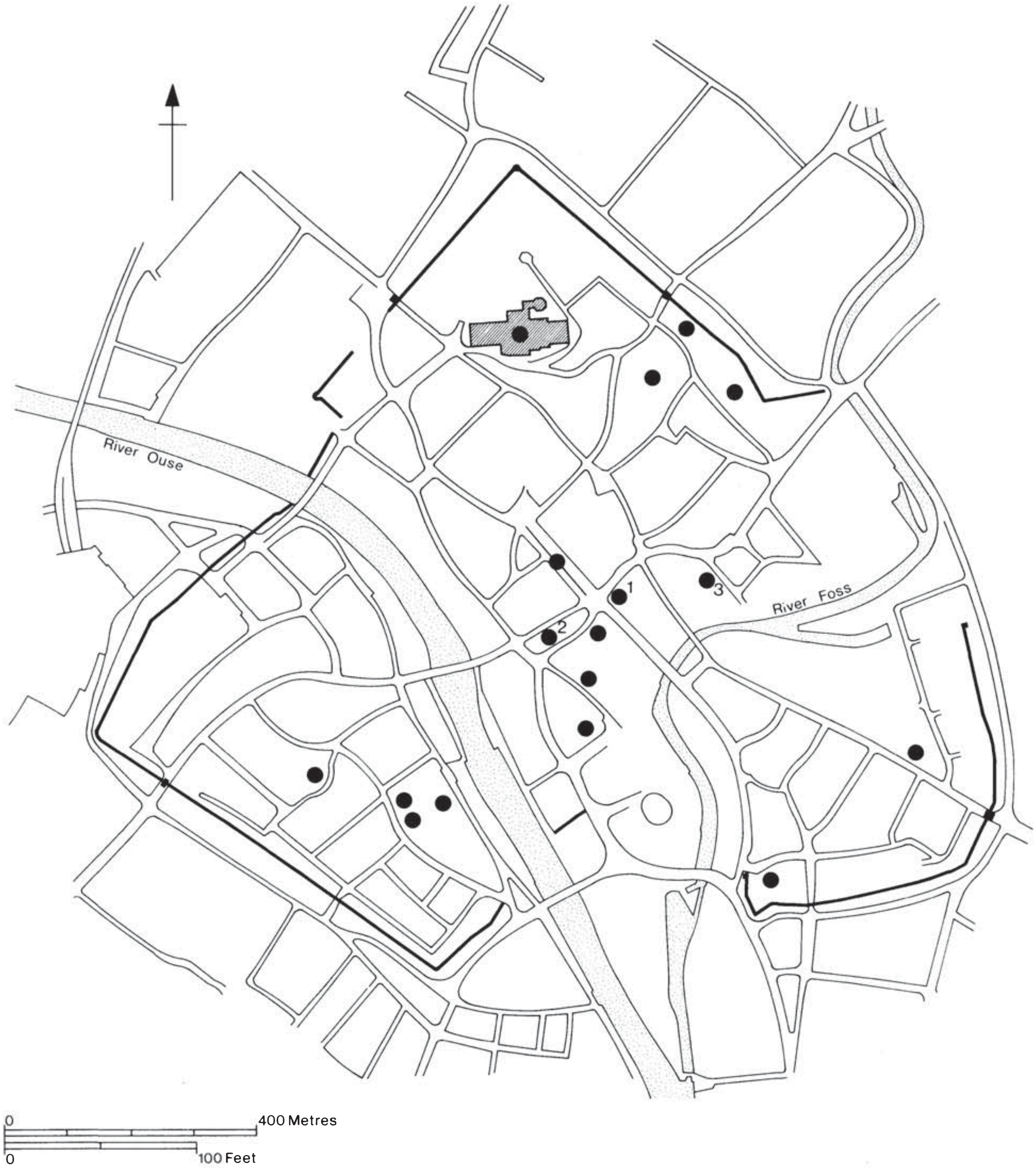
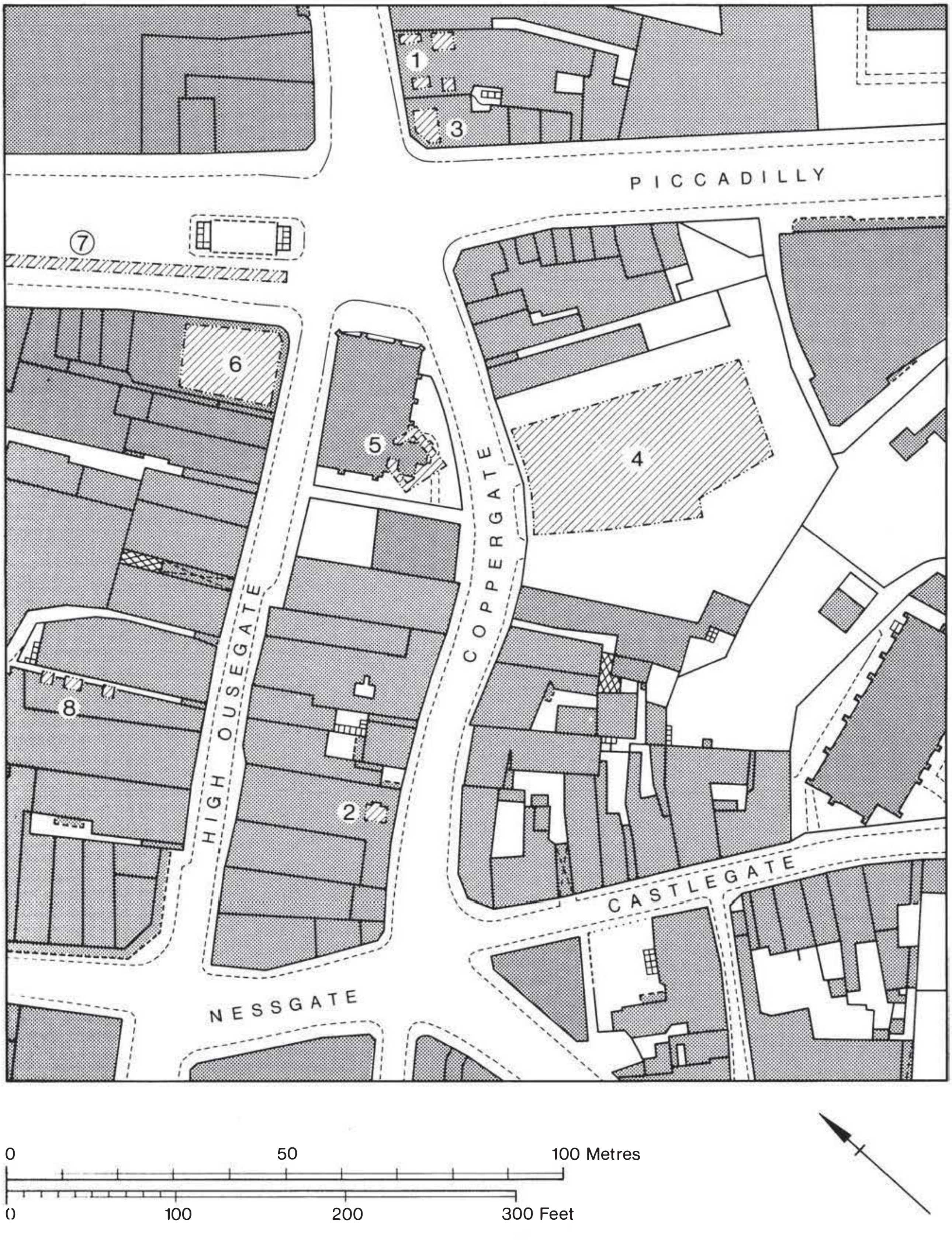


Fig. 24 *Plan of York, showing the main excavated Anglo-Scandinavian sites. Numbered sites: 1 Lloyds Bank, Pavement; 2 5–7 Coppergate; 3 Hungate. (Based on the Ordnance Survey map with the sanction of the Controller of Her Majesty's Stationery Office, Crown Copyright reserved.) Scale 1:12,500*

Fig. 25 *(facing) Plan showing location of the sites at Lloyds Bank, 6–8 Pavement (1) and 5–7 Coppergate (2). Adjacent Anglo-Scandinavian sites are also shown: (3) Lloyds Bank, 2–4 Pavement (Radley, 1971); (4) 16–22 Coppergate; (5) All Saints, Pavement; (6) Barclays Bank, 1–3 Parliament Street (Radley, 1971); (7) Parliament Street sewer trench; (8) Peter Lane. (Based on the Ordnance Survey map with the sanction of the Controller of Her Majesty's Stationery Office, Crown Copyright reserved.) Scale 1:1250*


1
3
PICCADILLY
⑦
6
5
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COPPERGATE
HIGH OUSEGATE
8
2
CASTLEGATE
NESSGATE
0
50
100 Metres
0
100
200
300 Feet

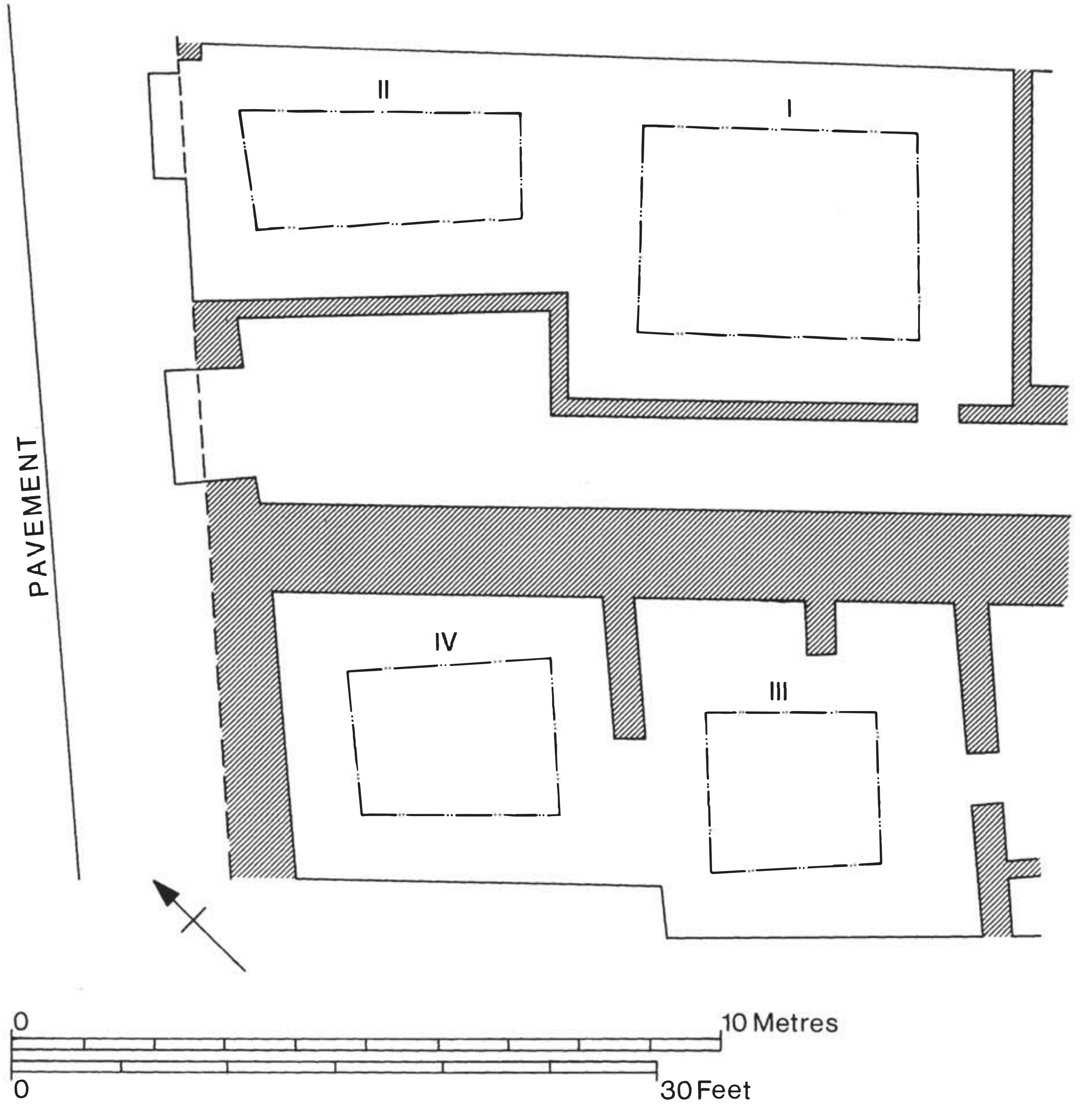


Fig. 26 Plan of the site at Lloyds Bank, 6–8 Pavement, showing the four trenches excavated. Scale 1:120

Moreover, the work has promoted research into new ways of looking at ancient biological remains (e.g. Kenward, 1978a, *AY* 19/1). An enormous volume of data for future analysis has been obtained, and — perhaps its most important aspect — the work has provided an invaluable opportunity to develop techniques applicable to other sites and especially to the vastly greater quantity of material from the York Archaeological Trust's excavations of Roman, Anglo-Scandinavian, and medieval deposits at 16–22 Coppergate during 1976–81 (*AY* 14 forthcoming).

A preliminary report on material from 6–8 Pavement has appeared elsewhere in an essentially speculative paper (Buckland, Greig and Kenward, 1974), and it is further discussed by Buckland (1974) and Kenward et al. (1978); a number of the tentative conclusions drawn must be revised in the light of more detailed investigations and new interpretative methods (see p. 220, below). It is unfortunate that these early speculations have become embedded in the literature (e. g. Brown, 1978, 91–2) without the caveat that 'the . . . interpretation represents a model, predicted on the rather limited evidence of the trial samples . . .' (Buckland et al., 1974, 26).

The Archaeology of the Sites

The archaeology of the two sites is described in reports by P. V. Addyman and R. A. Hall (*AY* 8, forthcoming), the small finds in MacGregor (1982, *AY* 17/3), and the pottery from Lloyds Bank in Holdsworth (1978, *AY* 16/1). The following provides a background to discussion of the biological evidence.

Lloyds Bank, 6–8 Pavement

The excavation at Lloyds Bank, described by Brown (1978, 91) as 'one of the most extraordinary excavations ever undertaken', was carried out in 1972–73, under the supervision of M. Harrison. Four small trenches (about 3m × 2m) were dug in the cellars of the former York Coffee House; a site plan and diagrammatic sections are given in Figs. 26 and 27. Three trenches (I, II, and IV) revealed what was in essence an horizontally layered succession, interpreted as a sequence of construction, occupation and destruction deposits from timber or post and wattle buildings, with associated rubbish accumulations during occupation phases. The deposits in Trench III appeared to be similar, though in the upper levels there were cuttings and pits more likely to have been made in a yard. It was impossible to obtain full plans of any of the structures, the areas excavated being too restricted. Some layers associated with structures seemed to represent internal floors, though it was not always clear whether others lay inside or outside the buildings concerned. As many as eleven phases of building and rebuilding were revealed in Trench IV (the deepest). The other trenches would probably have produced a similar number if full excavation had been possible. The buildings had no special foundations, most uprights simply being set into the earlier layers. Walls were generally of stakes and wattle, occasionally with more substantial uprights. Floors were difficult to distinguish, but most seemed to have been of beaten earth, some of mortar, and others planked. Burnt areas interpreted as hearths were recorded within some of the structures.

The pottery comprised principally Late Saxon grey wares with smaller amounts of gritty ware, York ware, Stamford ware and some residual Roman sherds, and a few sherds of other glazed wares, St Neots-type ware and Pingsdorf-type ware. This series places the sequence within the mid 9th to late 11th centuries. While there is some change in the pottery through the succession (*AY* 16/1, 5–10, fig. 1) there is little evidence for the time taken for the deposits to form. Three radiocarbon samples from stakes, leather, and plant debris from the lower, middle and upper parts of the succession in Trench IV gave dates of ad 880 ± 100 (1070 ± 100 bp, BIRM – 403), ad 960 ± 100 (990 ± 100 bp, BIRM – 402) and ad 920 ± 100

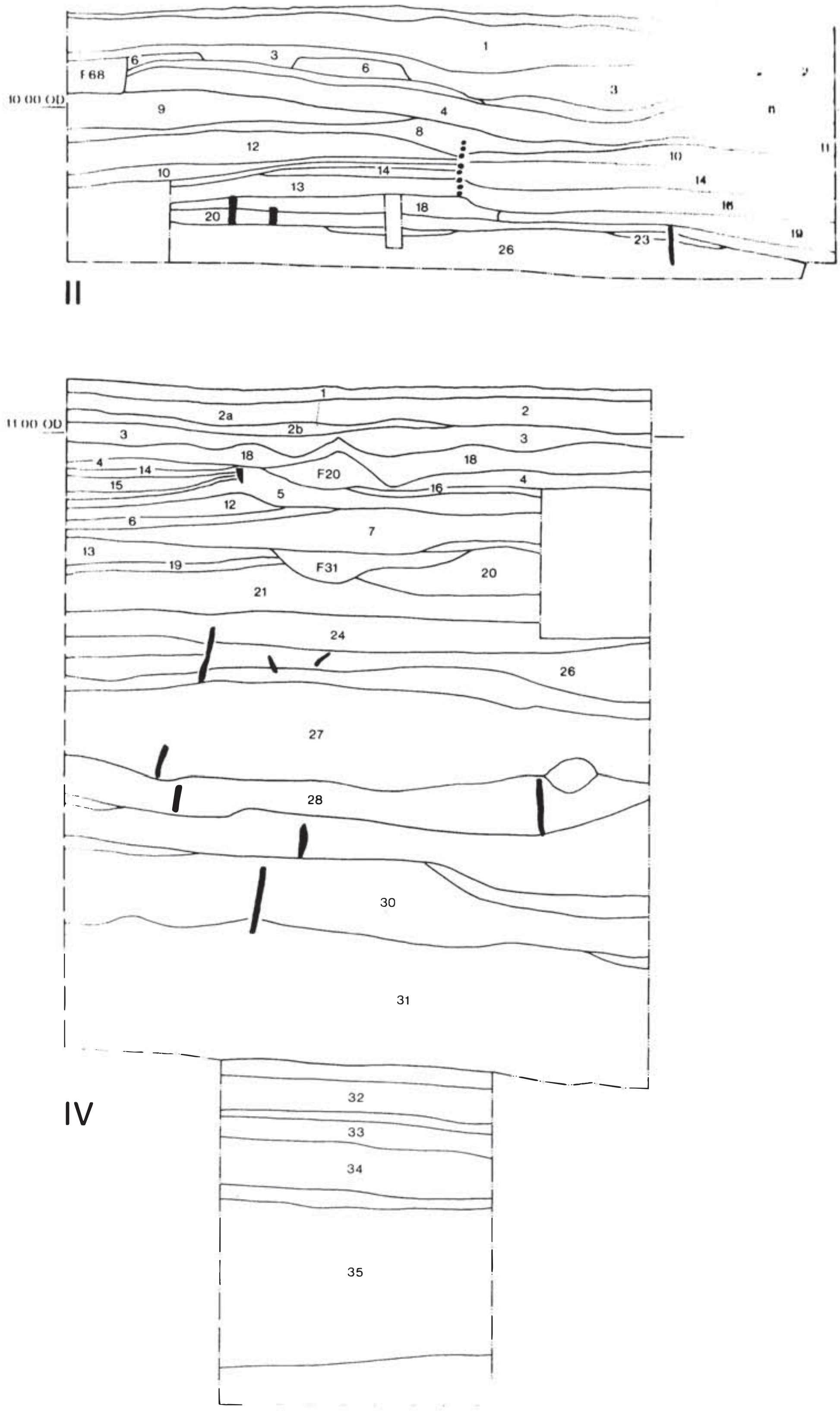
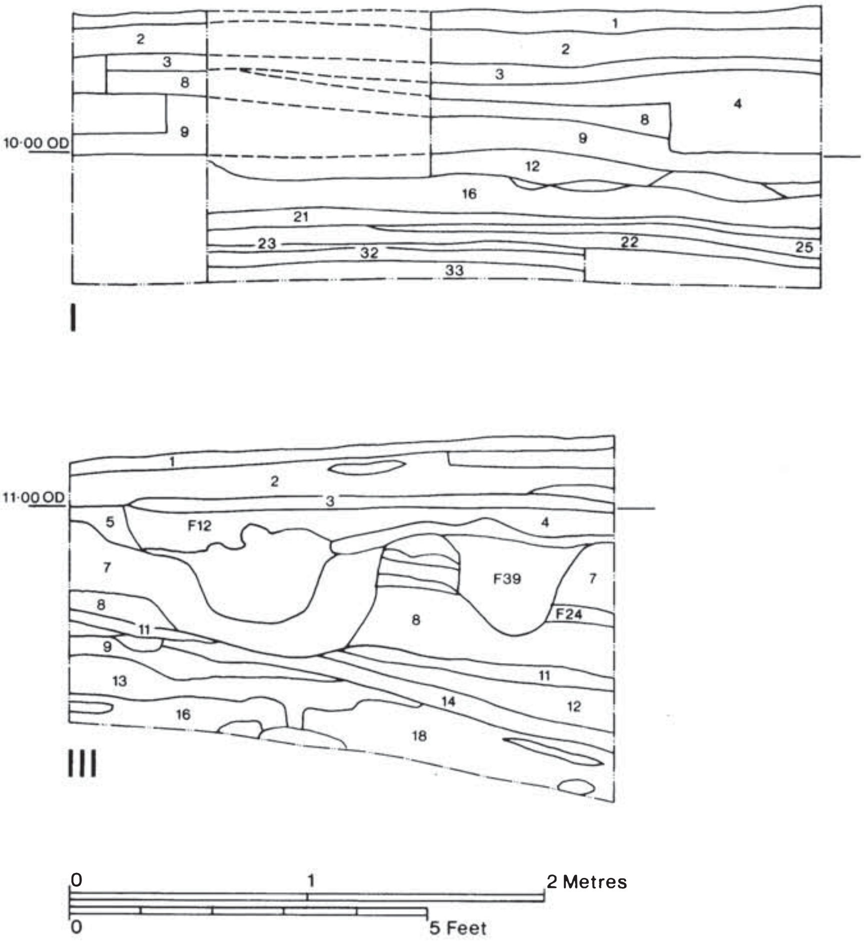


Fig. 27 (above and facing) Sections of Trenches I–IV at Lloyds Bank, 6–8 Pavement, showing the north-east face of each trench. Scale 1:40



(1030 ± 100 bp, BIRM – 401), respectively. An alternative method of dating is provided by dendrochronology. Cross-matched curves were obtained by Mrs R. Morgan for eight oak timbers from Pavement, and felling dates could be estimated for five of them, giving at least a provisional terminus post quem for the archaeological deposits concerned. Timbers from the lowest structures excavated (Trench II, layer 31; Trench IV, F100M and layer 32) were felled around AD 940–50. Timbers from higher levels (Trench II, F85, F88 and F127, all from layers 21–3) were felled around AD 970 or a little later. One timber from Trench I (layer 12, F22) was cut around AD 990. The dates thus give some general indication of the age of the deposits, but cannot be used to give precise dates to particular layers. Taken as a whole, the dating evidence suggests that the deposits, even in Trench IV, may have accumulated very quickly, perhaps in little more than a century and a half.

5–7 Coppergate

Dug by workmen in 1974, a single trench, about 4m × 3m, beneath a cellar floor revealed richly organic deposits containing some horizontally lying wattle as well as traces of a stake and wattle alignment which perhaps consisted of two parallel rows of stakes (Fig. 28; see R. A. Hall in *AY* 8, forthcoming). Sample columns were collected in 1974 by D. J. Rackham from immediately adjacent to the stake alignment (E), through the horizontal wattle (N) and

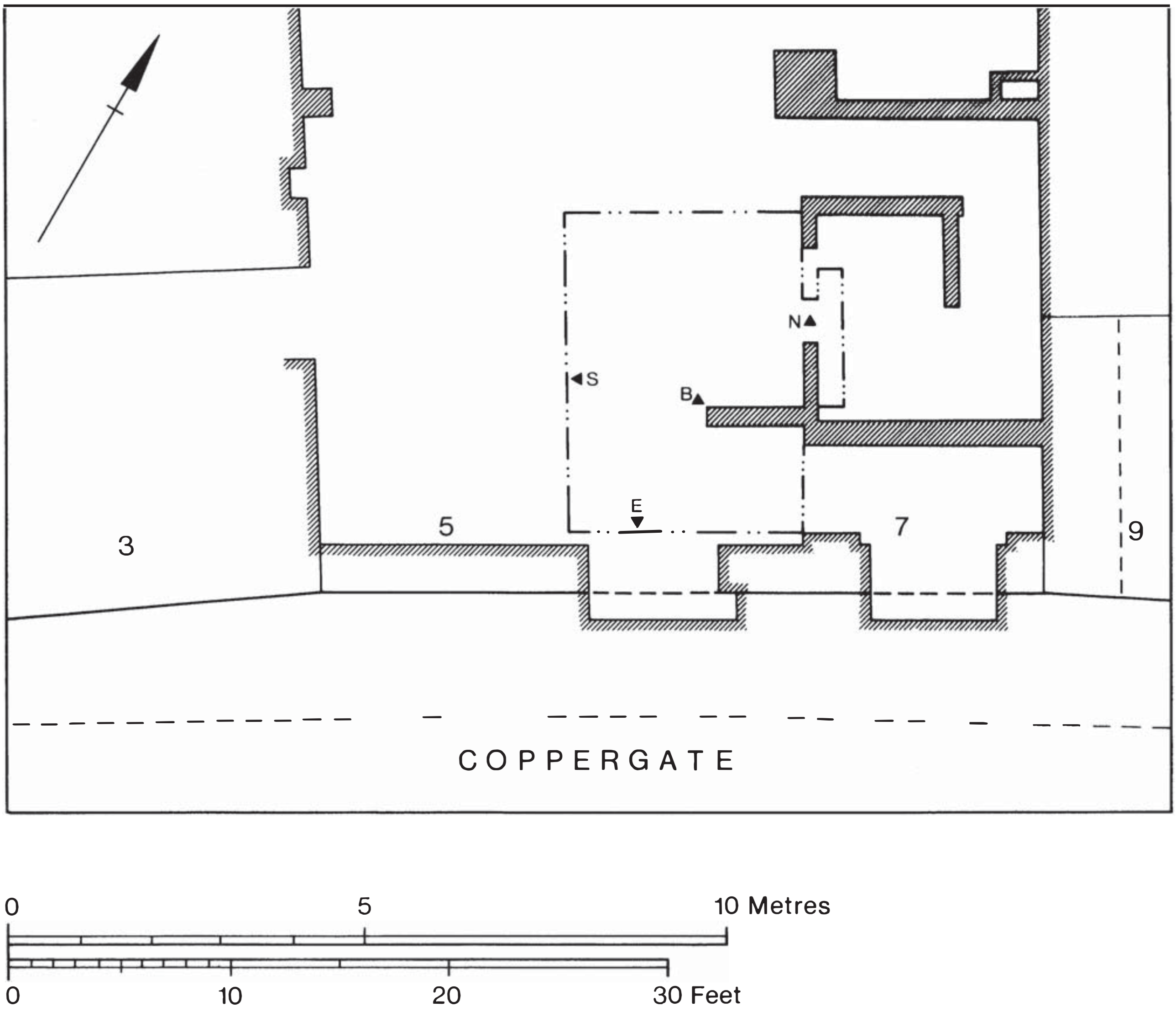


Fig. 28 Plan of the site at 5–7 Coppergate, showing the area excavated and the position of the sample columns N, S, B, and E. Scale 1:120

from two other faces of the trench (S, B) (Figs. 28–9). The deposits could not be dated very accurately; seventeen pottery sherds were recovered including residual and Anglo-Scandinavian to Norman material. The area overlaps that of the excavations recorded by Benson between High Ousegate and Coppergate in 1902–3 (Benson, 1903).

The History of the Analyses

A number of circumstances have placed constraints on the interpretation. The Lloyds Bank samples were marked with the relevant layer numbers, but no more precise records of location were kept. Most layers were laterally extensive, and many quite thick and complex,

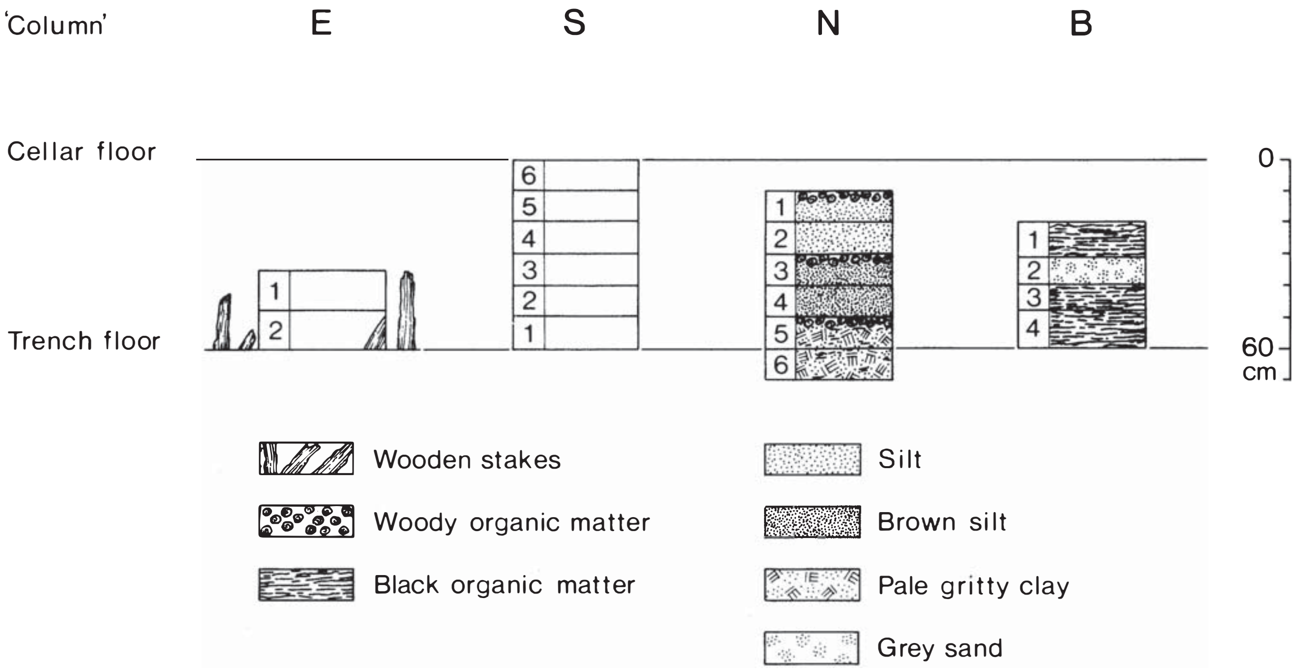


Fig. 29 Diagram showing the sample columns at 5–7 Coppergate. Compare with Fig. 28. Stratigraphy of columns E and S was not recorded. Vertical scale 1:30

so it is not clear how far a sample is representative of the layer from which it came. Some samples were certainly selected to represent the most richly organic parts of the layer. Not all layers were sampled, and some samples had to be rejected because they were too small or had deteriorated during storage. As an experiment, columns of sediment were left at one corner of each trench and removed as 'block' samples for later subdivision; unfortunately they proved too unwieldy to store without collapse and were unsuitable for examination. A series of samples from the base of Trench IV was taken using a bucket auger, but heavy contamination by material washed down from above during coring greatly limited their value.

The bulk of the biological samples from both sites was processed in 1974 by Mrs J. Constantine under the supervision of H. K.K. (who carried out the insect analyses at that time) and D. J. Rackham. The main plant macrofossil analyses were also carried out in 1974, by D.W., who examined primarily the seeds from paraffin flots (see below). Further subsamples from six of the Lloyds Bank samples (II, 10, 12, 14, 15, 17, 18) were processed by A.R. H. in 1978, at which time critical insect identifications were also rechecked. It has not proved possible to relate the series of samples described by Buckland et al. (1974) to the present material.

Pollen subsamples were taken in 1972–73 from the middle of lumps of sediment from certain of the samples from Trenches II, III and IV, and later from more of the samples from Trench II, 6–8 Pavement. The pollen from the 'block samples' proved to be poorly preserved, and added little to the results. Subsamples for soil analysis, carried out in 1978, were also taken from sample bags from the main Trench II series.

Practical Methods

The samples were placed in polyethylene bags, some double-wrapped, and stored in a cool, dark basement, subsamples being taken in the laboratory for plant macrofossil and insect analyses. Sediment type, Munsell colour and main inclusions were recorded before processing. Insects were extracted by paraffin flotation (Kenward, 1974; Kenward et al., 1980). Seeds were taken from the same flots by D.W. and the residues briefly examined dry to check that no abundant taxa were overlooked. It was later realized that the seed content of paraffin flots was not reliably representative of the assemblage within the sample, and for this reason additional material from Trench II, 6–8 Pavement, was examined by A.R.H. — samples marked 'H' in histograms and Table **62**, Microfiche 1 (see p. 239). A graded sieve-bank was used in the extraction of the macrofossils from these duplicate samples (method outlined by Kenward et al., ibid.). The dried residues from paraffin flotation were sorted to monitor the efficiency of the process and to recover small bones; insect fragments from the residues were insignificant to interpretation. Samples for pollen analysis were prepared following customary methods, including acetolysis; the material was mounted and counted in glycerine jelly.

Untreated sample material was, if sufficient, processed in a bulk-sieving apparatus (ibid.) for fish bones and small finds; the latter included numbers of small glass beads (*AY* 17/3, 164). At the same time, the gross composition of untreated sediment and residues was re-recorded. Mammal and larger fish bones, together with shellfish and wood, were collected as 'finds' during excavation.

Interpretative Methods

Pollen

Although pollen analysis of urban archaeological deposits was deemed 'unprofitable' by Godwin and Bachem (1959), and certainly would be so if approached in a similar way to the analysis of natural peat and lacustrine deposits, it is believed that useful information may be obtained and that at least exploratory analyses should be made. The interpretative methods used for the pollen results obtained here are discussed in detail by Greig (1982). In summary, spectra are interpreted by comparison with a wide range of others, from both urban and rural archaeological deposits. Two principal kinds of spectra are recognized: firstly, those thought to have originated primarily through deposition of the natural pollen rain; and secondly, those thought to comprise mainly pollen dispersed and deposited by human activity. Amongst the latter, it has been found useful to select certain characteristics of the pollen record, together with other botanical evidence, as particularly significant for interpretation. Thus, for example, high percentages of Cerealia type pollen together with a substantial component of Compositae (Tubuliflorae) seeds are likely to have originated in straw, while large amounts of grass pollen combined with moderate levels of both pollen and seeds of Compositae (Liguliflorae) may indicate an origin in hay. As with the two main types of insect assemblage (p. 196), there is intergradation and interpretation is certainly not as straightforward as may first appear. Integration with the widest possible range of evidence is desirable, particularly the corroborative evidence from plant macrofossils and insects. A phytosociological approach to the interpretation of the pollen results has not been attempted, since the records cannot be matched with plant communities to the extent possible for plant macrofossils (Willerding, 1978).

Plant macrofossils

In view of the bias introduced by the method of extraction of the plant macrofossils, the quantitative approaches to their interpretation used on the material from Highgate, Beverley (Hall and Kenward, 1980) and Skeldergate, York (Hall et al., 1980, *AY* 14/3) have not been adopted. Instead, emphasis has been placed on the ten most abundant taxa from each sample, rather than the complete lists.

Despite the limitations imposed by the extraction techniques, it was felt worth while to calculate an index of diversity for the seed assemblages, in order to explore the potential of this statistic in the analysis of this large data set. The index is α of Fisher et al. (1943), the usefulness of which is well established for analyses of insect assemblages (see *AY* 19/1). The results appear in Fig. 33.

Another way of interpreting these plant macrofossil assemblages would be the phytosociological approach adopted by many palaeobotanists in Continental Europe (e.g. Körber-Grohne, 1967; Opravil, 1978; Wasylikowa, 1978). In their work, an attempt is made to identify, by inspection, groups of taxa within the fossil assemblages which occur as elements of modern communities of living plants; the position of these elements in a phytosociological classification can then be recognized. Such classifications seek to give order to vegetation types much as taxonomy classifies organisms. For the present material, the phytosociological method has been borne in mind, but not rigorously applied. Green (1979a) has alluded to the potential of this approach and his call for more work on the vegetation of modern 'man-made' environments can only be echoed. It is unfortunate that weed communities (seeds from which form the bulk of the assemblages from these urban medieval deposits) have received so little attention, particularly in Britain. Harper (1960, xi) sums this up thus: 'Weeds have for many years been regarded as slightly improper material for biological studies and almost all aspects of their biology, except those directly related to control measures, have been badly neglected'. Elsewhere in North West Europe, a long tradition of phytosociology has resulted in numerous accounts of modern weed associations, but it is uncertain how far Continental classifications may be applied to British vegetation.

Insects

The methods of analysis of insect (Coleoptera and Hemiptera) assemblages described in *AY* 19/1 were developed during the early stages of work on the present material. The definitions of 'probable outdoor' species and the presentation of data for aquatic and damp-ground/waterside species have subsequently been modified in the light of a better understanding of the ecology of some critical taxa, particularly certain *Anotylus*, *Carpelimus* and *Platystethus* species. This produces some inconsistencies between the data tables in *AY* 19/1 (tables 3–5) and the histograms in this report (Figs. 40–3). Values given here, however, are directly comparable with those for sites at Skeldergate, York (*AY* 14/3), Beverley (Hall and Kenward, 1980) and Oslo, Norway (Kenward, forthcoming a).

For calculation of an index of diversity and the construction of rank order tables, insects ideally should be recorded in monospecific groups. This has been done for difficult taxa by allocating the specimens to 'types' in each sample (Kenward, 1978b). The *Atomaria* were re-examined by Dr C. Johnson; the 'types' were found to correspond, for the most part, to the species identified by him. The 'types' are believed to be as good in the case of other difficult groups (e.g. *Philonthus,* Aleocharinae, *Cryptophagus* and Corticariinae), although for a few samples it was not practicable to make the division with very great accuracy.

In addition, estimates of the concentration and percentage of species associated with rotting organic matter are given. This component of archaeological assemblages, and the problems associated with it, are discussed by Kenward (1982 and forthcoming a). In the first instance, the values were calculated for two groups: species which are primarily associated with foul, wet, decaying matter and dung and not normally abundant in other conditions (Cw); and species typically abundant in comparatively dry, mouldy, plant remains (Cd) (Figs. 36–7). It is difficult to define either group precisely; the ecology of most species is poorly known and several must be disregarded because they are very eurytopic (catholic) and fall in both groups (e.g. *Anotylus rugosus*). As might be expected, some species are apparently most abundant in intermediate conditions, while the 'dry' group merge imperceptibly into the communities of nests and of litter beneath living plants. To tackle this problem, the rotting matter components for the samples from 5–7 Coppergate and Trench II, Lloyds Bank, have been recalculated on a different basis. Three categories are used: the total of species characteristic of decaying matter in general (Rt); those mainly found in rather dry, often mouldy plant debris (Rd); and those strictly associated with foul rotting matter or dung (Rf) (Figs. 38–9; see also Kenward, forthcoming a). Rt subsumes Rd and Rf. This refinement allows the proportion of the fauna definitely associated with rotting matter to be established.

The ecological significance of some of the most abundant species in the assemblages is particularly uncertain; the best example is *Carpelimus bilineatus* (p. 212). The abundant 'small *Carpelimus* sp.' from Trench IV, sample 31, is probably *C. pusillus,* recorded from waterside litter, hotbeds and dung heaps (Fowler, 1888, 389). An attempt has been made to determine statistically the relationship of some of these species to the less equivocal ecological groups using Jaccard's (1912) 'coefficient of correlation'. The results of these analyses are published elsewhere (Kenward, 1982) but summarized in Fig. 46.

A variety of other simple tests has been applied to the insect and plant macrofossil statistics in order to identify correlations (p. 192).

Because of the nature of the sites and the record of sampling, and because the analyses were carried out at a very early stage in the development of urban environmental archaeology, this work has been regarded primarily as an exploratory exercise, and conclusions have been drawn only with caution. A further and generally applicable caveat concerns the nature of 'samples' from urban deposits. Most of the layers at Pavement and Coppergate were probably fairly heterogeneous — this is certainly true of similar deposits at other sites in York, where heterogeneity on every scale can usually be observed. Thus a bagful of soil may not be fully representative of a layer, and subsamples taken from that bag may not even be representative of the bagful. However, in order to make an interpretation it has been guardedly assumed that the recorded fauna and flora approximate to those typical of the layer. Unpublished evidence from other sites in York, where replicate samples from single layers have been examined, has shown that while there may be very considerable variations in the identifiable biological remains, their general implications are usually much the same. These observations suggest that the sort of variation seen in the seed data from the samples from Pavement or Coppergate could conceivably occur in a single layer but that the same is unlikely to be true of the insect assemblages (p.195).

Presentation of Results

The results of the pollen analyses are presented in histogram form (Fig. 32). This is not a 'pollen diagram' in the strict sense, because the samples come from various positions in extensive layers in a stratigraphic succession, and because not all layers are represented. An interpretative diagram by J.R.A.G. (Fig. 45) combines a summary of the pollen evidence with certain seed and insect data; the division between high and low values for 'outdoor' insects is not based on the groupings discussed on p. 196 ff.

The data for plant macrofossils and for insects are too extensive to be published in full, and a compressed form of data presentation, discussed by Hall and Kenward (1980, 46), is used in this report. Even the tables containing these essential data are of considerable length and are presented on Microfiche 1 at the end of this publication (Tables **60–75,** see list on pp. 239–40); smaller tables are included in the text in the usual way. References to microfiche tables are distinguished by numbers in bold type.

A complete list of recorded plant taxa is given in Table **60**, and histograms showing some characteristics of the data in Figs. 30, 33 and 35; the wood from 6–8 Pavement is considered below (p. 179). All the records for all those species of plants occupying the 'first ten ranks of abundance' in any sample (FTRA lists) are given in Tables **61–5.**

A complete list of Coleoptera and Hemiptera recorded from the two sites is given in Table **66,** where the ecological groupings to which species were assigned, following a critical reading of the literature, are shown by codes; other invertebrates are listed in Table **67.** The FTRA lists for Coleoptera and Hemiptera for the four trenches at 6–8 Pavement are given in Tables **68–71** and those for the four columns at 5–7 Coppergate in Tables **72–4.** The main statistics for the assemblages from Trenches II and IV at 6–8 Pavement and from 5–7 Coppergate are given in *AY* 19/1, 46–9. These data, and those for Trenches I and III, are summarized graphically in Figs. 31, 33, 36–43.

The bones from both sites will be described in *AY* 15 but the findings have been drawn upon in the preparation of this report.

Recording sheets, working notes and tables of statistics for the insect and plant macrofossil assemblages are stored in the archive of the Environmental Archaeology Unit (EAU), University of York.

Throughout the text, statistics are given to the nearest whole number for readability.

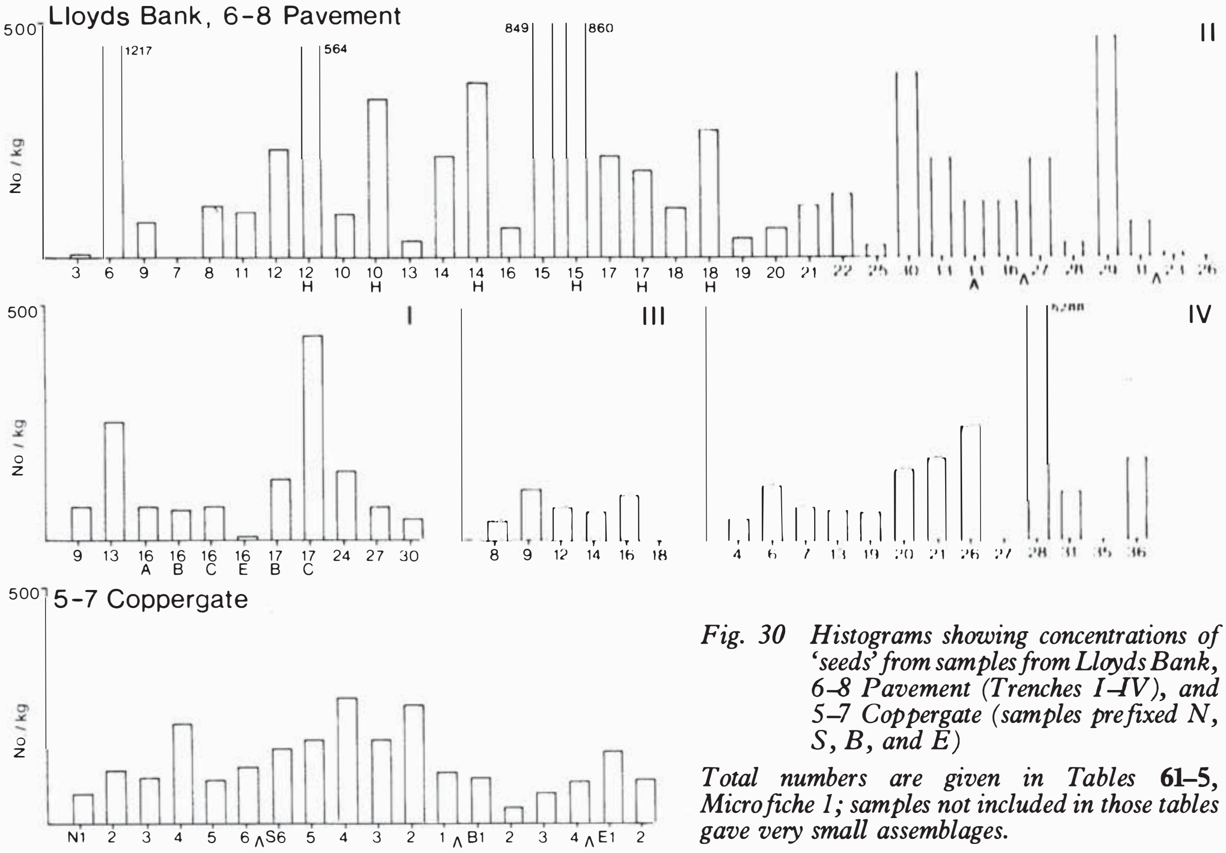


Fig. 30 *Histograms showing concentrations of 'seeds' from samples from Lloyds Bank, 6–8 Pavement (Trenches I–IV), and 5–7 Coppergate (samples prefixed N, S, B, and E)*

Total numbers are given in Tables **61–5**, *Microfiche 1; samples not included in those tables gave very small assemblages.*

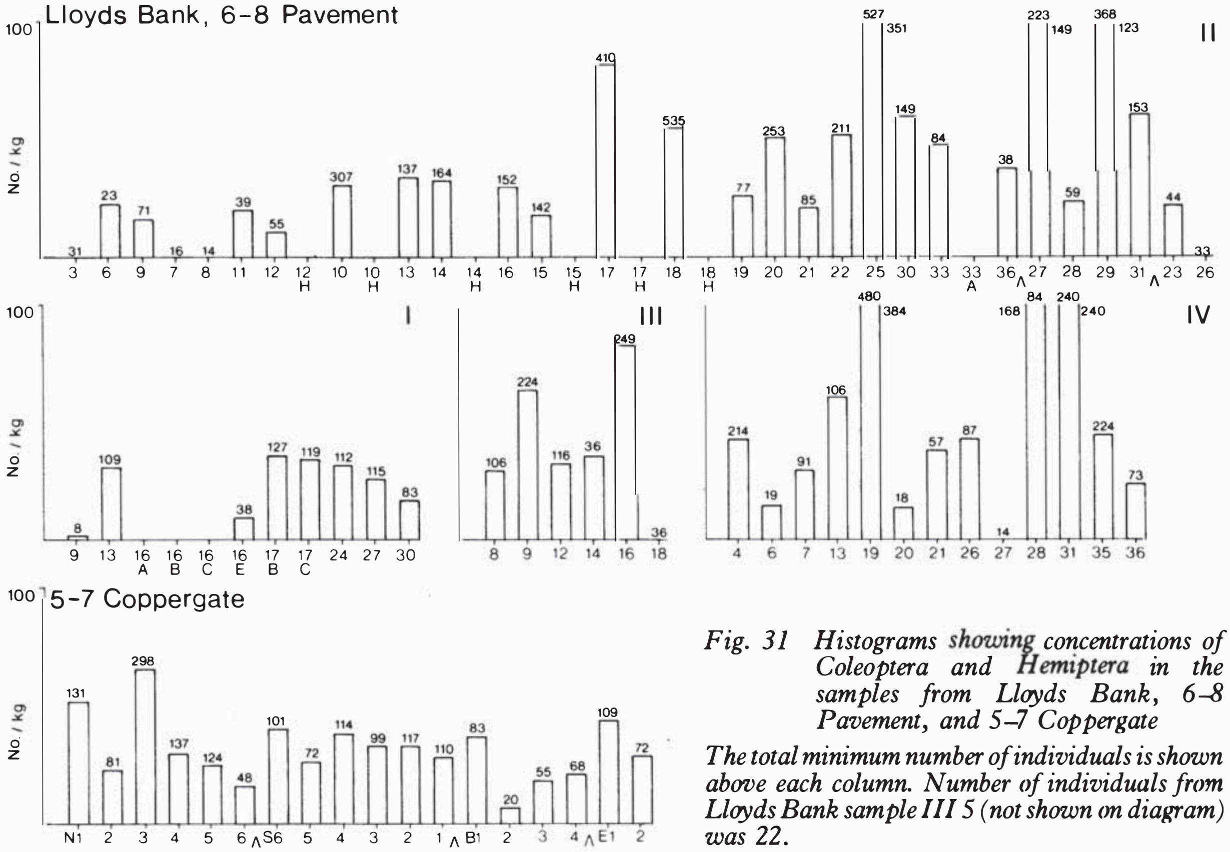


Fig. 31 *Histograms showing concentrations of Coleoptera and Hemiptera in the samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate*

The total minimum number of individuals is shown above each column. Number of individuals from Lloyds Bank sample III 5 (not shown on diagram) was 22.

General Characteristics of the Deposits and their Biota

The salient features of the deposits from the two sites and of the plant and animal remains in them are described here. As far as possible, discussion of their implications is restricted to subsequent sections.

Although a wide range of organic remains were subjected to specific analysis, some other components of the organic fraction could not be investigated in detail; the bulk consisted of plant debris, principally wood and unidentified herbaceous stem and leaf material. The remains of vertebrates formed a significant part of many of the layers at 6–8 Pavement, where bones were sometimes abundant, and leather offcuts occasionally made up more than half of the volume of a layer. Valves of shellfish were conspicuous, but formed only a small proportion of any layer by volume.

The soil matrix

Most contexts at both sites consisted of very highly organic deposits which are probably best described in loose terms as peaty silts. Some layers were recorded in the field as, for example, clays or ash, but the field description did not always tally with the sample; this is almost certainly because localized highly organic parts of the layers had been chosen for sampling, and because field sediment descriptions were not standardized.

Soil analyses were carried out on twenty samples from Trench II, 6–8 Pavement, selecting those which had yielded substantial plant and animal macrofossil assemblages. Practical work was carried out under the supervision of J. S. R. Hood by Miss M. F. Berry and Mrs P. A. Veilleux, following methods outlined by Hood (1979, *AY* 14/2, 78–9) and recording basic characteristics of the whole soil together with particle size analysis of the mineral fraction. Loss-on-ignition was used to determine the organic component and particles larger than 63 μm left after ignition were examined under the microscope for geological and archaeological constituents. The results of the particle size analyses were computer-processed to provide distribution curves and to compare the soils on the basis of their various characteristics. It is likely that the samples chosen for soil analysis are fairly typical of most of the richly organic deposits at both of the sites.

The following account is based on data and computer output in the archive of the EAU, together with observations made during the extraction of biological remains.

The mineral component was largely a mixture of clay, silt and sand, but minute fragments of iron, slag, plaster or mortar, limestone, sandstone, bone, pot, mica and shell were also recorded. The particle size distribution curves show little sign of sorting in the sediments and this, together with the presence of varied inclusions, indicates that the soils have a mixed origin, a characteristic of many urban deposits. A series of computer-generated dendrograms

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Note to Figs. 30–43: Samples lettered 'H' are duplicate samples analysed by A. R. H. (see p. 166); other lettered samples represent different facies of the layer, and are not replicates; caret marks indicate groups of samples forming parallel sequences based on the particle size distribution curves showed that the samples fall into two main and four to six lesser groups. The separation is by curve shape, particularly in the clay fraction, and is produced whatever method is used to construct the dendrogram. However, some samples are not consistently placed (notably samples II 23 and 33) and the significance of the groupings is uncertain.

The organic content of the samples varied from 10% to 60% by dry weight (mean 29%). This is, of course, only a crude measure of the original organic input. To the naked eye, the matrix of the majority of the samples from both sites appeared to be composed almost wholly of organic matter. However, its degree of humification varied considerably, the material ranging from compressed barely rotted plant remains through amorphous 'peat' to crumbly 'soil'. Some samples which appeared to consist chiefly of heavily-humified material in fact took their dark colour and crumbly texture from abundant fine charcoal in addition to humic material. Indeed, to judge from the available samples, two facies were prevalent in the material from Pavement—firstly, apedal, richly organic layers with little charcoal and often an abundance of incompletely decayed plant matter, and secondly, much more friable, often charcoal-rich, layers with a lower uncharred organic content.

Soil characteristics of the samples examined do not seem to correlate with any recorded biological variable and there are no reliable hints of any different origin for the matrix in any of the samples. Indeed, except for the extremes of organic content, the observed variation is very much what would be expected in an accumulation brought about by a variety of processes such as wind-blow, trampling, rubbish-dumping and attrition of soil from structures (e.g. daub).

The biota

Most samples contained large, diverse assemblages of plant and animal remains, preserved for the most part by waterlogging, but with a small component preserved by charring. Two samples particularly rich in charred plant remains were those from layers 21 and 33, Trench II, Pavement; the former also contained a number of charred beetles. Records of charred insects are given in Table 53.

The condition of the waterlogged remains varied considerably, some specimens being so decayed as to be barely recognizable, others astonishingly fresh, with a continuous series between the extremes. The insects from a number of samples, e.g. Trench III, sample 5 (the uppermost Anglo-Scandinavian layer), were reddish, clearly as a result of a moderate degree of oxidation. On the whole, poor preservation was correlated with low concentration of individuals. It is uncertain whether this reflects low input, or heavy decomposition during or after burial.

The most striking characteristic of the biota from these deposits is an underlying uniformity. Many of the species, both plants and insects, are present in a large proportion of the samples from both sites (Table **66**, Microfiche 1, for insects). Those taxa which are only present in a few samples generally occur as one or two specimens only. This suggests random occurrence and such species have little interpretative value. The FTRA lists (Tables **61–5**,

Table 53 Records of charred, 'pale' and congenitally mutilated beetles from samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate

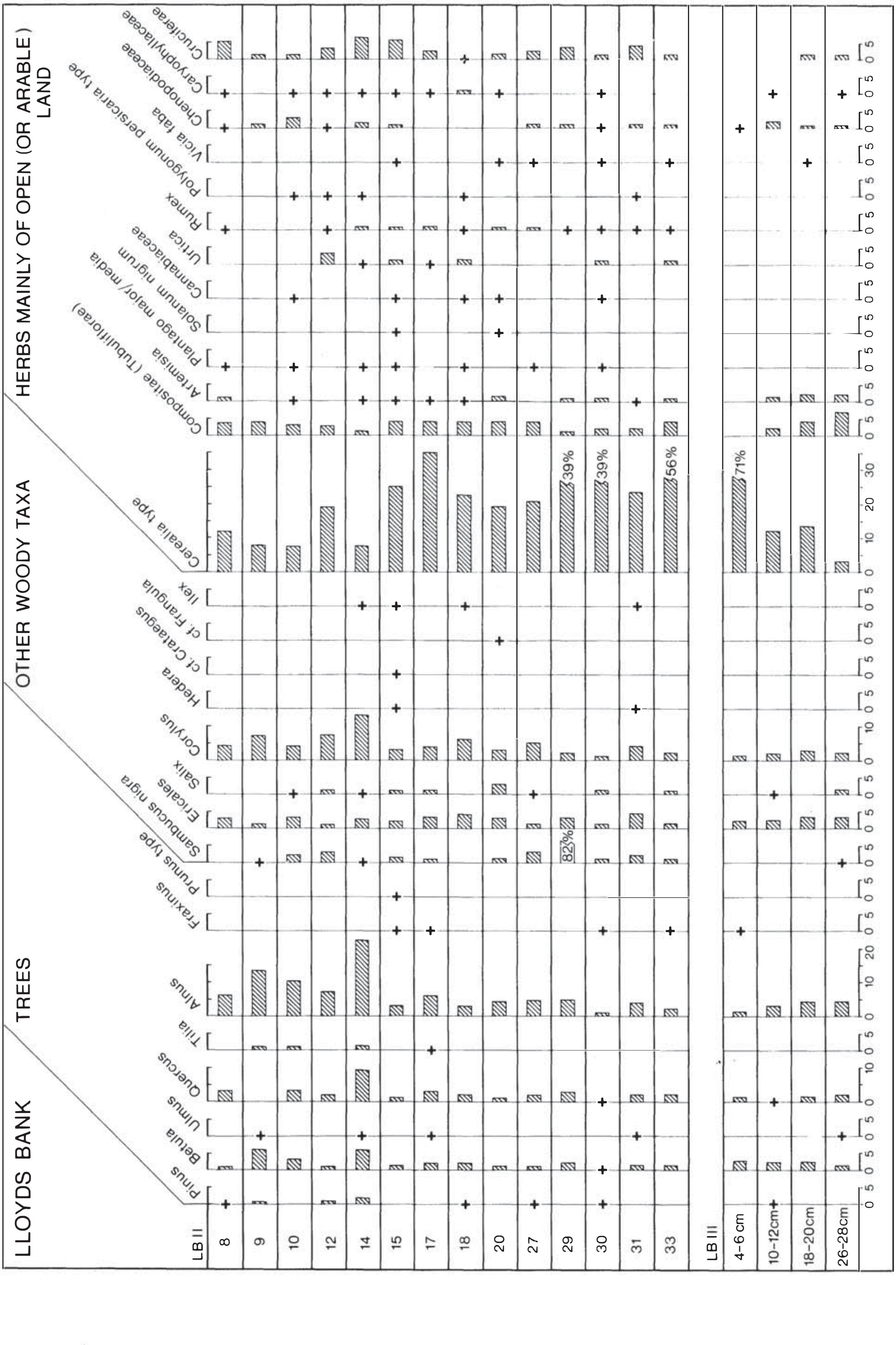
For discussion, see Kenward (1976b, 14). 1 — 1 individual, p — present, a — abundant. The Lloyds Bank samples are prefixed by Trench numbers I–IV, Coppergate samples by column letters N, S, B, E

Taxon	Charred	Pale	Distorted
Clivina fossor	—	IV 31 1	—
Gnathoncus sp.	—	II 17 p	II 17 p II 20 p
Hister sp.	II 13 1	—	—
Xylodromus concinnus	II 21 1	—	—
Carpelimus bilineatus	—	II 17 p II 25 p II 33 p IV 4 p IV 19 p	—
Anotylus nitidulus	—	N3 p	—
Anotylus rugosus	—	IV 31 1	III 9 1
Oxytelus sculptus	—	II 16 p IV 19 p	III 16 p
Aleocharinae	II 13 ?p	—	—
Monotoma picipes	—	II 17 p	—
Aglenus brunneus	II 21 a II 13 1	II 14 p II 17 a II 20 p II 33 p IV 19 a	—
Atomaria sp.	II 36 1	—	—
Cryptophagus scutellatus	—	II 17 p	—
Typhaea stercorea	—	III 16 p	—

68–74) illustrate this point, being dominated by a fairly small group of taxa. Only 59 of over 400 taxa of beetles and bugs are ever present in the FTRAs, and even fewer species regularly so. Of the plant macrofossils, 64 taxa of the total of 124 are represented in the FTRAs. Although uniformity of biota is clear enough on superficial inspection, it is well illustrated by the 'indicator species analysis' carried out on the insect data by Strudwick (1979). This quantitative multivariate statistical technique failed to identify clear groupings of samples on the basis of their insect assemblages. (It must be stressed, however, that the method cannot, unmodified, recognize differences which are detectable using the approach outlined by Kenward (*AY* 19/1), where statistics of the whole assemblages were used, or Kenward (1982), where an attempt was made to compensate for the presence of 'background' fauna.) The history of the plant macrofossil analyses precluded similar quantitative approaches.

Pollen

As the 'pollen diagram' (Fig. 32) shows, the spectra are dominated by pollen of cereals and other grasses (Cerealia type and Gramineae). Tree and shrub pollen is generally sparse (when compared with spectra from natural postglacial deposits), comprising 10–15% of the total pollen sum in most samples. On the whole, the spectra are rather uniform, although there is a group of four samples (II 8, 9, 10, 12) rich in Compositae (Liguliflorae)— a large sub-family, including sow thistles, hawkweeds and dandelions. Tree and shrub pollen reaches a maximum of 55% in sample II 14 and there are two samples in which Cerealia type exceeds 50% of the total pollen sum. The presence of cf. *Gentiana pneumonanthe* (?marsh gentian) is worthy of remark; it is an uncommon plant in Britain today, although it does grow as close to York as Strensall Common, a heath a few miles to the north of the city.


LLOYDS BANK
TREES
OTHER WOODY TAXA
HERBS MAINLY OF OPEN (OR ARABLE) LAND
Pinus
Betula
Ulmus
Quercus
Tilia
Alnus
Fraxinus
Prunus
Sambucus type
Ericales
Sambucus nigra
Salix
Corylus
Hedera
cf Crataegus
cf Frangula
Ilex
Cerealia type
Compositae (Tubuliflorae)
Artemisia
Plantago major/media
Solanum nigrum
Cannabiaceae
Urtica
Rumex
Polygonum persicaria type
Vicia faba
Chenopodiaceae
Caryophyllaceae
Cruciferae
LB II
8
9
10
12
14
15
17
18
20
27
29
30
31
33
LB III
4-6 cm
10-12cm
18-20cm
26-28cm
82%
39%
39%
56%
71%
0 5
0 10
0 10 20
0 10 20 30

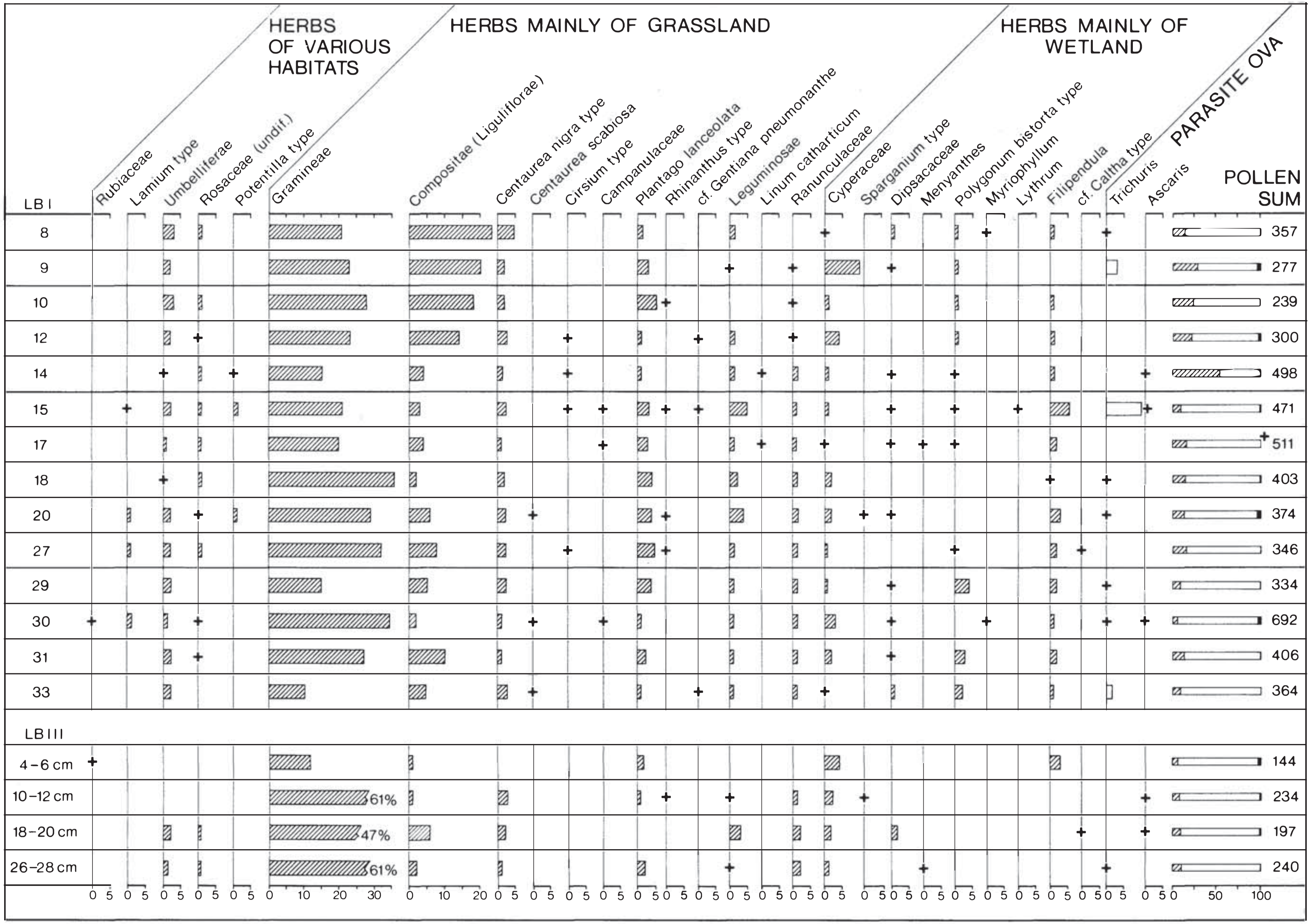


Fig. 32 *Pollen spectra from a series of samples from Trenches II and III at Lloyds Bank, 6–8 Pavement; Trench III samples were taken at regular intervals down the face of a block sample. Values are % of total pollen with the exception of II 29, where* Sambucus *has been excluded; + indicates values of < 1%. Parasite ova are not included in the pollen sums. The bars on the right of the diagram show the total percentage of pollen from trees and shrubs (hatched bars), dryland herbs (open bars), and wetland herbs*

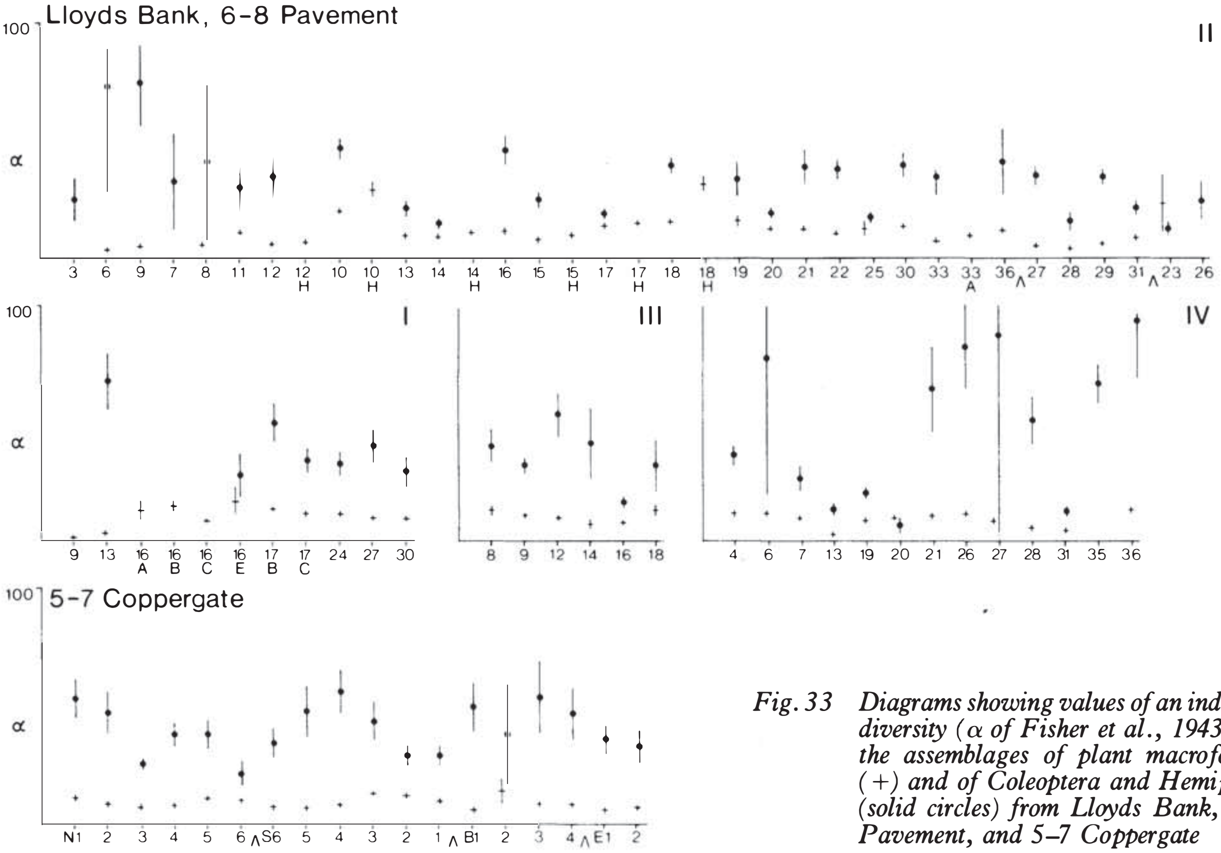


Fig. 33 Diagrams showing values of an index of diversity (α of Fisher et al., 1943) for the assemblages of plant macrofossils (+) and of Coleoptera and Hemiptera (solid circles) from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate

The bars show a one standard error (i.e. 66% probability) range. The errors for plant macrofossil assemblages are mostly too small to be shown. Means and errors for insect assemblages: Lloyds Bank Trench I — mean 40.6, SD 14.2, SEM 5.4; II — 31.9, 14.1, 2.9; III — 40.6, 16.0, 6.0; IV — 50.0, 31.4, 8.7; combined Lloyds Bank data — 38.9, 21.0, 3.0; Coppergate — 40.0, 10.4, 2.5

Note that while the values of α for the main range of seed samples may, with caution, be compared internally, external comparison would be unwise, since there was incomplete recovery. The duplicate samples marked 'H' may be externally compared. The distributions of values of α for plant and insect assemblages are shown in Fig. 34

Plant macrofossils (including wood)

The concentration of 'seeds' varied widely (Fig. 30). The mean for the samples from 6–8 Pavement analysed by D. W. was 291 per kg (standard deviation (SD) = 712; range 4–5288). These values, which are based on material from paraffin flots alone, are generally much lower than the counts from the six samples analysed by A.R.H. (see p. 166), which show a range of concentrations from 186 to 860 individuals per kg (mean = 431, SD = 245). Seed concentrations were generally lower, or at least more consistently low, for the samples from 5–7 Coppergate, with a mean of 128 (SD = 67; range 10–263). Moreover, in layers where large amounts of leather offcuts were observed, the seed concentrations were, not surprisingly, lower than in adjacent layers where abundant leather fragments were lacking, since there was less matrix. Concentrations were generally lowest in those samples recorded as 'sandy' or 'crumbly', suggesting strong humification during or after deposition. Plant macrofossils from some of the samples with low concentrations of seeds were poorly preserved.

The values for an index of diversity (α of Fisher et al., 1943) for seed assemblages from both sites are shown in Fig. 33, and the distribution of values in Fig. 34. It is clear that, with only

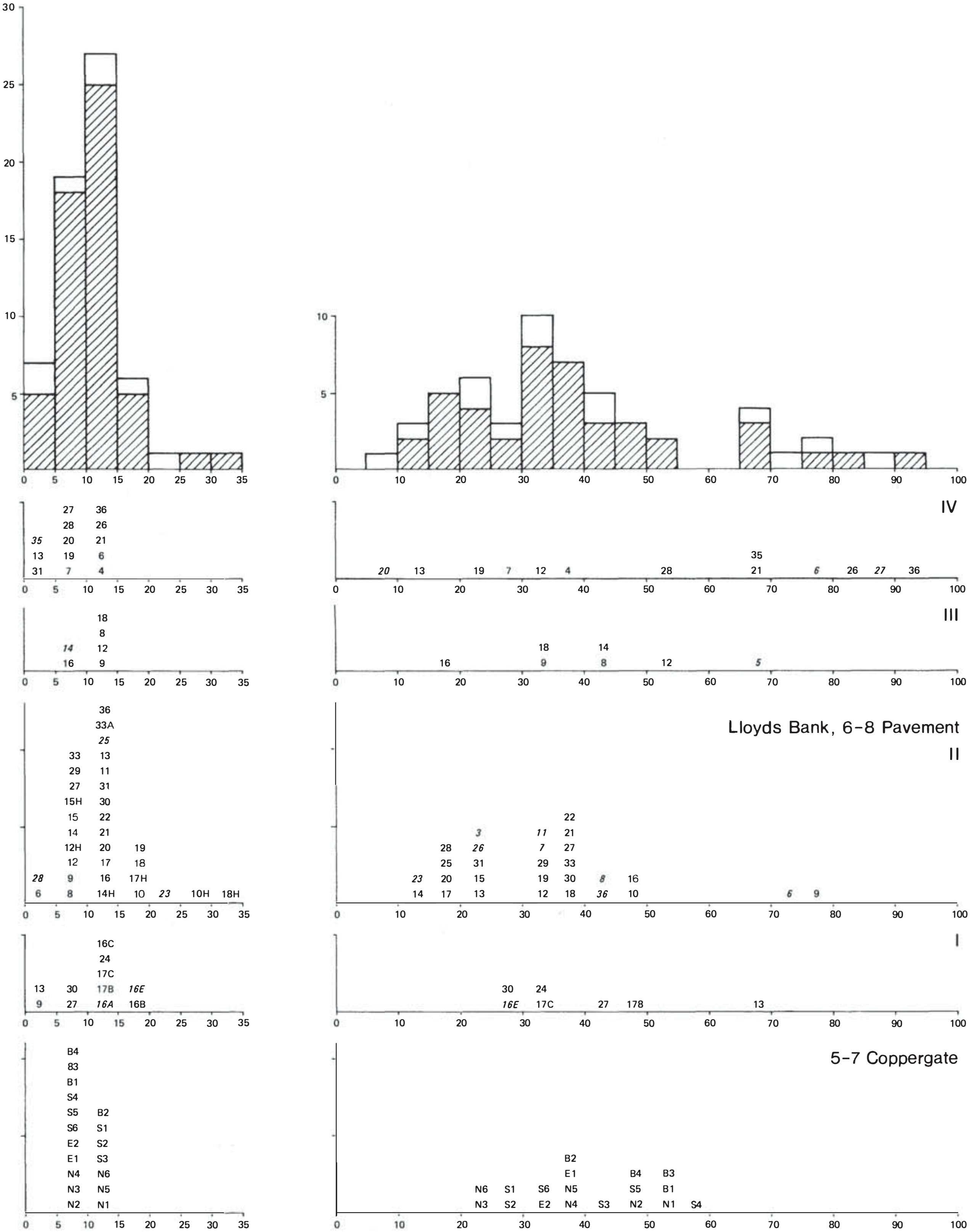


Fig. 34 *Histograms showing frequency distribution of the index of diversity α (horizontal axes) for plant macrofossil (left) and insect assemblages (right) for samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate. The uppermost histograms summarize data for all samples (small assemblages, <100 for seeds, <50 for insects, are unshaded). The lower ones give details for the four trenches at Pavement and for Coppergate (small assemblages shown in italics)*

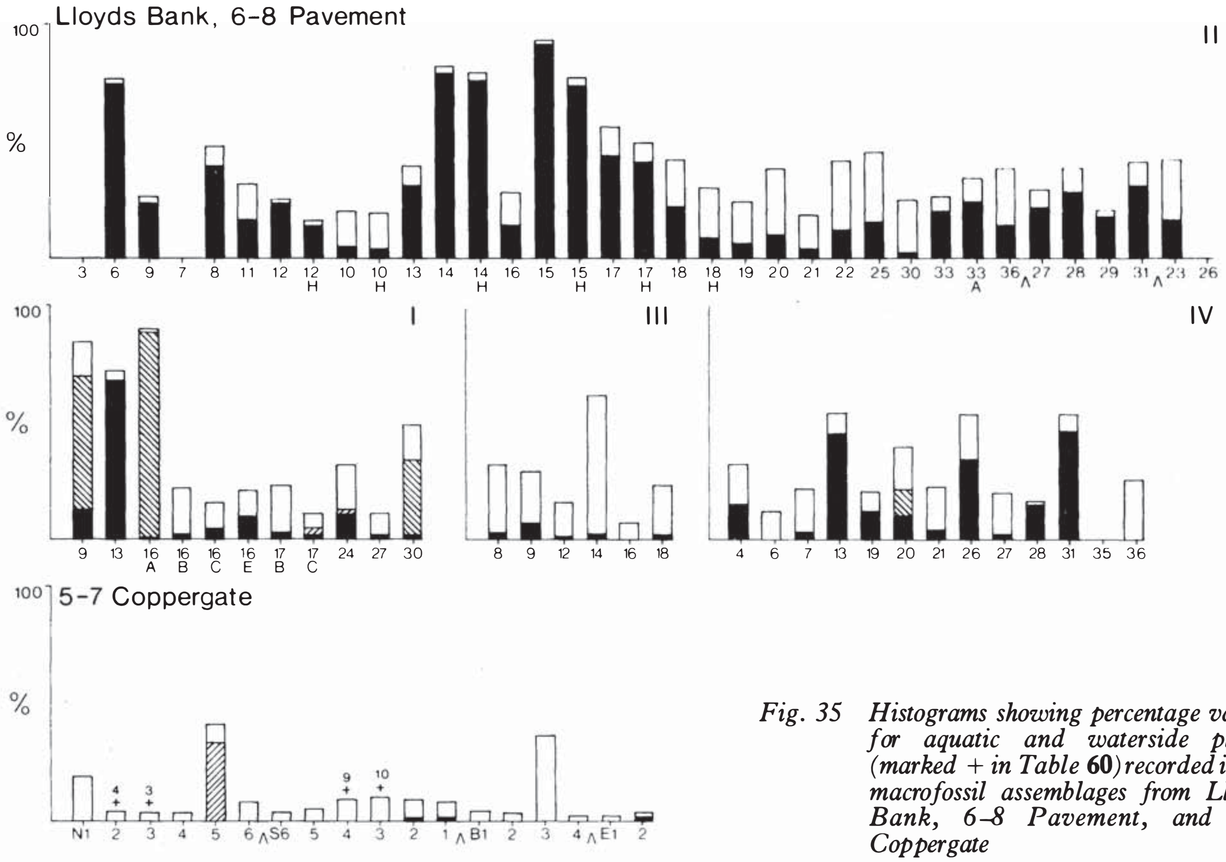


Fig. 35 Histograms showing percentage values for aquatic and waterside plants (marked + in Table **60***) recorded in the macrofossil assemblages from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate*

Solid bars — Ranunculus sceleratus*; shaded —* Juncus, *except in I 17C and 24, and N5, where shade —* Polygonum hydropiper*; open bars — remaining aquatic and waterside taxa. + above axes indicates values of* Ranunculus sceleratus *at less than 1%*

one or two exceptions, the seed assemblages have a low mathematical (although not necessarily ecological) diversity when compared with the insect assemblages. There is obviously a need to measure the diversity of assemblages of seeds in a wide range of ancient and modern deposits before the significance of such figures can be judged. Comparison with a variety of unpublished sites suggests that most of the present samples are of unusually low diversity, having a modest number of taxa in great abundance and a relatively small number of rare ones. The difference in α for the subsamples from II 10 and 18 is probably an artefact of experiment, resulting from the different extraction methods employed by D.W. and A.R.H. There is certainly no hint of the bimodality observed in some of the insect data (p. 196), nor any correlation between diversity of the plant and insect assemblages (p. 192 below).

As the FTRA lists (Tables **61–5,** Microfiche 1) and the histograms show, the assemblages from samples from both sites are dominated by plants of 'disturbed' habitats such as waste ground or arable land. They constitute about half of the taxa (but are much more important in terms of numbers of individuals) and include *Anthemis cotula* (stinking mayweed), *Chenopodium* species (goosefoots), *Atriplex* species (oraches), *Polygonum* species (knotgrass, persicarias), *Stellaria* cf. *media* (chickweed) and *Urtica* species (stinging and annual nettles). There is also a significant but variable component (Fig. 35) representing damp to aquatic habitats — *Carex* species (sedges), *Eleocharis* species (spikerushes), *Isolepis setacea* (bristle scirpus), *Polygonum hydropiper* (water pepper) and *Ranunculus sceleratus* (celery-leaved crowfoot). The last of these was often recorded in vast quantity in samples from Lloyds Bank (p. 214).

Remains of plants which might have been of some economic importance were occasionally encountered; these include hop (*Humulus lupulus*), hemp (*Cannabis sativa*), flax (*Linum usitatissimum*), apple (*Malus sylvestris*), hazel nut (*Corylus avellana*), walnut (*Juglans regia*) and, rarely, fruitstones of *Prunus* species. Nutshell fragments and larger fruitstones were almost certainly under-represented in the paraffin flots but were not systematically recorded from the dry residues. Charred grain was also recorded from many samples, though never in quantities sufficient for detailed investigation (concentrations were generally less than 5–10 per kg). Wheat (*Triticum* sp.) and barley (*Hordeum vulgare*) were the most common cereals, with small amounts of oats (*Avena* sp.), possibly a weed contaminant. The diagnostic spikelet fragments were either lacking or very poorly preserved, obviating closer identification. A few charred pea seeds (*Pisum sativum*) were noted by D.W. from sample 22, Trench II.

Mention was made by Buckland et al. (1974, 26) of 'recognizable fragments of reeds, probably *Phragmites communis*' and also of heather (*Calluna*) 'rootlets . . . still with a heath soil'. No evidence for reeds was found in the present investigation, but there were some flowers and fragments of leafy shoots of *Calluna* in many samples from both sites. It is possible that much of the unidentified plant debris comprised grass or cereal stems and leaves from hay or straw, rather than reed or sedge; analysis of phytoliths might have proved useful here, but was impracticable. Positive evidence for the remains of grass is provided by the pollen results, however. Gramineae and Cerealia type pollen was abundant in all the spectra (Fig. 32), together with some other pollen taxa which may have originated in grassland vegetation or cereal straw. Grass fruits preserved by waterlogging (rather than charring) were rare and those recorded could not be identified to species. Mosses, too, were rare.

Large amounts of wood were taken from both sites— structural timbers or piles, as well as posts, wattle and twigs. The results of wood identifications for the material from Lloyds Bank indicate that oak (*Quercus*) was used for the major timbers, though many of the posts with a diameter of about 50–100 mm (2–4 in) proved to be ash (*Fraxinus*) or alder (*Alnus*). Hazel (*Corylus*), alder, willow (*Salix*) and birch (*Betula*) were present in the brushwood and wattle, hazel being the most important. Pine (*Pinus*) was found as pieces of plank and a worked fragment from the lower layers of Trench IV; its wood is only rarely encountered amongst medieval timbers from York, though MacGregor (*AY* 17/3) records several softwood bowls from Pavement. No elm (*Ulmus*) was recorded, although it is noted for resistance to decay in damp soil.

Amongst the wood recovered from various layers were numerous chips of bark, not identified but considered by the excavators to have been oak. Characteristically rolled fragments of birch bark were present in many samples.

Invertebrates

A wide range of invertebrates was recorded (Tables **66–7**, Microfiche 1), but only the beetles and bugs could be subjected to systematic investigation. Fly puparia were present in all the samples and occasionally abundant; some have been identified (p. 180). Parasitic wasps, mainly of the superfamilies Proctotrupoidea and Chalcidoidea, were also present in most samples, and included the characteristic heads of the fly-parasite genus *Spalangia*. Ants of the genera *Myrmica* and cf. *Lasius* were recorded from several samples and honey bees (*Apis mellifera*) from a few. Earwigs, represented by elytra and cerci, and apparently all *Forficula auricularia,* were present in many samples and a single human flea, *Pulex irritans,* identified by its male genitalia, was recovered from Pavement.

There were small numbers of spider carapaces, head capsules and segments of millipedes, and many mites, while earthworm egg capsules were present in many of the samples. The distinctive resting eggs (ephippia) of *Daphnia* (water fleas) were recorded from two, but only in very small numbers. Of these invertebrates, only the mites were sufficiently abundant to have had much potential as a source of information about the site; it was not possible to investigate them.

The valves of oysters (*Ostrea edulis* L.) and mussels (*Mytilus edulis* L.) were abundant through much of the succession at 6–8 Pavement and present in smaller numbers at 5–7 Coppergate. At the former site, a few layers contained quite large numbers of oysters, for example 63 individuals from Trench I layer 12, 60 from II 8, 149 from III 10; the numbers show a marked increase towards the upper layers.

A small number of freshwater gastropods were recorded at Pavement from both the auger samples and the main sequence of Trench IV; all were *Planorbis* species (sensu lato). However, there were insufficient aquatic organisms to warrant the inference that even the basal deposits were waterlaid, and cross-contamination between the core samples made the original position of these remains uncertain.

Some fly puparia from a small number of samples from the Pavement deposits were examined in detail. **Dr Y. Z. Erzinclioglu** and **Professor J. Phipps** have submitted the following report on representative specimens.

> Four families dominate: Drosophilidae, Sphaeroceridae, Calliphoridae and Muscidae.
>
> The Drosophilidae belong to the genera *Drosophila* and *Amiota*. The only species which can be named with certainty is *Drosophila melanogaster* Meigen (the fruit-fly so widely employed by geneticists), which is particularly associated with rotting fruit and other vegetable matter.
>
> Among the Sphaeroceridae, six species of *Leptocera* and two of *Copromyza* have been identified. *Leptocera* (subgenus *Limosina*) *heteroneura* (Haliday) is on the wing throughout the year but found mainly indoors in spring and autumn. The larvae have been recorded from human habitations but also from small mammal burrows, cormorants' nests and caves. *L.* (*Limosina*) *claviventris* (Strobl) is occasionally found indoors but more often in decaying vegetation and small mammal runs. It flies mainly in winter. *L.* (*Limosina*) *bifrons* (Stenhammar) is common throughout the year, breeding in haystacks, grass cuttings and other decaying vegetable matter, mouse runs, and horse dung. It is often found indoors, especially in barns and stables. *L.* (*Thoracochaeta*) *zosterae* (Haliday) (tentatively identified) is a mainly coastal species, the larvae living in seaweed along the strand line, but it is occasionally found inland. *L.* (*L.*) *caenosa* (Rondani) is a very common species indoors, characteristic of water-closets with defective plumbing. It is rarely found outdoors, but is occasionally recorded from caves and mammal burrows and has been bred from wasps (*Vespula*) nests. *L.* (*Trachyopella*) *leucoptera* (Haliday) is uncommon in Britain, but has been recorded from dung in

Germany. The members of the genus *Copromyza* are small and the specimens cannot be determined at present.

The Calliphoridae belong to the genus *Lucilia*; these are sun-loving flies that rarely come indoors and include species causing 'strike' in sheep.

In the Muscidae, many fragments of the puparia of the common 'house fly', *Musca domestica* L., have been found. The species is closely associated with man. Other muscid puparia appear to belong to the genus *Dasyphora,* species of which often enter buildings and may hibernate in them. (Nomenclature follows Kloet and Hincks, 1977.)

While this exploratory work clearly shows the potential value of fly puparia, in the present state of knowledge and for the present sites the assemblages of bugs (Hemiptera) and beetles (Coleoptera) have been much the most useful invertebrate remains for interpretation. For the samples from 6–8 Pavement, their concentrations, based on minimum number estimates, gave a mean of 63 per kg (SD = 81; range 10–384) and, for assemblages from 5–7 Coppergate, a mean of 31 (SD = 14; range 7–66). These means differ significantly at the 95% level. (Histograms showing the data on which these statistics are based are given in Fig. 31.)

Of over 400 bug and beetle taxa recorded from the two sites, four are both regularly present and occasionally extremely numerous: *Ptenidium* spp. (mostly *P. punctatum*), *Carpelimus bilineatus, Anotylus nitidulus* and *Aglenus brunneus.* Discussion of the distribution and ecology of the abundant and regularly occurring species draws upon the following standard works in addition to other sources cited: Fowler (1887–91), Freude et al. (1965–81), Horion (1941–67), Hansen (various dates), Balfour-Browne (1940–58), Donisthorpe (1939), and Palm (1948–72). Because this is the first time a large group of samples from urban waterlogged deposits has been published, and because there are few modern summaries of species' ecologies, the species are discussed in some detail. They are typical of all early medieval urban sites for which insects have been examined. Where appropriate, the codes for ecological groups (see caption to Table **66,** p. 239, and Figs. 36–44) are given after the species names.

At least three species of the genus *Ptenidium* (Rt), minute beetles mostly found in rotting plant matter, were present at Pavement — *P. intermedium, P. nitidum* and *P. punctatum* (determined by C. Johnson). *P. punctatum,* the most abundant at Pavement, is recorded as living under stranded seaweed on the coast (Backlund, 1945, 203) and Allen (1970) states that this is the usual habitat. It was also abundant at Chapel Lane Staith, Hull (Kenward, 1979c), in 14th century material believed to have been deposited at the high water mark in estuarine conditions, together with *Actidium coarctatum* (Haliday) and *Cercyon depressus* Steph., two species characteristic of marine strandline litter. In the supplement to Fowler, however, a point is made of 'inland records' with three localities, one 'in manure-heap' (Fowler and Donisthorpe, 1913, 252). Thus under unusual circumstances the beetle seems able to invade inland habitats, a view confirmed by records for Central Europe (Besuchet and Sundt, 1971, 317). According to Horion (**2,** 1949, 231), the inland records are from areas with saline soils, but C. Johnson (pers. comm.) records it as occurring frequently in large numbers in old dung-heaps inland. Some other rotting seaweed beetles are known from inland habitats, a good example being *Actidium coarctatum* which, despite arguments to the contrary (Horion, ibid., 240), undoubtedly occurs in hot-beds inland (Fowler, 1889, 135). Interestingly, some coastal plants will colonize nutrient-rich inland habitats as weeds (e.g. *Atriplex hastata* and *A. patula, Chenopodium rubrum* and *Tripleurospermum maritimum,* the last of these, however, as an ecologically distinct subspecies). *P. punctatum* is abundant in the material from Pavement in insect assemblages of both the main types discussed below for Trench II (p. 196).

Of the other *Ptenidium* species, *P. intermedium* has been recorded from vegetable refuse and under bark, and also from mud and shingle (Allen, 1970), perhaps being particularly associated with wet conditions (Horion, **2,** 1949, 229; C. Johnson, pers. comm.). *P. nitidum* occurs in a wide range of rotting-matter habitats and is very common and often abundant. According to Johnson (pers. comm.) it is particularly associated with dung in open terrain.

The small staphylinid beetle *Carpelimus bilineatus* (not coded), very abundant in several samples from Pavement (e.g. 230 individuals in 1.5kg in II 25), is known mainly from flood-refuse and at grass-roots in marshy places, and from the banks of ponds and streams. It is common and widely distributed in Britain. The many hundreds of fossils vary in shape and sculpturation and may include a few *C. rivularis,* known from similar habitats. Like *Ptenidium punctatum, C. bilineatus* seems not to have occupied its typical modern habitat on the sites at Coppergate and Pavement and for this reason has not been assigned to an ecological category. It is discussed in detail below (p. 212).

Anotylus nitidulus (OA, D) has been recorded from a wide variety of habitats in Britain and Europe, ranging from mud by water, through wet refuse, to corpses, nests and dung. Although described as common by the authorities, and recorded in abundance on occasions, field experience (H.K.K.) suggests that it is not generally common today. *A. nitidulus* is present in most of the samples and abundant in one, N3 from 5–7 Coppergate, representing 55% of the large assemblage. In this and related samples it is accompanied by unusually large numbers of *Platystethus cornutus* group (OA, D), the latter being associated with mud by water (Hammond, 1971). Whether these species bred on the sites (and if so, in what), or came from elsewhere is crucial to interpretation, but problematic (see below, p. 211).

Archaeological and modern records of *Aglenus brunneus* (Cd/Rt), a blind, flightless beetle present in almost every sample from Pavement (where it was occasionally very abundant, e.g. Trench II, 13–18, Figs. 38–9) but less important at Coppergate, have been discussed elsewhere (Kenward, 1975a, 1976a). The species is now quite rare but undoubtedly was much more abundant in the past; this, and the lack of modern equivalents of a town with extensive, long-lived spreads of rotting matter, make its significance hard to judge, beyond likely association with mouldering organic remains. At least partly subterranean, *A. brunneus* may have lived in buried deposits.

A number of other species or groups of beetles are present in a large proportion of the samples, but not as abundant as the preceding.

Cercyon analis (Cw/Rt) is recorded from most samples, occasionally in quite large numbers (e.g. II 25). Its principal habitats according to the standard works range from compost to dung but, being a common species today, it has received little attention in the literature. It appears, however, to be more abundant than other *Cercyon* species in rather dry rotting matter and compost (see p. 195 and Fig. 46). Some other *Cercyon* species, especially *C. pygmaeus*, *C. terminatus* and *C. unipunctatus* (all Cw/Rf), are frequent, particularly at Coppergate. All occur in many kinds of rotting matter but seem to be primarily associated with foul conditions, for example wet plant matter and dung.

The tiny histerid beetle *Acritus nigricornis* (–/Rt) was recorded from 34 samples, but always in small numbers. It is found in dung, compost, stack-refuse, hotbeds and the like, and less often under bark, in carrion and human excrement; it is quite common in Britain (Kryzhanovskii and Reichardt, 1976; Halstead, 1963).

Xylodromus concinnus (Cd/Rt) was present in almost all the samples in small numbers at Coppergate but sometimes quite abundant at Pavement (e.g. II 18). In nature the species is associated with dead wood, and is also found in birds' nests and similar habitats, but it has successfully colonized man-made environments and is commonly found in hay and straw refuse and in stored products (Hinton, 1945).

Also occurring regularly were *Platystethus* species: *P. cornutus* group (at least some being *P. degener*, OA, D), *P. nitens* (OA, D) and *P. arenarius* (Cw/Rf). The first was sometimes abundant at Coppergate (e.g. N5), while the other two were rarely represented by more than one or two individuals. It has been argued elsewhere that such species, constantly present in small numbers, originated as 'background fauna' (*AY* 19/1, 6–8, table 1). *P. cornutus* group and *P. nitens* are associated with damp mud, generally by water, and *P. arenarius* with dung and other rotting matter of similar texture (Hammond, 1971). Two other oxyteline genera, *Anotylus* and *Oxytelus*, include three further species of regular occurrence. *Anotylus rugosus* (–/Rt) is present in almost all of the samples, generally in small numbers, but occasionally abundant (e.g. II 29). This beetle is extremely catholic; among its habitats are soil and the roots of vegetation, waterside mud, and decaying matter both dry and foul, including seaweed and dung. *A. complanatus* (Cw/Rt), also present in almost all the samples but never very abundant, is less eurytopic and principally found in dung and foul matter. *Oxytelus sculptus* (Cw/Rt), consistently present at Coppergate but less so at Pavement, and abundant in sample III 16, is recorded from rather similar habitats, but may be a little more eurytopic.

Most of the Aleocharinae, present in almost all samples, cannot be sufficiently closely identified to be of value. However, one taxon can be identified more closely: *Falagria caesa* or *sulcatula* (–/Rt). Never abundant in the samples, these beetles are recorded from a variety of habitats, from marshy places to stack refuse. Two other staphylinids, *Leptacinus pusillus* (–/Rt) and *Gyrohypnus fracticornis* (–/Rt) are present in a large proportion of the samples. They are found mainly in rotting matter ranging from haystack refuse to old manure, but occasionally elsewhere, for example in rotting fungi and fallen leaves.

Trox scaber (–/Rt), also consistently present in small numbers, lives on drying animal remains, though it is primarily associated with birds' nests, usually in hollow trees (Palm, 1959, 301; Britton, 1956). Leatherdale (1955) cites an example of large numbers emerging from a birds' nest in a house. It seems, however, to be able to exploit other kinds of rotting matter, having been found for example, in abundance in a pitfall trap baited with rotting tinned cat-food set near a garden compost heap in Kent (Kenward, unpublished).

Dung beetles of the genus *Aphodius* (OB, Cw/Rf) are present in most of the assemblages, with several species quite regular but never abundant. Most of these insects are primarily associated with dung, but *A. prodromus* and *A. granarius*, the two species best represented, are also found in rotting vegetable matter, while *A. granarius* is also known to feed on carrion (Landin, 1961).

The spider beetle *Ptinus fur* (–/Rd) is certainly or tentatively identified from over half the samples, but rarely as more than one or two individuals. At present primarily associated with buildings and stored products, it is also known from dead wood and birds' nests, presumably its natural habitats (Hinton, 1941; Palm, 1959).

Always present and generally abundant are a number of species of the genera *Atomaria* (Cd/Rd), *Cryptophagus* (Cd/Rd) and *Monotoma* (Cd/Rt), and the family Lathridiidae. These beetles, while found in a variety of habitats, are mostly recorded from rather dry rotting plant matter. Representative *Atomaria* have been examined by C. Johnson, who distinguished *A. munda* (quite common), *A. nigripennis* (quite common, especially in II 25), *A. apicalis* (much the most abundant), *A. ruficornis*, *A. fuscata* and *A. pusilla*. The following summaries of their ecology are based on his notes: *A. munda* and *A. nigripennis* are strictly synanthropic, found in mouldy hay and the like in barns, sometimes outdoors but then in warm spots such as dung-heaps and haystack bottoms; there are also records from cellars. *A. apicalis* and *A. ruficornis* are found in decaying plant matter and mouldy dung, commonly in compost heaps, *A. pusilla* in stack bottoms, old grass etc., and *A. fuscata* in decaying leaves, grass and moss, often in rather damp places, less often in compost heaps.

The *Cryptophagus* included species of the difficult *C. dentatus* group, and *C. scutellatus*, found in most of the samples from Trench II, Pavement; the latter was present in the

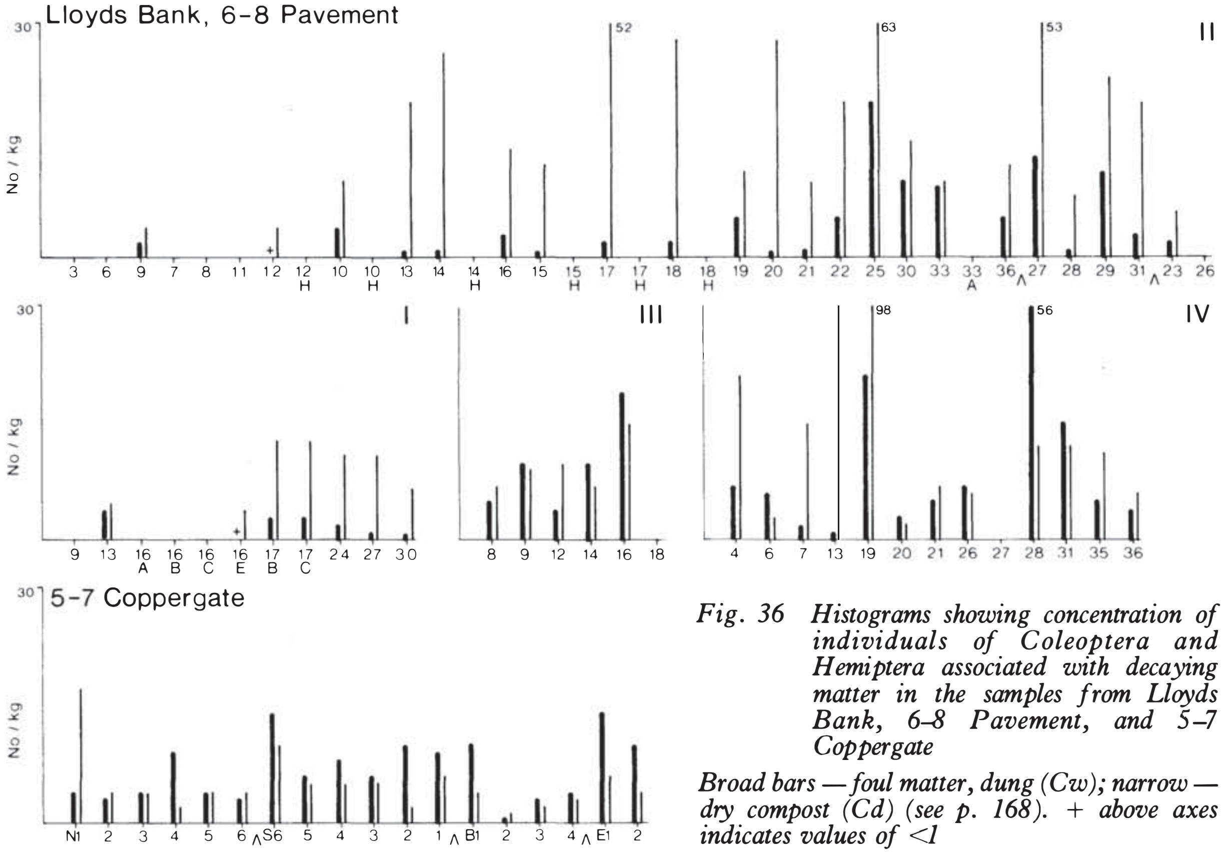


Fig. 36 *Histograms showing concentration of individuals of Coleoptera and Hemiptera associated with decaying matter in the samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate*

Broad bars — foul matter, dung (Cw); narrow — dry compost (Cd) (see p. 168). + above axes indicates values of <1

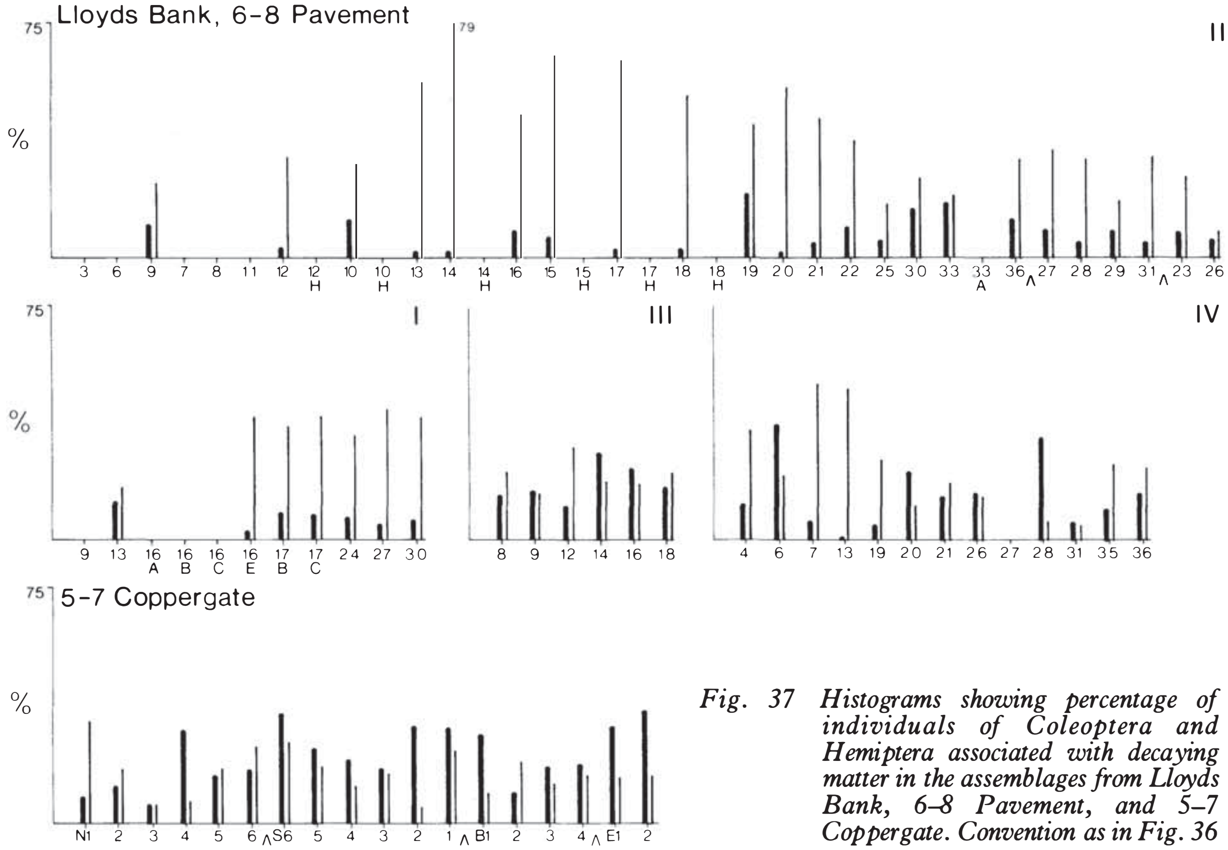


Fig. 37 *Histograms showing percentage of individuals of Coleoptera and Hemiptera associated with decaying matter in the assemblages from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate. Convention as in Fig. 36*

remaining trenches and at Coppergate, but not recorded separately. *Cryptophagus* species occur in a wide range of habitats, in buildings, haystacks, birds' nests and dead wood (Coombs and Woodroffe, 1955; Palm, 1959, 264).

Of the lathridiids, the *Lathridius minutus* group (Cd/Rd) predominate, with *Enicmus* species (Cd/Rd) less abundant and less regularly present. These are eurytopic beetles found in natural plant litter, compost, etc., and even on dead leaves on standing plants. They are among the first colonizers of rotting matter unless it is too wet. In the experience of H.K.K., *Enicmus* spp. are much more abundant than *Lathridius* in modern communities. Of the other abundant Lathridiidae, many Corticariinae (–/Rt) are found in plant remains of all kinds, unless too wet.

The recorded beetles are mostly synanthropes, using the broad sense of the word to imply species favoured by the presence of man and by his influence on the landscape. A few are synanthropic in a strict sense, being dependent on artificial habitats in Britain at least; *Aglenus brunneus*, one of the commonest species at 6–8 Pavement, is almost certainly one such (Kenward, 1975a; 1976a).

When the associations are seen as a whole, the great majority of the beetles at both sites are typically associated with decaying matter and many other more catholic species might have exploited the same habitats. Subdivisions may be recognized among the rotting-matter species (p. 168). The relative and absolute numbers allocated to this group and its subdivisions vary greatly and are given in Figs. 36–9.

Many other habitats are represented. The most important are dead wood, water and water margins, buildings, various plants and open ground. Wood beetles are quite abundant; woodworm (*Anobium punctatum*), for example, occurs regularly in moderate numbers. The wood insects range from those typical of structural timber (e.g. *A. punctatum*, present in over half the samples, and *Xestobium rufovillosum*), through those that may exploit timber but are more common in natural habitats (*Grynobius planus, Ptilinus pectinicornis*), to those mostly found in natural habitats (Table 75). The latter may have lived in medieval towns in damp wood, unseasoned timber, or wood retaining bark, but they are just as likely to have been imported with firewood or to have been 'background fauna'. The bark beetles are often imported in logs, and *Leperisinus varius*, in particular, may emerge from them in vast numbers (Mourier and Winding, 1977, 130).

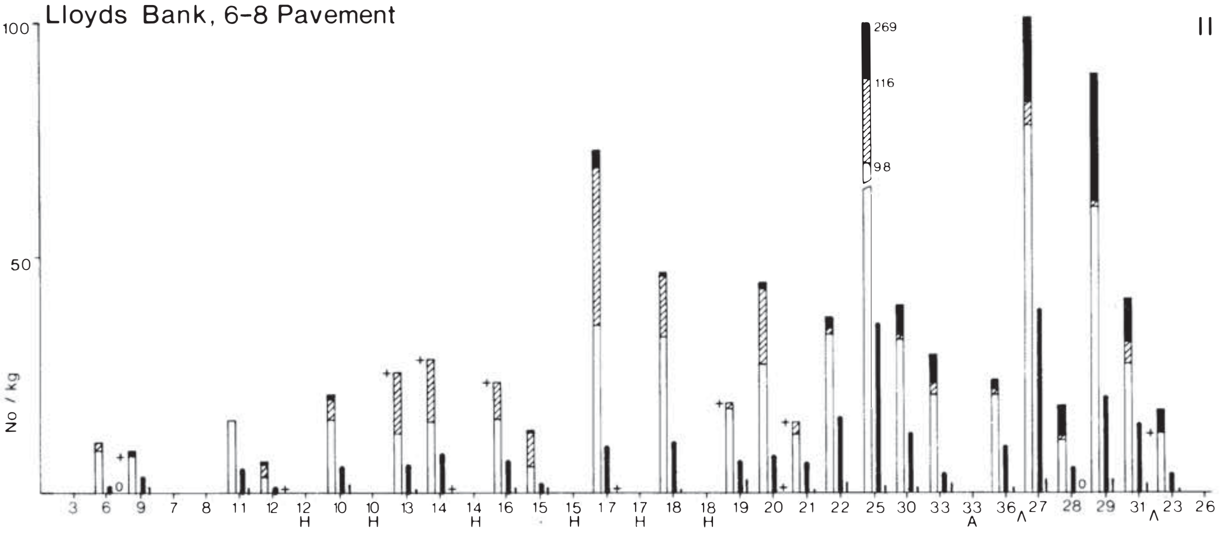
Grain beetles (*Sitophilus granarius*, *Oryzaephilus* sp. and *Cryptolestes* sp.) occur as single specimens in three samples from Trench II at Pavement, and in one sample (N5) from Coppergate. There are good reasons for suspecting that they were contaminants from the Roman grain warehouse material from Coney Street (Kenward and Williams, 1979, *AY* 14/2), having been introduced from an undetected damaged sieve during processing. They must be discounted until good evidence of Viking-age grain beetles is found. Some undoubted modern contaminants did occur: single specimens of *Ptinus tectus* and *Lithostygnus serripennis*, both obviously fresh and containing viscera. Both are found in stored products and houses and are recent introductions from the Antipodes. One sample contained a breeding colony of nematoceran flies, together with a pselaphid beetle, another an aleocharine staphylinid, and a third an individual of the thrip *Aptinothrips rufus* (Gmelin). The problem of contaminants and their recognition is discussed by Kenward (1974, 21); there is no reason to suspect that any other specimens in the present assemblages are contaminants.

More than 50 species which at the present day are generally associated with marshland, waterside and aquatic habitats are recorded. Their concentration is generally very low (Fig. 40) although together they sometimes make up 20–70% of assemblages; the range 0–10% is, however, more typical (Fig. 41). The habitats indicated range from damp places, perhaps carr-like (represented, for example, by *Trechus secalis*), through mud and vegetation by water (the majority of the species in this group) to open water (hydrophilids and dytiscids) and running water (elminthids). The most abundant species, *Carpelimus bilineatus* and *Anotylus nitidulus*, are, however, of uncertain habitat in archaeological material (see p. 212 and Fig. 46).

Species such as ground-living beetles and the flea-beetles *Phyllotreta nemorum/undulata* (associated with weeds of disturbed habitats as well as brassica crops) are present in most samples, but in small numbers. Most of the plant-feeders are associated with nettles (*Urtica* spp.), Cruciferae and Papilionaceae; other host plants indicated include Polygonaceae and heather or ling (*Calluna*). Some of the ground beetles are fairly common, for example *Clivina fossor, Trechus quadristriatus/obtusus, Pterostichus melanarius* and *T. micros*. The first three are common eurytopic species found in open places (Lindroth, 1974) and somewhat synanthropic. The standard works, both British and European, indicate that *T. micros* is a waterside species, and so it might be seen as a part of the waterside component in archaeological assemblages. However, it has been found living deep in archaeological deposits in York and in moist garden soil (Kenward, unpublished), in the Roman sewer in York (Buckland, 1976, *AY* 14/1) and also in mammal burrows (e.g. Israelson, 1972, and an ambiguous allusion by Lindroth, 1974); other archaeological records suggest that it may live a subterranean life away from water (e.g. Kenward, forthcoming b).

Vertebrates

A variety of vertebrate remains has been found at the Lloyds Bank and Coppergate sites. Chief amongst these were the abundant leather fragments and bones of large mammals. At both sites cattle (*Bos*) bones were much the most abundant (estimated by numbers of bones recovered), with pig (*Sus*) and sheep/goat (*Ovis/Capra*) both about half as numerous. Bones of domestic fowl (*Gallus*) and goose (*Anser*) were moderately common and small numbers of horse (*Equus*), dog (*Canis*), cat (*Felis*), and hare (*Lepus*) bones were also recorded. Fragments of red deer (*Cervus elaphus*) antler were abundant at Coppergate, and less so at Pavement, probably waste from antler working. There was modest evidence for bone-working at both sites (*AY* 17/3). The number of bones recovered from the layers at Pavement varied greatly, from zero to over 400. This variation does not only reflect differences in the volume of each layer excavated; some clearly had high concentrations of bone. There was no indication of selection of particular joints, but cattle bones apparently became more frequent in the later deposits. Some hair (of cattle and an unidentified small mammal, Rackham, 1982), feathers (similar to chicken, *Gallus* sp., P. C. Buckland, in litt.) and eggshell were also recorded. Fish bones collected during excavation were predominantly cod (*Gadus morhua* L.), but sieving produced large numbers of smaller bones, with herring (*Clupea harengus* L.) and eel (*Anguilla anguilla* (L.)) the most abundant. No bulk-sieving (using a 1mm mesh sieve, Kenward et al., 1980) was carried out during excavation, and the amount of material available for processing in this way was limited; the small quantity of fish bones recovered does not imply that they were particularly rare in the deposits. An account of the bones will be given in *AY* 15.



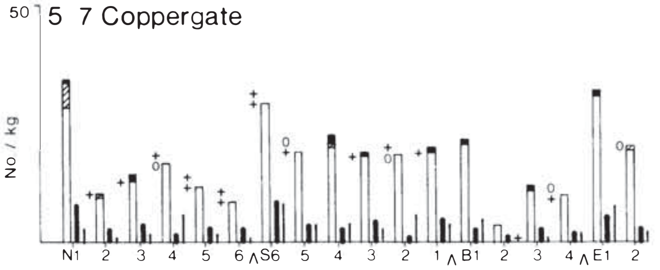
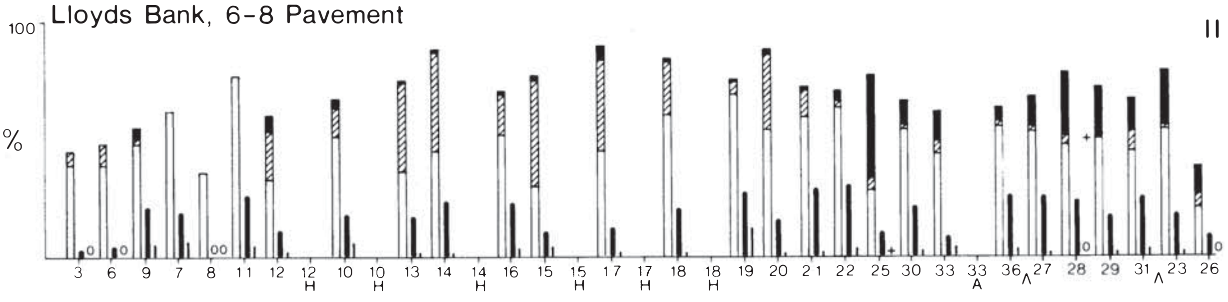


Fig. 38 Histograms showing concentrations of individuals of Coleoptera and Hemiptera associated with decaying matter according to a tripartite system (for discussion see text, p. 168). Samples from Lloyds Bank, Trench II, and 5–7 Coppergate only

Rt — all species associated with decaying matter of any kind; Rd — species associated with rather dry matter; Rf — species associated with wet rotting matter and dung; Carpelimus bilineatus, *although not included in Rt, is also shown as a significant and ecologically related species (p. 212). For each sample, left hand bar — Rt plus* Carpelimus bilineatus *(shaded —* Aglenus brunneus; *open — remaining Rt taxa; solid —* C. bilineatus*); middle bar — Rd; right hand bar — Rf; + indicates values too small to be shown.*



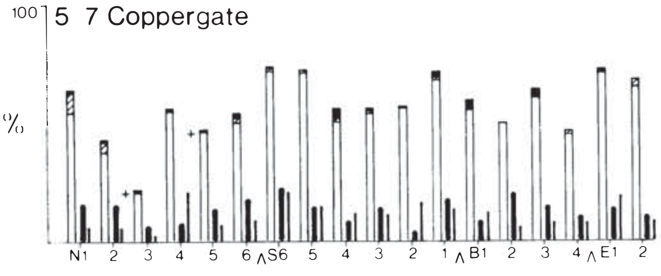


Fig. 39 Histograms showing percentage of individuals of Coleoptera and Hemiptera associated with decaying matter in the assemblages from Lloyds Bank, 6–8 Pavement, Trench II, and 5–7 Coppergate. Convention as in Fig. 38

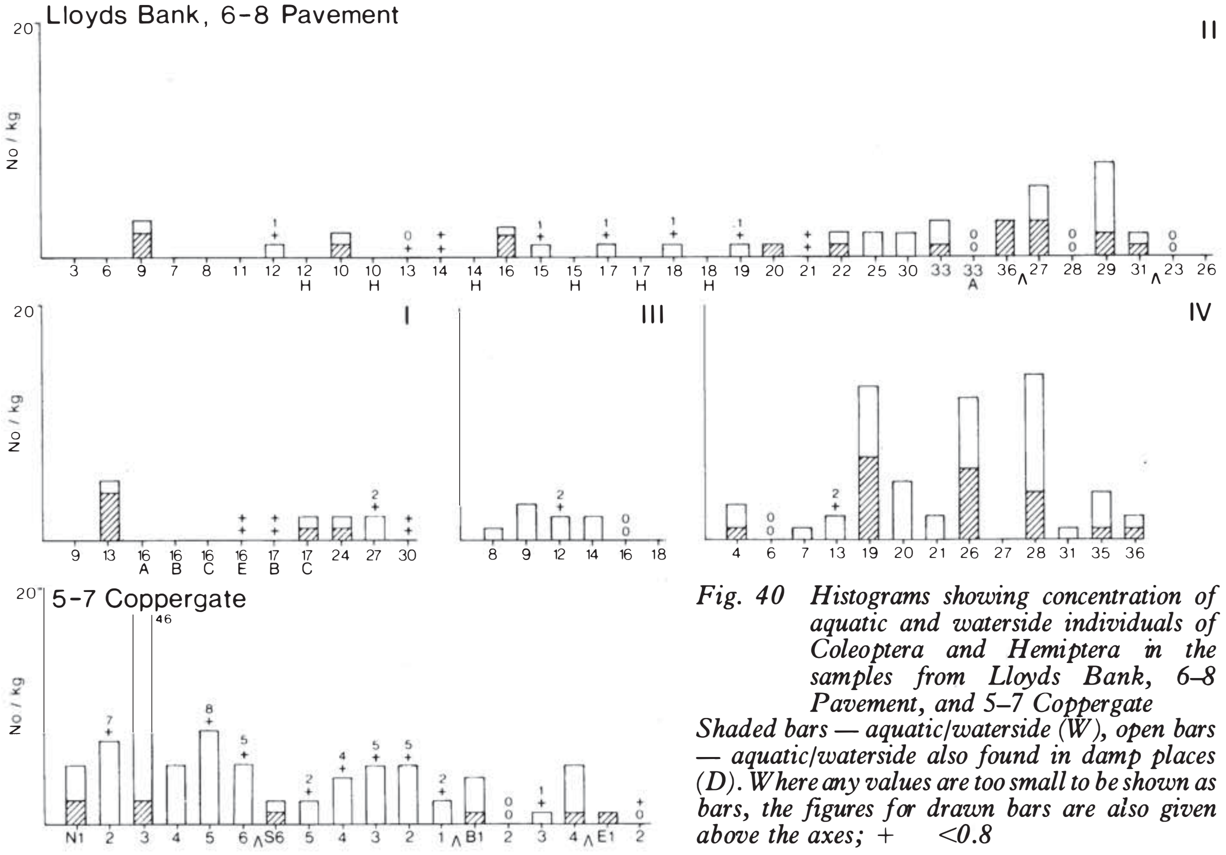


Fig. 40 Histograms showing concentration of aquatic and waterside individuals of Coleoptera and Hemiptera in the samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate
Shaded bars — aquatic/waterside (W), open bars — aquatic/waterside also found in damp places (D). Where any values are too small to be shown as bars, the figures for drawn bars are also given above the axes; + <0.8

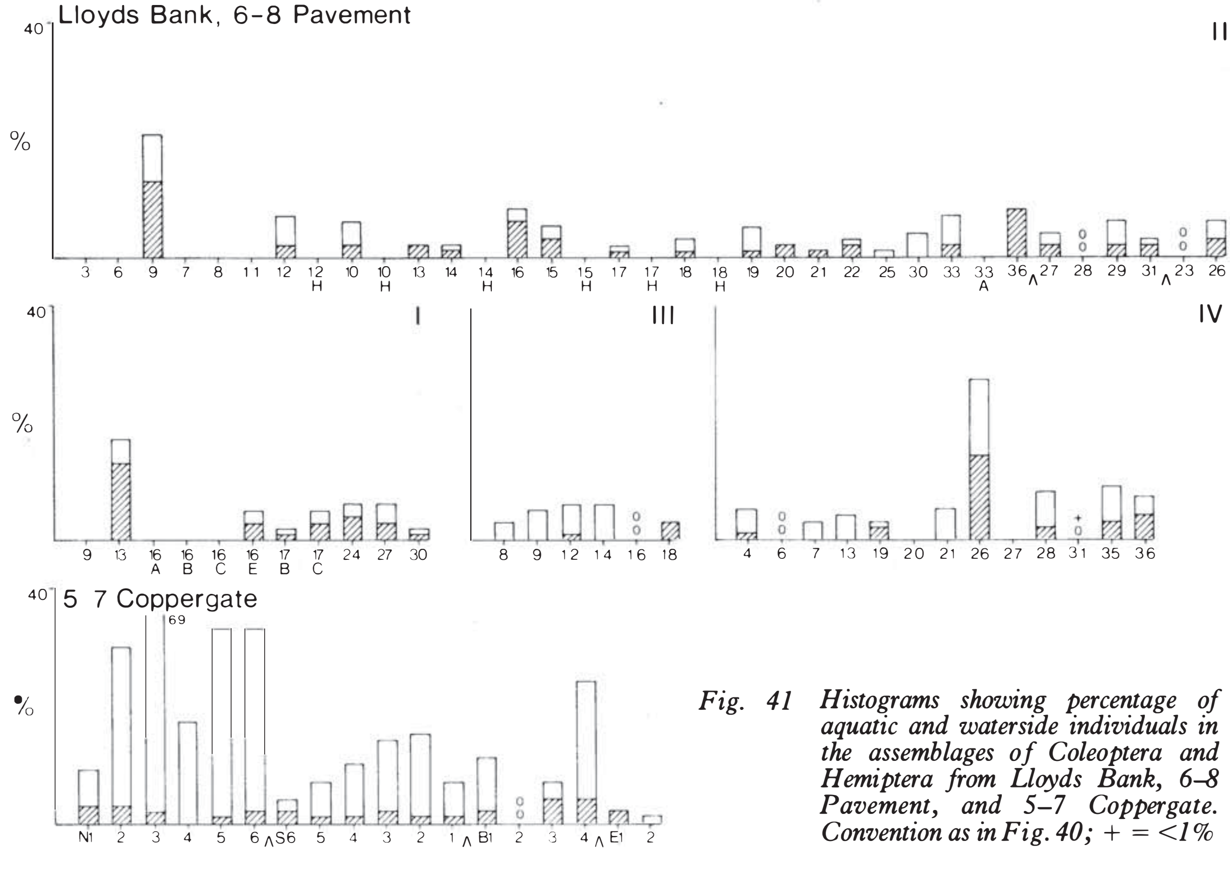


Fig. 41 Histograms showing percentage of aquatic and waterside individuals in the assemblages of Coleoptera and Hemiptera from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate. Convention as in Fig. 40; + = <1%

The Implications of the Biota

Although the many samples examined doubtless represent deposition in a variety of circumstances, the fauna and flora are rather homogeneous. Many habitats are indicated (see previous section) — but where were those habitats, and what implications does their presence have concerning the occupants of the site, and of York in general, in the Anglo-Scandinavian period?

The origin of the build-up

Central to the interpretation of environment and living conditions at these two sites is an understanding of the enormous accumulation of generally well-humified organic matter; how did it form and what are its implications? Was man responsible for all of the deposition? Massive build-ups of richly organic deposits are characteristic of the medieval period (in the broad sense) in many towns in northern Europe, for example Bergen, Dublin, Novgorod, Oslo, and Perth. In York the build-up is widely recorded and is particularly deep in the Coppergate-Pavement-Parliament Street area (Fig. 25). Since the evidence was evaluated by Radley (1971), similar deposits have been seen in the Parliament Street sewer trench, in Peter Lane, and under All Saints Pavement (see *AY* 8, forthcoming) as well as in the two excavations considered here. Their nature is now more completely understood as a result of the excavations at 16–22 Coppergate. At 6–8 Pavement their total depth was at least 6m (proved by auger), although only the uppermost 5m were excavated. Many of these deposits clearly built up largely as a result of the accumulation of plant and animal matter, mineral particles contributing little to the original volume.

An analogue for these deeply stratified, highly organic deposits is found on the North Sea coast of north Holland, north-west Germany and south-west Denmark, where massive organic occupation build-up has been described from mounds known in Holland as *terpen* and in Germany as *Warften, Wierden,* and *Wurten* (van Zeist, 1974; Todd, 1975, 97–107). These are mounds formed from the coalescence of smaller mounds accumulating on farmsteads. A major study of one such mound, the Feddersen Wierde in north-west Germany (Körber-Grohne, 1967; Haarnagel, 1979), revealed layers of well-preserved plant material representing not only field crops grown near the mound, but also straw and animal dung from byres within the farmhouses. The nutrient-rich deposits in such mounds were recognized by later farmers who dug them out for manuring their fields (Munro, 1899, 436; de Laet, 1958, 153–4). Although the Feddersen Wierde dates to the early centuries of the 1st millennium AD, some of these *terp* mounds continued to grow well into the Middle Ages, and richly organic material from a 'Viking-age' mound has been described from Elisenhof, at the mouth of the Eider in north-west Germany (Behre, 1976). Many of the factors involved in the accumulation of organic material in Anglo-Scandinavian York were doubtless the same as those inferred for the *terpen*: long-lived settlement, short-lived buildings and a large organic input.

Attempts to identify the nature of the original organic 'input' to the urban build-up are hampered by the current limits to identification of fragmentary plant material. The evidence that can be examined is largely 'second-hand': the pollen and seeds of plants, doubtless often divorced from vegetative parts at the time of deposition; the remains of the invertebrates that colonized waste matter, living plants and buildings; 'background fauna'; and the remains of vertebrates and shellfish directly or indirectly included in the deposits through human activity. Yet the material which formed the bulk of the original organic deposition was surely the vegetative parts of plants, which usually decay rapidly, leaving remains which are not identified routinely. This easily rotted material is represented by fragments of tissue and amorphous humus, which formed a very large proportion of the deposits by volume. Further plant material had evidently decayed completely, or been destroyed by burning to leave only charcoal fragments or dust.

Sometimes, however, the nature of the materials originally contributing to the build-up is self-evident. Thus at 16–22 Coppergate many layers have yielded plant remains such as grass, straw (sometimes apparently in animal dung) and heather, whose preservation appears often to be as good as that for material from the Feddersen Wierde (Körber–Grohne, 1967). It was unfortunate that the organic deposits at 6–8 Pavement and 5–7 Coppergate were generally rather well humified, so that vegetative remains were rarely identifiable.

The largest and most recognizable organic remains were bones, shells, leather offcuts and wood, and these have doubtless undergone little gross change since they were discarded. Recognizable timbers and wattle were abundant at both sites and ranged in preservation from firm to extremely soft, either buttery or crumbly. Moreover, certain layers yielded large quantities of fine wood debris (e.g. II 10, III 7 and IV 7); this material was so rotted that it was impossible to decide whether it came from decayed large timbers, wattle or brushwood, or the debris from wood-working.

The enormous amount of wood deposited at Pavement is not surprising in view of the repeated rebuilding evident from the archaeological record. The short life of the wooden structures was probably more a consequence of the design of their foundations than of social or economic pressures. The timbers, set into or resting on damp soil rich in organic matter, would have been highly susceptible to decay at surface level, where they were exposed to fluctuating moisture levels and open to the air. Clarke and Boswell (1976) tested a variety of round hardwood posts set in peat, clay and loam soils. Few untreated timbers survived as long as 10 years. Chestnut (*Castanea sativa* L.) was most durable, 30% of posts resisting the moderate lateral pressure applied by the experimenters after 15 years. Oak (the most widely-used timber at Pavement) showed little resistance to decay in Clarke and Boswell's tests; all of the posts failed within 10 years. It seems unlikely that timbers at ground level at Pavement would have retained their strength for any longer.

The enormous quantity of leather deposited at Pavement doubtless represents the product of leather working on or near the site, although it is possible that some layers record attempts to build up the ground with waste material, including leather, brought from another part of the town. The Pavement site may have been extended out over marshland in such a way, since the auger samples from the bottom of Trench IV contained some aquatic snails and water fleas (Cladocera) and the lowest excavated layers were very thick and featureless. Like the wood, the leather ranged in preservation from astonishingly good, appearing quite fresh, to almost completely humified. Probably even more had rotted into an indistinguishable component of the organic matrix of the deposits. Decay of the leather appeared to be related not only to the nature of the layer containing it, but also to the quality of preparation. Most leather fragments showed a characteristic pattern of decay, the surfaces being preserved but the middle having rotted; this presumably resulted from incomplete penetration of the tanning agent leaving a 'pelty' streak (Radley, 1971, 51).

Some of the constituents of the build-up are thus obvious, as are their implications. However, more information concerning ecological conditions and human activities is to be obtained from the less bulky and less easily interpreted pollen, seeds and insects.

Conditions at the sites

A primary objective of this study was to determine the conditions enjoyed or tolerated by the occupants of the two sites. This has, however, proved difficult, since there is limited archaeological evidence for the nature of many of the layers. The deposits were clearly associated with buildings, but it is not known if these were dwellings, as opposed to workshops or byres, or whether the layers formed on floors during occupation, as opposed to construction, disuse or demolition. To what extent can investigation of the sediments and fossil biota cast light on this? To use biological evidence alone to make fundamental archaeological interpretations is — with present knowledge and with notable exceptions — to approach the problem from the wrong direction. Many assemblages from unequivocally identified buildings must first be examined, to establish a standard by which to judge others; the records and samples from 16–22 Coppergate are providing such material. However, some points may be made at this stage.

Variation between the assemblages

When the fossil assemblages are examined in detail, the fauna and flora of some of them appear unusual against the background of the majority, although in quantitative rather than qualitative terms. There are, for example, high percentages of *Sambucus* (elder) pollen in sample 29, Trench II, and of tree and shrub pollen in sample II 14; and unusually high concentrations of rush (*Juncus* spp.) seeds in samples 9 and 30 from Trench I and 20 from IV, elder seeds in samples 8, 9, 12, 29 and 33 from Trench II, and flixweed (*Descurainia sophia*) seeds in sample 7, Trench IV. Amongst the insects, *Xylodromus concinnus* is exceptionally abundant in II 18, *Anotylus nitidulus* in N3 (5–7 Coppergate), *Oxytelus sculptus* in III 16 and *Rhizophagus parallelocollis* in IV 19. Similarly, certain of the sample statistics show occasional exceptional values (see Figs. 30–44).

What is the significance of these unusual values? It would be easy to assume that exceptional abundance of macrofossil remains of a particular plant or animal indicates its habitat to have been exceptionally abundant too; or, in the case of plants, that the species found large-scale use by human beings. However, it is necessary to consider the ecology, and in particular the population dynamics, of the species involved before such deductions are made. Most of these taxa exploit disturbed ground and decaying matter, habitats which would be scattered and ephemeral in the British Isles at the present day were not the influence of man predominant. Such 'fugitive' organisms must disperse readily, colonize quickly, and reproduce rapidly before the substrate is exhausted or successional changes prevent further reproduction (e.g. Grime, 1979; Frankie and Ehler, 1978; Krebs, 1978, 34ff., 236ff.). In addition, towns are artificial places full of habitats which are rare or represented only by approximate analogues in nature, and which only a limited range of species is able to colonize successfully; in the absence of the competitors and predators which would check them in 'natural' environments, they may produce immense numbers of offspring or propagules. Which species became abundant might be largely a matter of chance.

Pollen seems even more likely to be subject to random variations. It could be imported on many materials or be deposited in whole flowers or inflorescences, resulting in locally high concentrations. Only replicate subsamples from a single sample will indicate whether unusual characteristics of spectra are other than isolated, chance occurrences. Bearing in mind such predictable variations in numbers and the element of chance involved, and in the light of observations of modern living communities and death assemblages, the variations observed in the assemblages from the present sites can be seen as quite small, and the fauna and flora very uniform. Ecological reconstructions must, in view of these and other factors, be based upon the recognition of groups of ecologically related species and upon overall parameters of sample assemblages (*AY* 19/1).

There are other reasons why underlying uniformity in biota might be predicted. All the samples were laid down under what was probably, on a gross scale, an unchanging regime: a large area covered by a mosaic of habitats which, taking the town as a whole, were likely to have been rather uniform. A fairly constant random assortment of plant and animal remains would be expected to be deposited, naturally or by the hand of man, at any point. Secondly, death assemblages will almost always include specimens from more than one living community — and the more mixed assemblages are, the more similar they will appear. Thirdly, it is likely that many of the death assemblages formed over a relatively long period of time, receiving corpses or propagules from a succession of populations exploiting a changing habitat, with the possibility of catastrophic changes such as the dumping of waste material. Fourthly, small-scale differences in the death assemblages within a layer will not be detected using normal sampling methods. Perhaps the question to be posed is 'What are the sources of variation between samples?' The most important will be chance (stochastic) effects associated with invasion, season and the vagaries of death assemblage formation. Threaded through these will be the effects of real differences in environment and human behaviour.

Tests for correlation

In a search for a pattern within the data from the biological analyses, a series of statistical tests for correlation were made. The STATPACK package (Houchard, 1974) was used to calculate the regression coefficient, Pearson's r (Downie and Heath, 1974, 89, 225), for all pairs of a series of 38 attributes of the insect and seed data. This coefficient measures how nearly a scatter of points plotted for a pair of attributes would approximate to a straight line; a perfect linear relationship would give $r = \pm 1$. Pollen and soil data could not be included as only a small, and perhaps unrepresentative, selection of samples had been examined; subjective assessment suggested that there were no good correlations. The attributes are

Table 54 Correlation Tests

List of attributes for the insect and seed data for samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate used in the tests of correlation and some results of the tests. Only correlations at +0.7 and above are given; there were no good negative correlations. Correlations between concentration and percentage attributes have not been shown, nor have those between an attribute and another containing it (e.g. *Aglenus brunneus* and dry compost (Cd), the estimate of which includes *A. brunneus*). Square brackets denote correlations with total concentration of insects, included since they suggest that correlating components are adding to the assemblages, rather than substituting for one or more other components. For explanation of OA, OB, Cw and Cd, see *AY* 19/1

1 Sample number
2 Seed concentration
3 Seed α
4 Insect α
5 Insect concentration
6 Insect OB %
7 Waterside Oxytelinae %
8 *Ranunculus sceleratus* %
9 *Anthemis cotula* %
10 Wet compost (Cw) %
11 Dry compost (Cd) %
12 *Cercyon analis* %
13 *Anotylus nitidulus* %
14 *Aglenus brunneus* %
15 *Carpelimus bilineatus* %
16 *Ptenidium* spp. %
17 Sample weight
18 *Chenopodium rubrum* %
19 *Sambucus nigra* %
20 *Chenopodium album* %
21 *Urtica dioica* %
22 No. insects
23 Insect OB concn
24 Waterside Oxytelinae concn
25 Wet compost (Cw) concn
26 Dry compost (Cd) concn
27 *C. analis* concn
28 *A. nitidulus* concn
29 *A. brunneus* concn
30 *C. bilineatus* concn
31 *Ptenidium* spp. concn
32 *R. sceleratus* concn
33 *C. rubrum* concn
34 *S. nigra* concn
35 *C. album* concn
36 *U. dioica* concn
37 *A. cotula* concn
38 Insect OA approx. concn

Moderate to good correlations

Pavement samples:

C. analis concn – *C. bilineatus* concn	+0.9
Insect α – Insect OB%	+0.8
[Insect concn – Wet compost (Cw) concn	+0.8]
[Insect concn – Dry compost (Cd) concn	+0.8]
[Insect concn – *C. analis* concn	+0.8]
Insect OB concn – *A. brunneus* concn	+0.8
Insect OB concn – Dry compost (Cd) concn	+0.7
Dry compost (Cd) concn – *C. bilineatus* concn	+0.7
Wet compost (Cw) concn – *C. bilineatus* concn	+0.7

Coppergate samples:

None

Combined data:

C. analis concn – *C. bilineatus* concn	+0.9
[Insect concn – Wet compost (Cw) concn	+0.7]
Dry compost (Cd) concn – *Ptenidium* concn	+0.7
Dry compost (Cd) concn – *C. bilineatus* concn	+0.7

listed in Table 54, together with the best positive and negative correlations obtained. Only a few of these correlations are at all good (Downie and Heath, 1974, 97; Finney, 1980, 124) and all those above 0.7 stem from the insect data. Again, this is scarcely surprising, since it is likely that many of the parameters being examined are largely independent. Thus, for example, many of the seeds were probably introduced by human beings, but in several different ways. On the other hand, the majority of the insects probably found breeding habitats on the sites, while a few of the abundant taxa may have originated as background fauna from breeding communities at some distance. Two other statistical tests were applied to the insect data: the Jaccard (1912) coefficient of community (see caption to Fig. 46) and an indicator species analysis by Strudwick (p. 173).

Table 55 Summary of a tentative model of deposition of mineral and organic material on an occupation floor within an early medieval building

Sources		*Mineral component*	*Primary plant component*	*Primary animal component*	*Secondary animal component*	*Post deposition*
Material deliberately thrown on floor to sweeten, level or dry it; bedding		Clean sand, clay, or almost any other soil for levelling; soil on roots if imported plants were uprooted	Vegetative parts of rushes, reeds, straw, hay; seeds of these and associated plants harvested with them; pollen	Insects, snails and other animals incidentally imported with these materials	Insects associated with decaying plant matter	Burrowing species, rootlets, organic and mineral material infiltrating root-channels, burrows, drying cracks, stake-holes, etc.; material carried down by animals
Material derived from structure of building, mainly roof or walls		Clay from daub, soil of any kind from roofing turves, mineral particles eroded from masonry	Plant and animal remains uprooted with turf, imported with reed, straw, heather, thatch, etc.; remains of structural timber, wattle, brushwood etc.		Animals living and nesting in wattle and thatch, including insects, rodents, bats, birds and bees; faeces from these containing plant and animal remains; their parasites	
Material dropped on floors by occupants of building incidental to domestic or industrial activities; material derived from stores		Full range of particle sizes; slag, burnt soil and ash from hearths, etc.	Food remains — fruitstones, cereals and associated weeds; waste from woodworking, etc.; bark, charcoal, turf, peat, twigs, wood, etc. for burning; materials from construction of building; stored products	Food remains — bones, skin, fur, eggshell, shellfish, feathers; waste from domestic and industrial processes — leather, bone, horn, antler; insects and other animals imported with food; fleas, lice and other human parasites; stored food products of animal origin	Wide range of scavenging and predatory insects associated with decaying matter; pests of stored products, for example grain beetles, hide beetles, rats and mice	
Material accidentally imported, for example mud on boots, and seeds on clothes		Varies according to source	Varies according to source; mainly seeds and pollen	Varies according to source	Negligible	
Material associated with the keeping of domestic animals		Small amount in dung; material trampled on hooves from local sources	Material imported for food and litter; seeds and other plant debris passed through gut	Animals incidentally imported with feedstuffs and litter; parasites of stock; fragments of insects ingested with food	Insects exploiting dung, rotting litter, and food remains	
Material imported by natural processes	Wind	Wind-blown particles, mostly fine	Loose debris from nearby vegetation and from rubbish on soil surface; parachuted and other wind-dispersed seeds; pollen	Background fauna of flying insects and wind-blown corpses	Negligible	
	Flooding	Sand to clay-sized particles, initially well-sorted	Wide range of aquatic and terrestrial forms; pollen	Wide range of aquatic and terrestrial forms	Negligible	
	Animal activity	Mud from nests	Moss, plant stems etc. used for nesting; plant remains in droppings	Feathers and hair used for nests; animals entering buildings to hibernate	Nest fauna, parasites, scavengers, etc.	
Material redeposited from earlier layers		Anything	Anything	Anything	Negligible	

In view of the theoretical problems consequent upon the biology of the species involved, and of the limited ability of simple statistical analyses to find pattern in the plant or combined plant and insect data, an attempt has been made to consider more broadly the formation of medieval urban deposits. To do this, a predictive model of the mineral and biological characteristics of layers according to their origin has been constructed. Presentation of the full model would be impracticable, but as an example a condensation of the scheme for the origin of material on house floors is given in Table 55. More specific predictions concerning, for example, the actual species of plants and animals likely to occur, could be given, albeit with decreasing certainty. While a few events or circumstances will predictably produce characteristic death assemblages, or mineral components, the picture is often so complex as to render the results of deposition rather uniform.

With all these arguments in mind, can any of the variation in the data from these two sites be regarded as significant? The insect assemblages show systematic variation which can be used as a basis for interpretation of the deposits.

An interpretation of the sample insect assemblages

Both plant and animal remains have a value as indicators of past environments, but insects offer the best evidence of ecological conditions on and around occupation sites with preservation by waterlogging. This is because man has no interest in the majority of insects (indeed one suspects that until the 18th century the very existence of most species went unnoticed), while plants may have been imported in vast quantities. The conditions created by man will, of course, determine which insect species are able to colonize.

The range of habitats of the insects recorded at these sites has been outlined above (pp. 181–6); the best-represented is rotting matter of all kinds, which accounts for the greater part of most assemblages. The rotting matter species suggest a wide range of habitats, from dung, through foul plant matter, or even corpses, to rather dry mouldering remains such as straw, wattle and structural timber. The proportion of insects associated with rotting matter, according to the two classifications described on p. 168, is given in Figs. 36–9. The tripartite division shows clearly the consistently high total values (Rt) and the low values of Rf compared with Cw. The latter is mainly a result of the exclusion of *Cercyon analis* (formerly in Cw) from Rf, the Jaccard (1912) analyses showing it to be closer to 'dry compost' species than 'foul' matter species (Fig. 46). *C. analis* can therefore only be placed in Rt. The mean value of Rt is 59%, with few cases below 40%, several above 70%, and some even above 80%.

Did these rotting matter insects originate on the sites, or was the greater part of the fauna allochthonous? Rotting matter habitats are mainly temporary under natural conditions, so that species exploiting them tend to be especially migratory and thus likely to be abundant in the background fauna (Southwood, 1962; Kenward, 1976b). There is, however, good direct and indirect evidence that at least a proportion of the insects were certainly autochthonous, living and breeding in the rotting material which contributed to the deposits. Firstly, examination of the sediment indicates the incorporation of abundant organic remains in which the insects could have bred. Secondly, there are pale and congenitally mutilated individuals of several species (Table 53), which are hardly likely to have dispersed and thus probably developed in situ (Kenward, 1976b, 14). Thirdly, some species are immensely

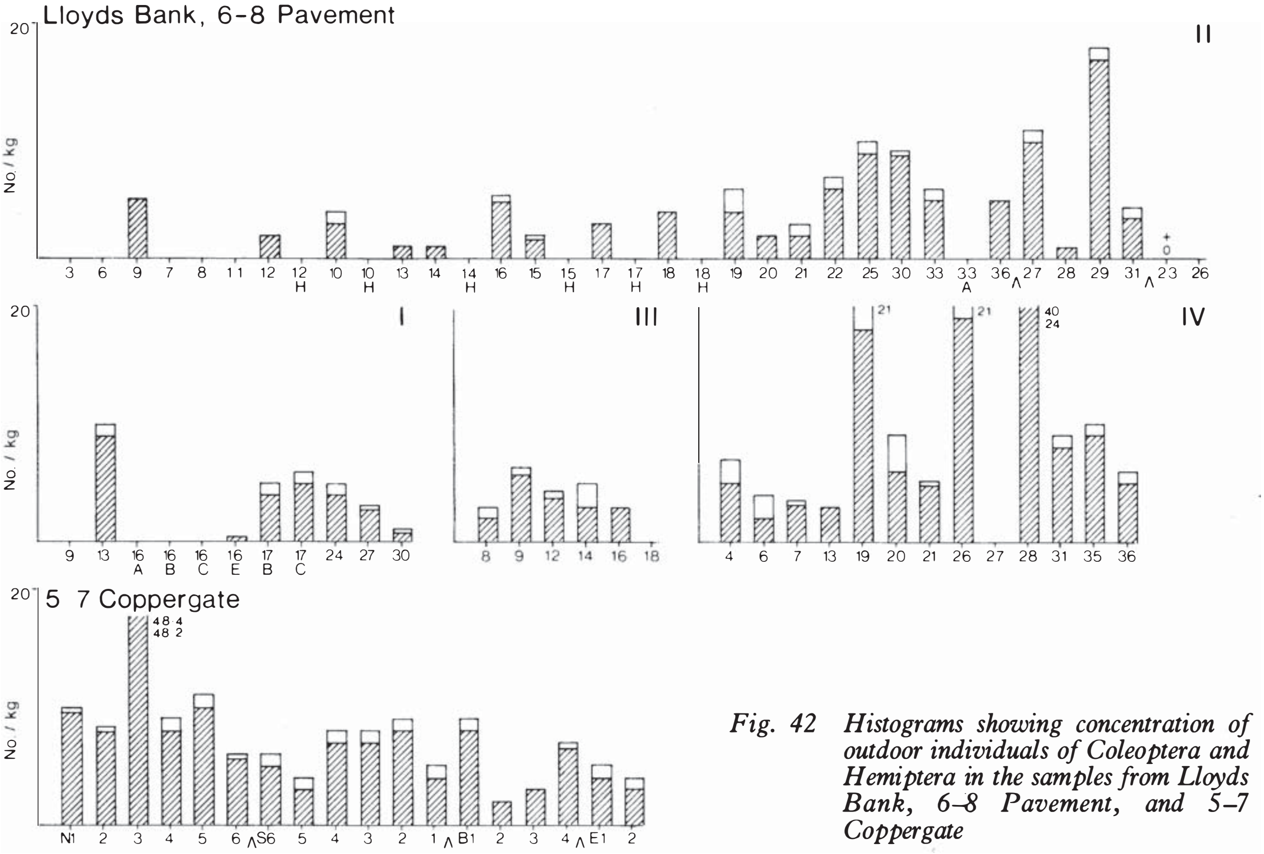


Fig. 42 Histograms showing concentration of outdoor individuals of Coleoptera and Hemiptera in the samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate

Shaded bar — certain outdoor (OA), shaded plus open bar — certain-plus-probable outdoor (OB) (for definition, see AY *19/1, 14–15). Figures above the axes distinguish low (+ < 1) and zero values*

abundant and seem unlikely consistently to have arrived from elsewhere; the blind and flightless *Aglenus brunneus* and the fly puparia, numerous in many layers, are very unlikely to be allochthonous. Whatever the precise habitats occupied by the decomposer species, their inescapable implication is that decaying matter was immensely abundant on or around the places of deposition.

Apart from the foul matter and compost component, most other ecological groups are insufficiently abundant to stand as clear evidence that their habitats existed on the site, although doubtless some insects, for example the dead wood species, bred there. An exception is the aquatic and aquatic/marginal group, which is sometimes abundant (Figs. 40–1); this, however, poses problems and is discussed further below (p. 212).

Lloyds Bank site, 6–8 Pavement, Trench II

The samples from Lloyds Bank Trench II will be taken as a starting point for discussion, being the largest group, and in addition, having given more consistent insect assemblages than those from Trenches I, III and IV and from 5–7 Coppergate. The Trench II assemblages fall into two main groups: those which, when compared with a wide range of samples from various archaeological sites, have high diversity (α) and high 'outdoor' percentages (OB); and

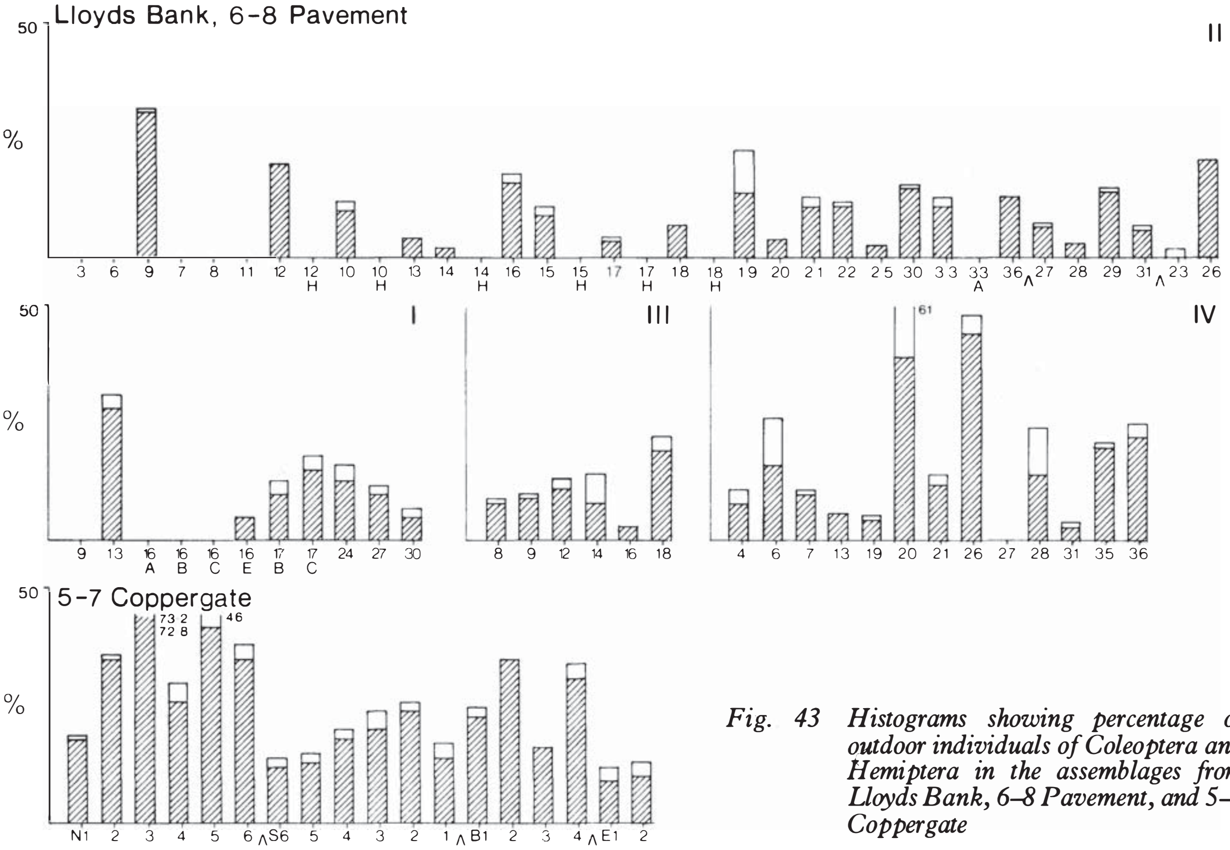


Fig. 43 Histograms showing percentage of outdoor individuals of Coleoptera and Hemiptera in the assemblages from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate

Shaded bar — OA, whole bar — OB. Means and errors for %OB: Lloyds Bank, Trench I — mean 14.7, SD 8.9, SEM 3.4; II — 11.4, 7.8, 1.6; III — 10.9, 6.3, 2.4; IV — 17.7, 13.0, 3.9; combined Lloyds Bank data — 13.2, 9.3, 1.4; Coppergate — mean 27.4, SD 15.1, SEM 3.6

those for which these values are low (compare Figs. 33 and 43). If cumulative percentage frequency plots of α and OB values are made on probability paper (Harding, 1949; Cassie, 1954), both give sinuous curves, showing distinct bimodality. If α is plotted against OB, two groups of points are produced, with only two outliers, samples 9 and 26, both small assemblages (Fig. 44a). These two groups are significantly different; Table 56 shows in which group the samples fall.

Initially these two main groups of samples from Trench II were interpreted as representing: (a) occupation deposits which accumulated inside buildings, giving insect assemblages of low diversity (being composed primarily of communities breeding in a restricted range of artificial habitats) and of low OB (since they formed indoors and were protected from background fauna); and (b) outdoor, destruction, abandonment, deliberate build-up and reconstruction layers, seen originally as having high diversity and OB (since the forming deposits were exposed to background fauna and included a variety of imported materials) (see *AY* 19/1, 35).

This interpretation requires further discussion for two reasons. Firstly, much higher diversity and outdoor percentages are found in some other urban archaeological assemblages, for example some from Trenches I, III and IV and 5–7 Coppergate (see below), and from Oslo

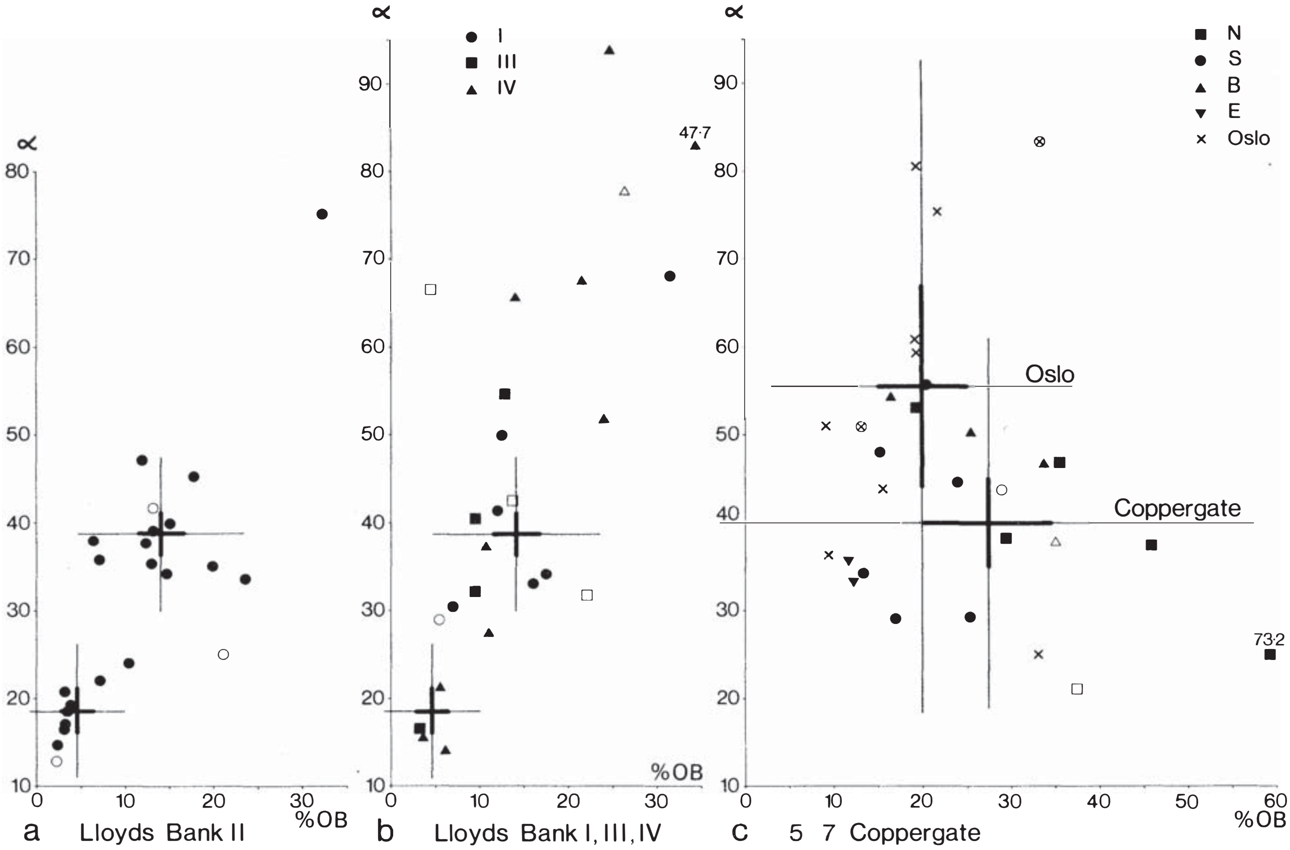


Fig. 44 *(above and facing) Scatter plots showing diversity (α), outdoor species (OB) and foul matter species (Cw, Rf) in the insect assemblages from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate. Data for samples from medieval deposits at a site in Gamlebyen, Oslo, are included for comparison (see text). In each diagram, open symbols represent small (n < 50) assemblages (circled cross for small Oslo assemblages)*

(a) diversity and % outdoor B, Trench II; narrow bars — 2 x sample standard deviation, broad bars — 2 x standard error of mean for intermediate and low groups

(b) diversity and %OB, Trenches I, III and IV; bars show 2 SD and 2 SEM ranges for intermediate and low groups in Trench II

(c) diversity and %OB for Coppergate and Oslo assemblages with 2 SD and 2 SEM ranges for each site

(d) %foul matter (Cw) and %OB, Trench II with 2 SEM ranges for intermediate and low groups as defined in (a)

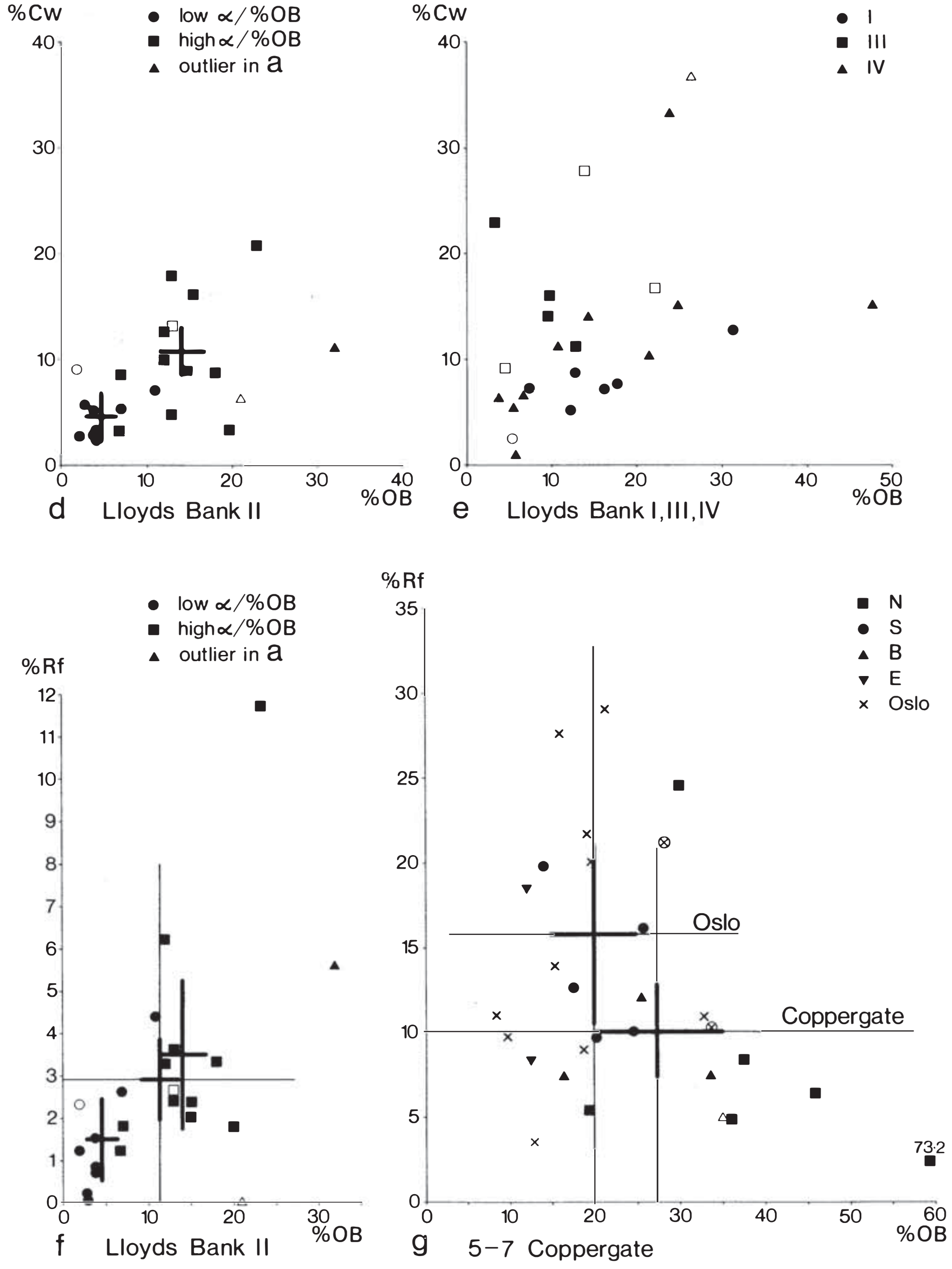
(e) %Cw and %OB, Trenches I, III and IV

(f) %foul matter (Rf) and %OB, Trench II with 2 SEM ranges for intermediate and low groups as defined in (a) and (central cross) 2 SEM and 2 SD ranges for all Trench II assemblages

(g) %Rf and %OB, Coppergate and Oslo with 2 SD and 2 SEM ranges for each site. Note that the scales for Rf in (f) and (g) are different

(Kenward, forthcoming a). Secondly, an assemblage of very high diversity and outdoor percentage was recovered from floor deposits inside a turf-and-straw-roofed building at Pow Bank, Cumbria (p. 208, and Kenward et al., forthcoming); it appears that indoor deposits may acquire large quantities of background fauna.

Alternative hypotheses must thus be examined. The assemblages of low α/OB may indeed represent use-phase deposits, formed in well-closed buildings. However, those of intermediate α/OB may represent either destruction to construction (probably with subsequent



invasion by communities of decomposer species), or deposits which built up in a more open kind of building. Alternatively, both groups may be fundamentally the same, composed of background fauna with the addition of autochthones, the latter more abundant in the low α/OB group.

The FTRA ('top ten') list (Table **69**, Microfiche 1) shows that the assemblages in both groups have much the same range of abundant species and much the same variation between samples. Both groups include some assemblages dominated by *Aglenus brunneus*, and others by *Carpelimus bilineatus*. These two species might be expected to characterize 'indoor' and 'outdoor' deposits respectively, but clearly do not. The variations in almost all the other abundant species show a similar pattern. There is no significant difference (at the 95% level) between the mean concentrations of insects for the intermediate and low groups (intermediate group: $\overline{x}=54$, SEM$=12$; low group: $\overline{x}=74$, SEM$=38$), or in the ratio of *A. brunneus* to *C. bilineatus*. The *concentration* of OB would be predicted to be constant, or unrelated to %OB and α, if the assemblages formed by the addition of autochthones to background fauna. The concentration of OB is in fact significantly higher in the intermediate group (intermediate group: $\overline{x}=6.6$; low group: $\overline{x}=2.7, p<0.05$). The structure of the assemblages in the intermediate α/OB group thus apparently differs from that in the low group by the addition of the component which increases α and OB.

This argument is further supported by analyses of the foul-matter component. The intermediate α/OB group mostly have higher percentages of foul-matter species (Fig. 44d, f; Cw$>8\%, p<0.001$; and Rf $>1.6\%, p<0.05$). (Rf is a more narrowly defined version of Cw, see p. 168.) The percentages of Cw and Rf are, however, much higher in many other samples, for example a few of those from Trenches III and IV and from Saddler Street, Durham (Kenward 1979a), and most of those from 5–7 Coppergate (below) and Oslo (Kenward, forthcoming a); at the last, values of 10–30% Rf were normal. Thus, while the relatively higher values of Cw and Rf might be explained by the intermediate α/OB assemblages having formed in the open, with foul-matter species breeding, it is more likely that the foul-matter component originated in background fauna. On balance, all or most of the assemblages in the low and intermediate groups of Trench II are regarded as having originated indoors.

P. V. Addyman (*AY* 8, forthcoming) interprets the buildings as having been constructed on the remains of their predecessors, with beaten earth floors in at least some cases. Each of the structural phases gave samples in both main groups, and there is no clear indication that 'floors' and 'occupation build-up' have a different fauna. Examples of each have faunas of both main kinds. This is not surprising, since levelled floors could have been made using material from either indoors or outdoors. The latter might initially contain low concentrations of insects (disturbed yard deposits appear to give poor preservation), and might subsequently be invaded by indoor insects, or have them mixed in by human activity. Reference to the model of indoor deposition (p. 195) will show the difficulty of detecting subtle differences of this kind.

A group of samples from structure II/4 is of interest. Four of them, 13–15 and 17, were taken from the north-west side of the dividing wall, and 16 from the south-east side. Samples 13–15 and 17 all fall in the low α/OB group, but 16 in the intermediate group. It is possible that this reflects different deposition of background fauna in adjacent rooms.

Doubtless, most of the assemblages from Trench II are dominated by communities of a small number of species which lived in the deposits in situ. The majority of the species in all the FTRA lists might be found in fairly dry to slightly damp mouldering matter, perhaps under the conditions found in rick bottoms and well-made compost heaps. Such might be the nature of material accumulating on damp earth floors in timber and wattle buildings. It is possible that the abundant species lived in two separate habitats: in the floors, and in the rather drier superstructure (especially in thatch or turf roofs). *Aglenus brunneus, Cercyon analis* and *Ptenidium* spp. might be more at home in the floors, the majority of the remaining abundant taxa might be found in either group of habitats, and *Anobium punctatum* would have

Table 56 Grouping of samples from Trench II, Pavement, according to values of diversity (α) and percentage of outdoor individuals (OB) in the insect assemblages. Samples 9 and 26 lie outside the two groups (see Fig. 44 a), and some other samples gave too few insects for inclusion in the analysis

Low α/OB group

Sample	α	OB	α x OB
13	21.6	3.7	80
14	14.9	2.4	36
15	24.6	10.6	261
17	18.5	3.7	68
20	19.3	4.0	77
23	12.8	2.3	29
25	17.1	2.8	48
28	16.4	3.4	56
31	22.4	7.2	161
mean	18.6	4.5	
SD	3.8	2.6	
SEM	1.4	1.0	

Intermediate α/OB group

Sample	α	OB	α x OB
10	47.1	12.1	570
12	35.0	20.0	700
16	45.9	17.8	817
18	38.5	7.1	273
19	33.6	23.4	786
21	38.9	12.9	502
22	37.6	12.3	462
27	36.0	7.2	259
29	34.7	14.7	510
30	39.9	15.4	614
33	35.4	13.1	464
36	41.9	13.2	553
mean	38.7	14.1	
SD	4.4	4.7	
SEM	1.3	1.4	

found suitable habitats in much of the structural timber. The place of *Carpelimus bilineatus* is uncertain, but in view of the evidence presented on p. 213 it may well have bred together with the other species in floors.

Excluding sample 9, the Trench II FTRAs include only the following species which seem at all unlikely to have bred indoors: *Platystethus arenarius* (II 10), *Aphodius granarius* (II 19), *Anotylus nitidulus* (II 29), *Oxytelus sculptus* (II 10), and *Anotylus complanatus* (II 29, 33). All these records are from samples in the intermediate α/OB group, and the specimens, especially of the last two, may have colonized habitats in foul spots in open buildings, invaded during abandonment or had a 'background' origin. All were probably very common in the Viking-age urban background fauna. Such an origin is supported by the rarity of *Cercyon terminatus*, *C. pygmaeus* and *C. unipunctatus*, none ever present at a frequency above 2, all typically abundant in samples believed to have formed under foul conditions out of doors and all at least occasionally represented in the Coppergate FTRA lists. The same sort of pattern is evident amongst the rare species in the Trench II assemblages.

Sample 9, with no abundant species but with *A. nitidulus* and *Platystethus cornutus* group in the FTRA list, is reminiscent of some of the 5–7 Coppergate samples (below) and probably formed out of doors, or at least where background fauna contributed most of the death assemblage.

Trenches I, III and IV

The samples from Trenches I, III and IV do not repeat the pattern seen in Trench II. Plots of diversity against outdoor percentage give a wider scatter of values (Fig. 44b), suggesting more variety in origins. Some of the samples fall within the two-standard-deviation ranges of one or other of the groups identified in the Trench II data, but Trenches I, III and IV gave some samples with OB or α significantly higher than the mean for the intermediate group in Trench II (Table 57). These samples do not form a discrete group, but merge into the intermediate one; nevertheless it is convenient to categorize many of them as 'high α/OB'.

The FTRA lists for Trenches I, III and IV (Tables **68, 70–1**) are also more varied than that for Trench II. Some of the assemblages are reminiscent of the majority from Trench II, but even those which in the plot of α and OB fall into one or other of the groups from Trench II generally have some species in the FTRA list which are not, or are rarely, abundant in that trench's assemblages. Some of the assemblages are of the outdoor type postulated for II 9, with *Anotylus nitidulus, Platystethus nitens* (a damp-ground form like the *P. cornutus* group) and small *Carpelimus* sp. (mostly waterside but some able to breed in rotting matter, see p. 168). Other assemblages are quite unlike those from any of the Trench II samples. It appears that Trenches I, III and IV cut through deposits which had formed in somewhat different ways from most of those seen in Trench II. This variety makes brief discussion of the samples difficult; even within the three groups listed in Table 57 the assemblages differ strongly, at least by comparison with the uniformity of Trench II.

Four samples plot into the low group from Trench II. Of these, III 16 is unusual for its large numbers of *Oxytelus sculptus, Carpelimus fuliginosus, Typhaea stercorea* and small *Carpelimus* sp. On all the evidence this assemblage must surely be a living community, conceivably to be found in damp, even dungy (but not wet) straw or other open-textured plant material, perhaps on a stable floor or in a rick bottom. This assemblage is only paralleled by one from a medieval straw layer at 16–22 Coppergate (Kenward, unpublished). IV 13, 19, and 31 all have much in common with the Trench II assemblages, but IV 19 includes abundant *Oxytelus sculptus, Rhizophagus parallelocollis* and *Trechus micros*, while IV 31 has very large numbers of the small *Carpelimus*, and rather abundant *R. parallelocollis*. *T. micros* and *R. parallelocollis* are both subterranean. Such species may have invaded after burial of the deposits, but might be indicative of a closed damp building or even an underfloor cavity.

Of the samples falling in the intermediate α/OB group of Trench II, I 17c, I 24, I 27, III 8, III 9 and IV 4 gave assemblages much like those from Trench II, as did I 30, which plotted just outside this group; those from III 14 and III 18 are too small for useful comparison.

Nine samples gave assemblages with α, OB, or both, very high in comparison with those from Trench II. III 5 and IV 6 are too small for discussion; III 12, IV 21 and IV 36 gave rather small assemblages with FTRAs resembling those from Trench II. The remaining samples all appear to have been taken from deposits exposed to a large 'background fauna'. I 13, with its high percentages of aquatics and Cw, is probably dominated by background fauna. Sample IV 26 gave a modest assemblage of high α and OB in which no species were very abundant, but the FTRA list includes three species not found in any other from Lloyds Bank and 5–7 Coppergate: *Helophorus* sp., *Cyphon* sp. and *Ceutorhynchus contractus*. With *Anotylus nitidulus*

Table 57 Grouping of samples from Trenches I, II and IV, Pavement, according to values of diversity (α) and percentage of outdoor individuals (OB) in the insect assemblages. Small assemblages marked with *

Samples giving assemblages with high values of α or OB

Sample	high α	high OB
I 13	x	x
III 5*	x	–
III 12	x	–
IV 6*	x	x
IV 21	x	–
IV 26	x	x
IV 28	x	x
IV 35	x	–
IV 36	x	x

Other samples falling in the intermediate α/OB group of Trench II:

I 17C
I 24
I 27
III 8
III 9
III 14*
III 18*
IV 4

Other samples falling in the low α/OB group of Trench II:

III 16
IV 13
IV 19
IV 31

and *A. complanatus* also high in the FTRA list, this assemblage surely formed in the open air, near weeds and marshy ground. Samples IV 28 and IV 35 give the appearance of assemblages like those from Trench II, but with the addition of much background fauna, including species from foul-matter habitats.

Rf values have not been calculated for the Trench I, III and IV samples, but would generally be quite low, only a little higher than those from Trench II. None of the assemblages would give Rf percentages anywhere near as high as the samples from Oslo; the higher values of Cw (Fig. 44e) are generally caused by *Cercyon analis* and *Oxytelus sculptus*, excluded from Rf since they are now considered to be too eurytopic. Thus there is no reason to believe that any of the deposits included breeding communities of species associated with dung and other very foul rotting matter. The samples containing large numbers of *O. sculptus*, *R. parallelocollis*, *C. fuliginosus* and the small *Carpelimus* sp. (III 16, IV 19, 31) may merely have come from deposits where conditions were moister than usual.

5–7 Coppergate

Although they mostly include the same range of species as the Lloyds Bank assemblages, quantitatively those from Coppergate are rather different. This is expressed both in the FTRA lists (Tables 72–4) and in parameters such as diversity, percentage of outdoor insects and the foul-matter component. Diversity is generally quite high (Fig. 44c). Only two samples have α as low as in the low group from Trench II: N3, with α depressed by abundant *Anotylus nitidulus*; and N6, with a small assemblage. OB is generally high or very high, often, however, as a result of abundant *Anotylus nitidulus*. Most of the assemblages have one to several of the following in the FTRA lists: *Platystethus arenarius, P. cornutus, P. nitens,* *Anotylus complanatus, A. nitidulus,* the small *Carpelimus* sp., *C. corticinus, Oxytelus sculptus, Cercyon pygmaeus, C. unipunctatus, C. terminatus, Cryptopleurum minutum.*

These species represent two kinds of habitat: foul matter or dung, and waterside/damp ground. All may be autochthonous, but a good proportion probably constitute background fauna. Whether the waterside species bred at the site will be discussed below (p. 212). The foul-matter percentages are high (Fig. 44g), with a mean Rf of 11%, significantly higher than for Trench II at Pavement (mean Rf 3%). Most of these assemblages seem to have come from deposits which accumulated in the open, and the trench probably cut through damp yard build-up. The line of posts recorded during the excavation is thus more likely to be a fence, as suggested in the site report (*AY* 8), than part of a building.

The interpretation of 'floor' deposits

It has been argued above that many of the Pavement assemblages formed on floors within buildings and that consequently conditions indoors may be inferred. However, it should be noted that 'indoor' assemblages may have originated deep within middens or straw piles as well as in internal floors or other parts of buildings; that the transport of materials either to level up floors or to clear them, may have resulted in the deposition of characteristically 'indoor' or 'outdoor' deposits some distance from their origin; and that the 'outdoor' component is generally much smaller than at some other sites.

The build-up of deposits on house floors will obviously not have been a straightforward process. Firstly, the rate at which deposits accumulate will greatly affect the fauna and, perhaps to a lesser extent, the flora which became incorporated in them. Secondly, as indicated by the analyses above, a division into indoor and outdoor assemblages is obviously excessively simple. Buildings with open windows or doorways will inevitably have accumulated more background fauna than those which were better sealed, and the recent work on a modern deposit has shown that indoor accumulations may have a large percentage of outdoor insects (Kenward et al., forthcoming; F. Stone, unpublished). Constant human trafficking may have resulted in the transportation of many insects or their remains, giving a false 'background' fauna to indoor deposits. Further, houses temporarily used for storage, as byres or workshops, or standing empty, may have been the only ones to acquire thick deposits of rubbish, perhaps surreptitiously dumped by neighbours (Keene, 1982), and accumulation truly associated with occupation may only rarely be sufficiently substantial to permit detailed study. Indeed, Hamilton (1956, 97), discussing deposition on Viking floors at Jarlshof, Shetland, points out that 'Man, once he erects a dwelling with a well-defined floor, tends to keep it relatively clean, gathering and depositing the refuse of everyday life in one or more selected areas outside his house and usually at some distance from it. From the archaeological point of view, therefore, a house floor is an area of minimal growth' — clean floors will leave no trace. Hamilton also suggested that even the cobbled surroundings of his buildings might have been kept relatively clear of refuse. If buildings were, indeed, cleaned out, then the material taken from them would most probably accumulate in pits and middens (Hamilton's 'areas of maximum growth') or be spread over yards. This, like most of the problems encountered in the interpretation of the present sites, will probably be alleviated by working on carefully recorded open-area excavations such as those at 16–22 Coppergate. However, some of the thick 'litter' layers at Pavement may have accumulated indoors. It remains to be established whether the buildings were used as dwellings or were merely sheds, workshops or even byres.

Craft and industry

There is good evidence from the organic artefacts (*AY* 17/3) for a variety of manufacturing industries at both sites. The large quantities of leather offcuts, for example, suggest that the usage of the buildings at Pavement included leather working. Further activities might be argued from the biological evidence, but the suggestion that tanning was actually carried out at Pavement can no longer be substantiated (p. 221) and the earlier interpretation of structures in Coppergate as tanning pits (Benson, 1903) is discounted in R. A. Hall's assessment of the site (*AY* 8, forthcoming). Fragments of bark of silver birch and ?oak, including small regular ?oak chips, were frequently recorded during excavation and have been observed in residues from bulk-sieved samples from the Pavement site. Although bark is typically used as a tanning agent and certainly was so in the past (Howes, 1953; 1962), it is found in the majority of the richly organic deposits in York and therefore offers poor evidence for a specific industrial use. The chips are more likely to have originated in building construction, and the other bark simply by the decay of old timbers; fragments of wood, as opposed to bark, were also abundant in these deposits.

Modest amounts of antler of red deer were identified from both sites and were probably waste from working on or near them. Antler tines were quite common and often showed signs of modification. Radley (1971, 51) suggested that such artefacts might have been used to peg out hides during leather preparation, although other uses are possible.

The sporadic records of achenes of hemp (*Cannabis sativa*) and seeds of flax (*Linum usitatissimum*) perhaps suggest fibre or oil extraction or processing, but neither plant is abundant at either site; indeed, to judge from evidence from other medieval deposits the remains could merely represent the 'background' for urban build-up. The achenes of hop (*Humulus lupulus*), on the other hand, present a much more intriguing problem. They are relatively abundant in many samples from 5–7 Coppergate and it is tempting to conclude that hops were deliberately imported to that site for brewing purposes, or for the fibre in their stems. Unfortunately it was not possible to distinguish between *Cannabis* and *Humulus* in the pollen record for Cannabiaceae from five samples from Trench II.

The history of hops and brewing in Britain has been discussed at length by Wilson (1975) and Wilson and Connolly (1978), who recorded quantities of hop fruits in a 10th century boat at Graveney, Kent, perhaps a cargo imported from the Rhineland. Hop achenes have also been recorded from Anglo-Danish deposits in Hungate, York (Godwin and Bachem, 1959) and are occasionally found in the residues from bulk-sieving of medieval deposits from 16–22 Coppergate. Hop, besides having an economic importance, is a plant of wet woodland (it is recorded, for example, from alder woodland at Askham Bog, near York, by Fitter and Smith, 1979), hedges and other habitats, and the material from York might have been collected from such places rather than imported or cultivated. The Viking-age hops found at Haithabu (Hedeby) were thought to have been collected from the wild (Behre, 1969).

Food and drink

The plant and animal remains offer some evidence of the Anglo-Scandinavian diet. The bone and shell, for example, must largely have originated in food refuse. From the stratigraphy, it seems that this may not only have been disposed of in localized pits (recorded during excavation of Trench III), but at least sometimes thrown on the ground. It is possible, however, that bones and shells found in supposed floor layers were distributed by domestic animals or redeposited from pits or middens. Rolfsen (1980), for example, discusses mechanisms whereby material may be reworked in archaeological deposits. Unfortunately, insufficient samples were available from the Trench III pits to allow adequate analysis. Equally, there was no archaeological or biological evidence for cesspits at either site and thus little information about the softer food remains. The value of faecal remains as a source of evidence concerning soft foods is discussed elsewhere (e.g. Dickson et al., 1979; Hall et al., forthcoming); it appears that organic compounds and fossils may indicate something of the nature of the easily digested component of the diet.

A single elongate-fusiform mass of organic debris, concreted by mineral deposition, was recovered from layer 36, the lowest excavated in Trench IV, and apparently not associated with structures. From its shape and size it was thought to be a human stool, and this was confirmed by analysis. It was rich in cereal bran, probably wheat (*Triticum*), and included eggs of two worms parasitic in the gut of man, whipworm (*Trichuris trichiura*) and maw worm (*Ascaris lumbricoides*). This stool is discussed in detail by Jones (p. 225, Pl. I).

Shellfish appear to have been imported to York throughout the Anglo-Scandinavian and medieval periods; unless the shells are all redeposited, their consistent presence suggests that there was a regular trade in such commodities up the Ouse from the North Sea coast. The fish bones, too, indicate such trade, although they may have arrived in dried, salted or smoked fish. Freshwater fish, in particular pike (*Esox lucius* L.), Cyprinidae (carp family), perch (*Perca fluviatilis* L.), and salmonids no doubt represent local fisheries (*AY* 15).

Of the mammal and bird bones mentioned above (p. 186), it seems likely that most are food debris, except for cat and dog, and the red deer antlers. The evidence does not indicate whether this food was consumed on the sites or whether the bones were merely dumped as rubbish.

The remains of edible plants were not at all common at either site, except for hazel nuts, which were almost always present, often in some quantity. These nutshells are generally well-preserved in waterlogged deposits, and may be readily redeposited on occupation sites. Elder seeds were recorded in abundance from some samples (e.g. II 12, 29 and 33), but there is no convincing evidence that they originated in berries used for food or drink or, as postulated by Buckland et al. (1974), for leather preparation (p. 221). It is suggested that elder was, as now, a common urban plant, an opportunist favoured by nitrogen-rich soils, readily dispersed by birds, regenerating quickly and able to withstand the kind of damage likely to be incurred on an occupation site.

Many other plants represented at the two sites by their seeds or fruits might have found a use in the town, for food or medicinal purposes. These include ?dill (cf. *Anethum graveolens*), wild celery (*Apium graveolens*), deadly nightshade (*Atropa belladonna*) and henbane (*Hyoscyamus niger*). None is sufficiently abundant, however, for any conclusion to be drawn concerning their use by the occupants, and all (except, perhaps, dill) might readily have grown on or near the site.

The pollen of *Vicia faba* from five samples from Trenches II and III no doubt represents locally grown field beans. The few honey bees recorded from the sites obviously do not constitute evidence for the keeping of bees or the production of honey (and wax) at 5–7 Coppergate and Pavement. There was, however, a layer rich in honey bee corpses together with twisted straw, interpreted as a 'skep' beehive, in Anglo-Scandinavian levels at 16–22 Coppergate. Clearly bees were kept by the inhabitants of York, at least a proportion of whom enjoyed honey as a sweetener or fermented as mead.

Evidence of cereals may also be elusive, unless their remains are charred, or there is exceptional preservation. Occasionally, however, the pericarp of cereals (i.e. the 'bran') is preserved (Dickson et al., 1979; Greig, 1981; Hall et al., forthcoming), as in the stool from Pavement. Pericarp was not observed in any of the samples, although in low concentrations it is easily overlooked. It may be that some of the Cerealia type pollen originated in faeces; a few parasite ova were recorded from pollen samples rich in Cerealia (Fig. 32). These eggs may have come from human faeces, but were too rare for the statistical examination required for identification (Jones, below, p. 225). However, it is likely that faecal material would occasionally have been redeposited from older layers.

Small amounts of charred grain occurred in most samples from both sites. Charred grain and other charred plant remains are extremely resistant to decay, being, of course, amongst the few kinds of plant material to be preserved in deposits where there is no waterlogging. This durability renders charred seeds, and particularly grain, liable to be redeposited (much more so than waterlogged remains), so that very little importance can be attached to them when in very low concentrations on sites where there has been prolonged occupation. Charred grain on urban sites is, however, worth investigating in detail where large quantities, preferably including the characteristic flower parts, are recovered in good preservation from well-dated deposits. Most of the grain from both the present sites was poorly preserved, often somewhat abraded, and no spikelet fragments were recorded. Some samples from the Lloyds Bank site yielded better evidence for the contemporaneous presence of cereals. Thus sample II 21 yielded cereal grains (mostly oats, *Avena* sp.), seeds of arable weeds (principally *Anthemis cotula*) and aquatic/waterside taxa (*Carex* spp., *Eleocharis palustris*), including charred, uncharred and partly-charred specimens. The sample also included large quantities of fine charcoal (up to about 2 mm in diameter), so it is quite likely that charring took place on the site. Moreover, there are charred insect remains in this and some other samples (Table 53); these are extremely fragile and seem most likely to have been burnt in situ, probably by fires on top of the layers containing live insects.

The grain and associated weeds present on the sites do not necessarily represent cereals brought for food. Reynolds (1979, 57–8; 1981, 33–6), for example, has voiced a caveat concerning the interpretation of charred cereal and weed seeds, commonly encountered in prehistoric deposits on the chalkland of southern England — such remains might have originated in threshing debris which was deliberately burnt, or in straw imported for thatching or other purposes. This is amplified by schemes for grain processing given by Hillman (1981, figs. 5–7). In Viking-age York cereal grains and weed seeds might have been concentrated by cleaning straw prior to thatching, or at the end of its life when the roof was stripped and the thatch dumped or burnt. Another possible source would be dung burnt as fuel (P.C. Buckland, in litt.). Accidental roof fires may have produced abundant charred seeds and grains. Imported straw might also account for the high values for Cerealia type pollen recorded in many samples from Trench II (Fig. 32).

Roofs, floors and walls

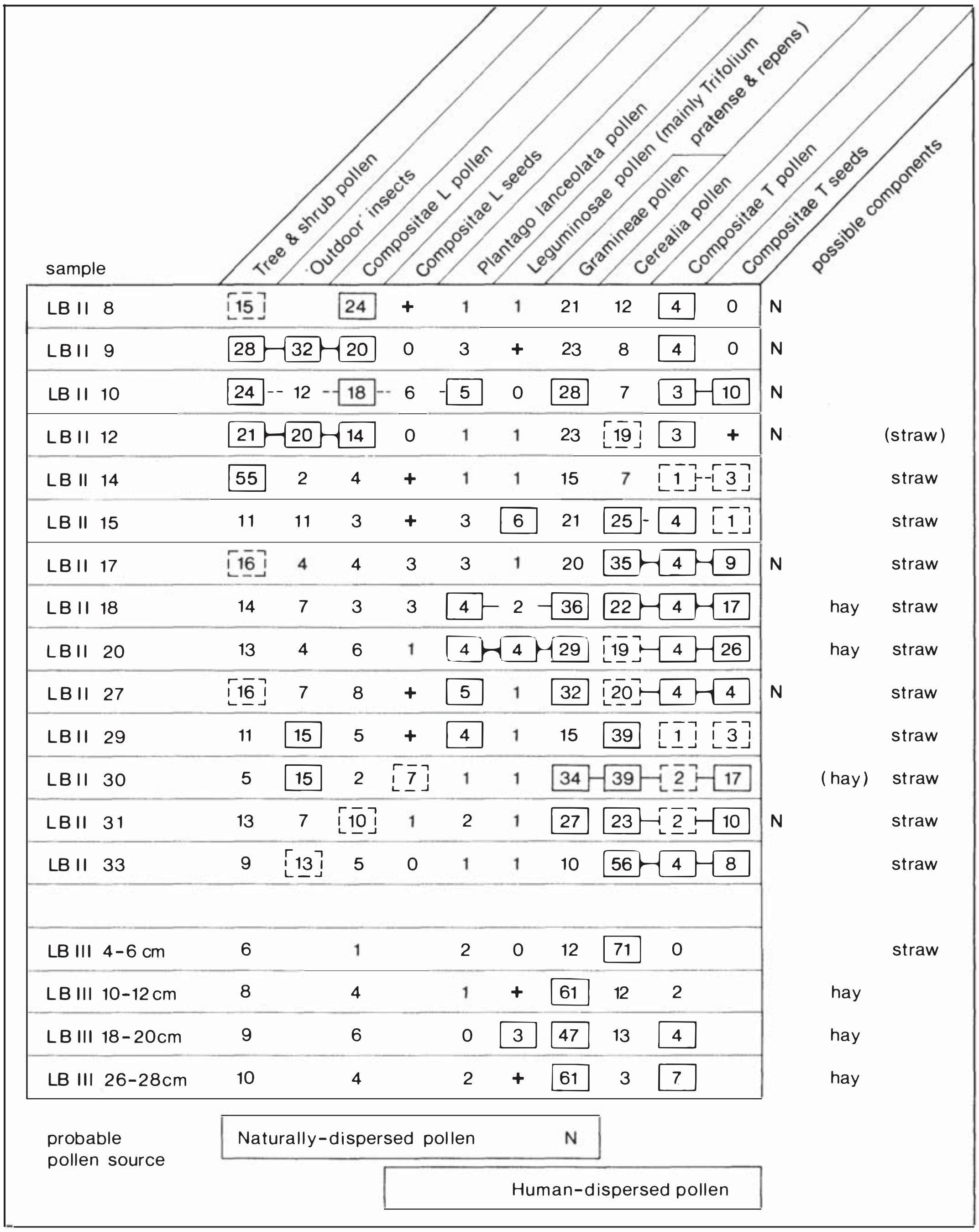
The excavation record offers reasonable evidence concerning the nature of the walls of the buildings at Pavement and, to a lesser extent, that of the floors; of the roofs, however, nothing can be inferred.

It has already been suggested that the combined evidence of pollen and plant macrofossils represent straw and perhaps also hay brought to the Lloyds Bank site. As the summary (Fig. 45) shows, some samples from Trench II gave pollen spectra particularly rich in Cerealia type together with modest quantities of Compositae (Tubuliflorae) (including *Anthemis* type) and achenes of *Anthemis cotula*, *Chrysanthemum segetum* and seeds of other arable weeds. A fuller discussion of the implications of such data is given by Greig (1982). It may be that this straw and hay were used in thatching the buildings at Pavement.

For comparison, H.K.K. and A.R.H., with Andrew Jones, have studied a small barn attached to a farmhouse at Pow Bank, near Carlisle, Cumbria, where they examined fresh thatch, material discarded during thatching, old thatch in situ, and dumped partly rotted old straw thatch (Kenward et al., forthcoming). Whole ears of grain were abundant in the straw prepared for incorporation into new thatch, even more so in the old thatch being replaced. No weed seeds were observed in the new straw, but it almost certainly originated in a crop treated with herbicides. Straw could hardly have been weed-free before the advent of modern agricultural techniques, any more than was grain.

A wide range of plants and animals may have been introduced to Anglo-Scandinavian York with roofing material of another kind — turf. The thatch on the barn at Pow Bank had been laid over turves in which a variety of plant and insect remains was found. Apart from organisms colonizing turf on the roof, the species present would of course depend on the origin of the turf; heathland or moorland turf was used at Pow Bank.

The investigation of the Pow Bank material has shown clearly that turf roofs (or indeed, turf walls) would provide immense quantities of mineral soil as well as plant and insect remains. Soil would doubtless have dropped from the roof during the useful life of the turves or have become incorporated into the build-up of the site when the roof was stripped or collapsed through neglect or disuse. Pollen typical both of the turf vegetation and of the rain-out of the area from which the turf came would also be redeposited in this way. Although various remains that might have originated in turf have been observed in archaeological deposits in York no samples have given more than a few specimens. Positive identification must await the discovery of large fragments of preserved turf or assemblages dominated by turf biota.



sample	Tree & shrub pollen	'Outdoor' insects	Compositae L pollen	Compositae L seeds	Plantago lanceolata pollen	Leguminosae pollen (mainly Trifolium pratense & repens)	Gramineae pollen	Cerealia pollen	Compositae T pollen	Compositae T seeds		possible components	
LB II 8	15		24	+	1	1	21	12	4	0	N		
LB II 9	28	32	20	0	3	+	23	8	4	0	N		
LB II 10	24	12	18	6	5	0	28	7	3	10	N		
LB II 12	21	20	14	0	1	1	23	19	3	+	N		(straw)
LB II 14	55	2	4	+	1	1	15	7	1	3			straw
LB II 15	11	11	3	+	3	6	21	25	4	1			straw
LB II 17	16	4	4	3	3	1	20	35	4	9	N		straw
LB II 18	14	7	3	3	4	2	36	22	4	17		hay	straw
LB II 20	13	4	6	1	4	4	29	19	4	26		hay	straw
LB II 27	16	7	8	+	5	1	32	20	4	4	N		straw
LB II 29	11	15	5	+	4	1	15	39	1	3			straw
LB II 30	5	15	2	7	1	1	34	39	2	17		(hay)	straw
LB II 31	13	7	10	1	2	1	27	23	2	10	N		straw
LB II 33	9	13	5	0	1	1	10	56	4	8			straw
LB III 4-6 cm	6		1		2	0	12	71	0				straw
LB III 10-12 cm	8		4		1	+	61	12	2			hay	
LB III 18-20cm	9		6		0	3	47	13	4			hay	
LB III 26-28cm	10		4		2	+	61	3	7			hay	

probable pollen source: Naturally-dispersed pollen N; Human-dispersed pollen

Fig. 45 *Summary of main pollen evidence and some other characteristics for fourteen samples from Trench II, Lloyds Bank, 6–8 Pavement, and four from Trench III. Figures are given as % total pollen, seeds (from paraffin flots only, see caveat in caption to Fig. 33) or insects. A solid box shows an arbitrarily defined 'high' value for that attribute, a dashed box an intermediate value. N — spectra believed to be dominated by naturally-dispersed pollen. 'Straw' may include chaff. Entries for unavailable data are left blank*

In addition to their direct contribution of biological remains (and soil) turf and thatch roofs would secondarily have offered a habitat for many plants; A.R.H. and H.K.K. have observed stands of nettles, grasses and other herbs, and even young birch and ash trees, on

British thatched roofs. In Norway, too, vegetation has been observed on turf roofs (e.g. at the Folk Museum, Oslo, and on the mountain plateau of the Hardangervidda). Melheim (1953) provides an account of the living vegetation of turf roofs in the Hornindal district of west-central Norway. Some Norwegian roofs slope to the ground and are accessible to grazing beasts, whose droppings no doubt introduce undigested plant remains from pastures and provide a habitat for dung-beetle communities.

A further source of roofing material in the past was aquatic and waterside vegetation. Dimbleby (1978, 43) has suggested that 'the long sword-shaped leaves of some marsh plants (e.g. sweet flag (*Acorus*), reedmace (*Typha*) or [sedge] *Cladium*), the straight stems of rushes (*Juncus*) and doubtless various tall-growing grasses could have been used much as wheat straw is used for thatching today'. *Acorus* was, however, a 17th century introduction to Britain (Clapham et al., 1962; Grigson, 1975) and does not concern us here. A longer list of known thatching materials, with references, is given by Adams (1977, 116), while Billett (1979) surveys methods of roofing with organic materials, ranging from turf and reed to hazel sticks and flax. However, the authors know of no case in which remains from archaeological deposits have been shown to derive from roofing materials.

A variety of pollen types, seeds and insects might be incidentally carried to occupation sites with such material, particularly if use was made of 'rough hay' containing reed and other coarse plants as described by Ravensdale (1974, 54) in respect of thatching in medieval Fenland. Waterside vegetation might also have been imported to be strewn on floors, an explanation offered by some workers (e.g. Buckland et al., 1974; Donaldson, 1979, 59; Green, 1979b, 190; Underdown, 1980) for the often abundant seeds of rushes (*Juncus* spp.) and other plants of damp habitats in urban archaeological deposits. There is irrefutable documentary evidence and indeed the practice continued in Ireland till recently (Evans, 1957); stems of soft rush (*Juncus effusus* L.) are used to this day at Trinity House, Kingston-upon-Hull, to cover the floor of a large room, a tradition continuing from the 15th century (J. Barling, in litt.).

It cannot, however, be assumed that the *Juncus* seeds recorded at Coppergate and Pavement came from plants used in this way. Analyses of many deposits in York indicate that the toad rush, *J. bufonius*, is one of the most commonly encountered. This low-growing plant (30–250 mm) of 'paths, roadsides, arable land, mud by ponds' (Clapham et al., 1962) is unlikely to have served as flooring material; it is much more credible that its seeds arrived on muddy feet, were wind-blown, or as at Pow Bank, originated in turves. This, of all the *Juncus* species, is perhaps the most likely to have grown on or near the sites. It is commonly (although not exclusively) a member of trampled weed communities (*Trittgesellschaften* and *Trittrasen* of Continental phytosociologists) with plants like *Plantago major, Polygonum aviculare* and *Poa annua*, all taxa regularly recorded in urban medieval assemblages. Although *Juncus* seeds are often difficult to identify, especially when preservation is not good, *J. bufonius* seems to be an exception and Körber-Grohne's (1964) atlas provides a useful description and photographs.

The state of the floors as indicated by the insect remains is discussed on p. 200.

Yet another use for straw, rushes and similar materials in the past was for daub, in which the chopped plant stems and leaves were mixed with clay and applied to a framework of woven pliable young tree stems. Daub, and clay roof cappings (Evans, 1957, 39ff.; Ravensdale, 1974, 55), as well as turf, would have been important sources of mineral soil in deposits. There was little archaeological evidence for the use of daub on the walls of structures found under Lloyds Bank, although at least one collapsed wall (of Structure I/6) was thickly coated with a clay mixture so interpreted.

To sum up, there seems little doubt that hay and straw were brought to the Lloyds Bank site, though the evidence is largely indirect. The specific purpose remains uncertain, but use as thatch and bedding for humans or animals seem likely. The heather and small number of heathland insects from the present sites are hardly evidence of turf importation; large quantities of cut heather were brought to the site at 16–22 Coppergate during the Anglo–Scandinavian period and the small amount found at Pavement may have originated in such material. The use of wetland vegetation on roofs or floors is unlikely, bearing in mind the range of species recorded. The origin of the wetland component is discussed in detail in the next section.

Marsh and river

The significance of the abundant and (mainly) ecologically well-defined group of aquatic and waterside plant macrofossils and insects is surprisingly difficult to determine. This component, which comprises species characteristic of the freshwater 'littoral zone' (sensu Ruttner, 1963, 179), may have become incorporated in the deposits in a number of direct and indirect ways. The deposits may have formed in a wet environment: in situ in a marsh; through flooding of normally dry land; through the dumping of rubbish on marshland or river bank; or through occupation of very damp ground or an area traversed by ditches. Under any of these regimes, the conditions required for the preservation of organic remains (waterlogging, or the presence of large quantities of organic matter whose decay is self-inhibiting, or both) could have existed. Alternatively, deposition may have taken place away from water and the aquatic component may have arrived from elsewhere, through natural dispersal, or deliberate or accidental transport by man. Combinations of these are of course possible and different processes may have been predominant at different times during the period represented by the deposits.

Both sites are close to York's rivers: 6–8 Pavement at present lies some 150 m from the Foss and 5–7 Coppergate about 200 m from the Foss and 100 m from the Ouse (Fig. 24). The Foss has certainly changed its course and been canalized; it was probably closer to both sites in Anglo-Scandinavian and early post-Conquest times (Hall, R.A., 1978b; Kenward et al., 1978). There is documentary evidence for marshland upstream by the Foss in the region of Hungate (Fig. 24) in the later medieval period (Richardson, 1959) and if this marshland existed close to the sites in the Anglo-Scandinavian period it probably would have provided habitats for all of the littoral plants and animals. Beetles of the family Elminthidae, of which three specimens were recovered, are confined to flowing water and stony lake margins and would have found habitats a little further away in the open rivers.

Were the sites subject to flooding? Benson (1903, and see Hall, R.A., in *AY* 8, forthcoming) described sediments from High Ousegate as 'warp', implying that they had been deposited by flood water, but this is undoubtedly a misapplication of the term to what may rather be occupation build-up. It might be predicted that if flooding gave rise to deposits thick enough to be preserved, some or all of the following features would allow their recognition: characteristic 'sorted' particle size distribution curves for the mineral component; characteristic distribution of particle size through the thickness of deposits, typically coarser below and finer above; presence of many waterside plants and animals including freshwater molluscs, together with a variety of terrestrial species from natural habitats; assemblages of high ecological and mathematical diversity; few synanthropic insects; and few food plants, when compared with occupation build-up. These characteristics have been repeatedly recognized in modern flood sediments along the Ouse and elsewhere (Kenward, unpublished).

None of the samples investigated in this study showed such characteristics in combination. Of course, flooding by low-energy (slow-moving) water might have left only small thicknesses of fine-grained sediments, perhaps without biota, which would soon have been lost in the general accumulation. Flood 'refuse', i.e. stranded plant matter, is often much less rich in aquatic insects and seeds of aquatic plants than flood silts (Easton, 1965; Lambrick and Robinson, 1979; Kenward, unpublished); nevertheless, none of the samples contained a substantial component characteristic of such flood refuse.

For most of the sequence at 6–8 Pavement, natural deposition in marshland or riverside, or deposition of rubbish in a similar environment, can clearly be ruled out by the stratigraphy and evidence of structures. However, the presence of a few aquatic snails in the lowest deposits recorded by augering in Trench IV make it possible that these layers were formed by dumping on wet ground in order to raise the level. A similar range of plant and animal species to those at the present sites was found in deposits interpreted as having formed through rubbish dumping, perhaps on poorly drained ground, at Highgate, Beverley (Hall and Kenward, 1980). It seems that abundant remains of aquatic and marshland organisms do not necessarily imply aquatic or waterside deposition.

This problem of the origin of aquatics in deposits thought, on the basis of abundant evidence, to be terrestrial is an important one. Two especially significant species are *Carpelimus bilineatus* and *Ranunculus sceleratus*, which occupy the first rank of abundance in the beetle and seed lists respectively in many of the samples from 6–8 Pavement (Tables **61–4, 68–71,** Microfiche 1).

Carpelimus bilineatus

C. bilineatus is regularly abundant in medieval urban assemblages and so of considerable importance in their interpretation. Modern records of this small staphylinid beetle suggest strong association with decaying plant matter at the edge of water (see above, p. 182). It might, therefore, be taken as evidence for the deposition of plant remains, as either rubbish or as flood debris, on wet mud in the open, especially since some other species abundant in related habitats, e.g. *Anotylus nitidulus, Platystethus nitens, P. cornutus* group and *Neobisnius villosulus*, are consistently present. This interpretation does not, however, appear to be correct.

Firstly, *C. bilineatus* is abundant in assemblages thought to have formed indoors (p. 196 ff.). Secondly, using rather crude methods, a preliminary analysis of the relationships

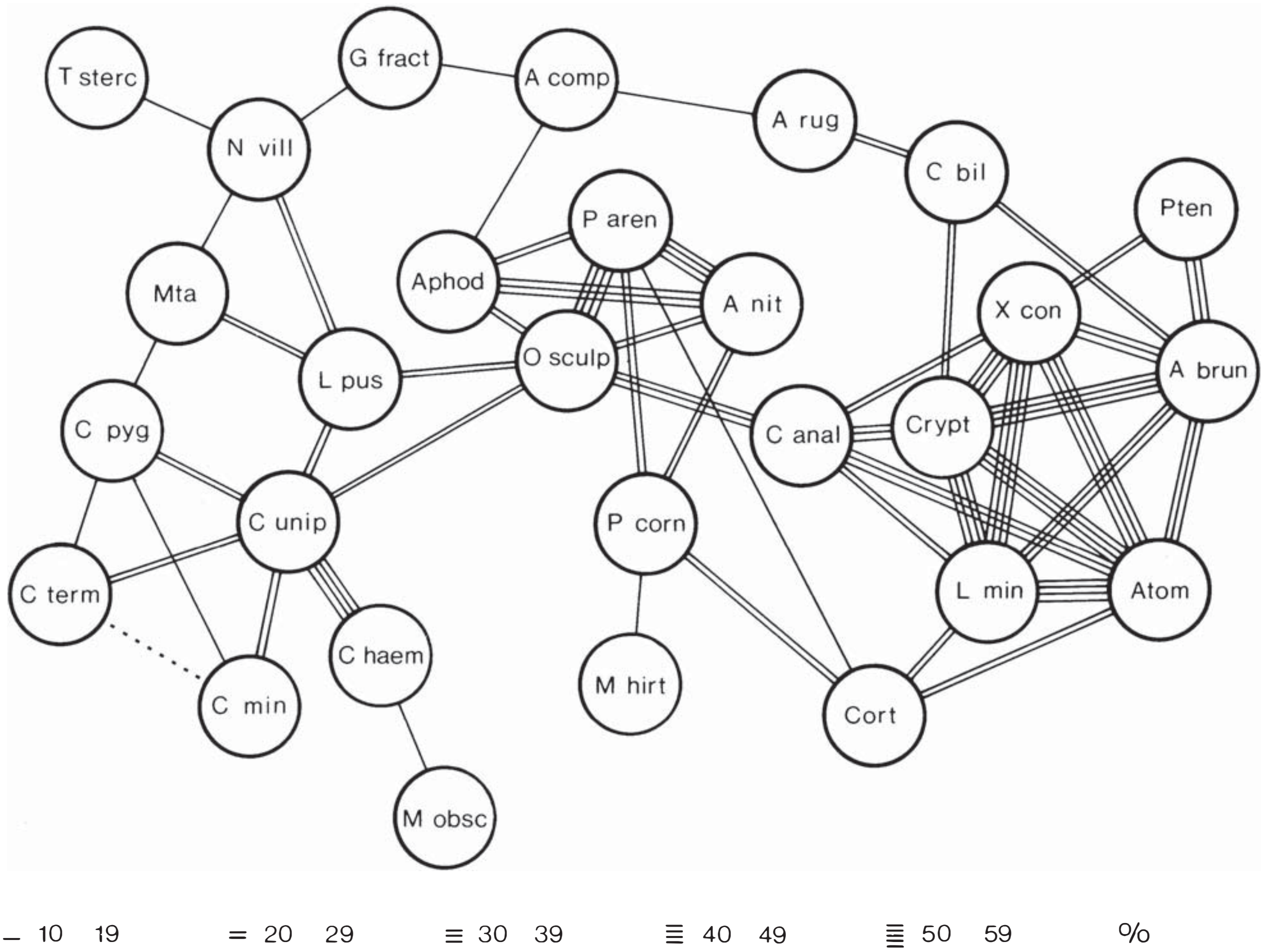


Fig. 46 'Constellation' diagram representing the correlations between occurrences of the more abundant species of Coleoptera in samples from a number of British archaeological sites of Roman and medieval date. The diagram is based on values of Jaccard's (1912) coefficient of community, using the best six mutually inclusive linkages for each species (see Kenward, 1982). Correlations are represented by the number of lines (see key) and not by the proximity of the circles. For species abbreviations, see Table **66**; *for list of sites, see Kenward (1982, table 9)*

of the more abundant species in a variety of archaeological assemblages, including those from Pavement and Coppergate, has been carried out. A 'constellation diagram' showing the frequency with which species occurred together at over 3% of the whole assemblage is given in Fig. 46. This work is reported in more detail elsewhere (Kenward, 1982) and requires further development, but the diagram is, with reservations, a guide to the groups of species which occurred together in similar habitats in the past or, at least, to those which tended to die in large numbers in the same places. In the diagram, *C. bilineatus* falls close to a group of species characteristic of relatively dry organic matter, and is weakly linked to waterside species.

The correlations calculated from concentrations using Pearson's *r* (see above, p. 192) have similar implications, showing that *C. bilineatus* is much more closely associated with *Cercyon analis* (representative of decaying matter in a wide sense) and dry compost species than with a group of waterside oxytelines (*C. bilineatus*/*C. analis*, $r = +0.9$; *C. bilineatus*/dry compost +0.7; *C. bilineatus*/waterside oxytelines –0.05). Evidence that the species bred in the Pavement deposits is offered by records of pale, presumably freshly emerged, specimens in five samples (Table 53).

Remains of *C. bilineatus* were abundant enough in a well-rotted compost heap, perhaps some decades old, in Heslington village, York, to suggest that the beetle was attracted to the heap even if it did not breed in it. The only further clue is from passing unsubstantiated comments, for example by Hansen (1951, 110) and Backlund (1945, 206), that *C. bilineatus* is sometimes found in manure or dung — not, however, the habitat suggested by the present analysis! It has not been included in either grouping of rotting matter species (Cd, Cw) in constructing Figs. 36–7, or in Rt in Figs. 38–9, although it has been added to the diagram as a significant and possibly ecologically related species. It illustrates well the danger of excessive reliance on evidence concerning the modern biology of single species; many may have exploited habitats in the past which do not have modern counterparts. It is conceivable, however, that *C. bilineatus* found its (unknown) habitat requirements satisfied at Pavement in damp ditches or eaves-drips, from which it strayed into buildings, while other waterside insects did not.

Ranunculus sceleratus

At Rank 1 in twelve samples from 6–8 Pavement, and Ranks 2–3 in a further fifteen, *Ranunculus sceleratus* (celery-leaved crowfoot) appears unlikely to have been imported accidentally with waterside vegetation (like reed or sedge) to either site. It is not typical of tall-growing reed or sedge communities, though its achenes are adapted for dispersal by water, and are readily 'stranded' on emergent aquatic plants as water levels fall and might then be collected accidentally when reed or sedge is cut. Although *R. sceleratus* is a prolific seed-producer (Salisbury (1961, 232) cites an estimated 120,000 achenes from a very large plant), it is difficult to believe that the enormous numbers recorded throughout the deposits at Pavement all arrived on cut 'reed'. To import so many, the 'reeds' would surely have to be pulled together with mud rich in achenes around their roots — hardly an appealing or suitable method for material intended to make neat roofs or to purify floors.

It seems unlikely that *R. sceleratus* would so consistently have been imported intentionally. Grieve (1976, 235) points out that it is 'one of the most virulent of native plants; bruised and applied to the skin, it raises a blister and creates a sore by no means easy to heal'. Although the same author records that it has been used as a vegetable (after boiling) by peasants in Wallachia, it is doubtful whether it would be collected for food at a stage when ripe achenes were abundant. It is also extremely poisonous to both man and his livestock (Long, 1917, 11), a fact reflected in some of its French vernacular names: *mort aux vaches* and *herbe sardonique.*

While it is conceivable that all the wetland organisms found habitats on the sites in damp ditches or puddles in yards, it may be argued that *R. sceleratus, C. bilineatus*, and the other waterside oxyteline beetles, entered the deposits by different routes, since their occurrences correlate only weakly (Pearson's $r < 0.2$ in each case for both concentration and percentage data). *R. sceleratus* is consistently abundant at 6–8 Pavement but rare at 5–7 Coppergate, *C. bilineatus* is generally abundant at Pavement and much less so at Coppergate, and the other waterside oxytelines (*Platystethus cornutus* group, *P. nitens, Anotylus nitidulus*) are abundant at Coppergate (a site most unlikely to have been flooded), and much less abundant at Pavement. These beetles appear to disperse in large numbers (see *AY* 19/1, 7) and may well have emigrated from the Foss marshes in swarms on muggy summer evenings. The remaining aquatic and waterside insects are, with one or two exceptions, no more abundant than seems predictable in the background rain close to aquatic habitats (Kenward, 1975b, 1976b).

Seeds of waterside plants may also have arrived as a result of natural dispersal (discounting water transport, to which most are adapted) or 'semi-natural' dispersal, incidental to human activity. Indeed, all the aquatic and marsh plants at 6–8 Pavement could have been imported in the mud on people's footwear. Analysis of a sample of clay from the margin of a drying cattle pond in a grazed pasture near Redditch in Hereford and Worcester, where there were only a few plants of *R. sceleratus*, showed that its achenes may be extremely abundant in mud (Hall, unpublished). Salisbury (1961, 101–8) has recorded the efficacy of feet and footwear as agents of seed dispersal; this has been borne out by A.R.H.'s observations of muddy wellington boots passing through urban weed communities. The occupants of the buildings at Pavement very probably made frequent visits to the margins of the Foss for one purpose or another, perhaps to collect water or deposit waste, and such commerce would provide a regular route for the transport of seeds.

As stated above, *R. sceleratus* is a characteristic plant of nutrient-rich (including rather polluted) mud at the margins of ponds and rivers, especially where there is disturbance. It may have grown near Pavement in stands together with *Chenopodium rubrum, Polygonum hydropiper* (Timson, 1966), and *Bidens* spp., communities recognized in Continental Europe as part of the phytosociological class Bidentetea tripartiti (following the nomenclature of Lohmeyer et al., 1962; see also Shimwell, 1971). This comprises nitrophilous weed communities in habitats subject to periodic inundation (Tüxen, 1950, 108; Poli and Tüxen, 1960). Indeed, one association (Rumicetum maritimi) of this class comprises communities of 'moist to wet, nitrogen- and nutrient-rich open soils at the edge of cattle ponds, village ponds, on the beds of drained fish-ponds and sewage soakaways ... also in peat-cuttings on bogs' (trans. from Tüxen ibid., 110). *R. sceleratus* is a 'character' species of the Rumicetum maritimi, so much so that Tüxen suggests that it be renamed Ranunculetum scelerati.

The disparity in the records for certain waterside plants between the two sites (Fig. 35 and Tables **61–5**) might thus be explained by the distance of each site from the rivers and by differences in human activity unconnected with the plants themselves. Their seeds are of little value, therefore, as evidence of the mode of formation of the build-up or ecological conditions on the site.

Turning briefly to the pollen evidence, waterside and aquatic plants are not well-represented (Fig. 32). Cyperaceae pollen probably originated in sedges of damp or wet habitats (whether growing locally in a marsh or having arrived in cut stands used in thatching or flooring), and alder (*Alnus*) pollen may have blown from riverside trees. More detailed interpretations are problematic, since the level of identification of much of the pollen is only to family or genus. Thus whilst Ranunculaceae may include pollen of aquatic *Ranunculus* spp. (subg. *Batrachium*, the water-crowfoots), it is not always easy to separate this from pollen of the terrestrial species. Likewise some Umbelliferae are aquatic and waterside taxa (e.g. *Apium graveolens, Cicuta, Conium*, though the last of these exploits a very wide range of other habitats), and may account for some, at least, of the recorded pollen of this family.

Weeds and waste ground

In trying to visualize the Anglo-Scandinavian townscape, the presence or absence of living green plants is crucial. There are at least two lines of evidence worth pursuing: the remains of the plants themselves or their seeds or pollen; and the remains of the communities of insects specifically associated with them.

Some plants represented in the seed lists seem very likely to have grown in the town: elder (*Sambucus nigra*), stinging nettle (*Urtica dioica*), fat hen (*Chenopodium album*), goosefoots (*C.* sect. *Pseudoblitum*), oraches (*Atriplex* spp.), persicarias (*Polygonum persicaria* and *P. lapathifolium*), greater plantain (*Plantago major*), and black nightshade (*Solanum nigrum*). These are members of the weed communities of better-drained, often nutrient-rich soils (Chenopodietea) rather than those of damp to waterlogged habitats (Bidentetea, p. 215). Some of these were identified from both seeds and pollen, but in general pollen cannot be identified sufficiently closely to give direct evidence of particular weed taxa. However, some or all of the remains of many of these plants may have originated outside the town, for it is in their nature to exploit disturbed habitats of many kinds, rural as much as urban. Salisbury (1961, 287) lists a number of these weeds amongst those typical of gardens, though this is hardly evidence of horticultural activities on or near the sites.

One weed which is certainly not a denizen of urban habitats today, but which may have been so in the past, is stinking mayweed (*Anthemis cotula*), often abundant at both Coppergate and Pavement. Its biology is surveyed by Kay (1971), who records it as 'a locally common weed of arable land and farmyards in England and Wales' and remarks that it also grows on roadsides. Although Kay maintains that it is not a plant of waste ground, it may be argued that farmyards represent a kind of waste ground and that the poorly maintained weed-infested farmyard may be the nearest modern analogue to parts, at least, of the Anglo-Scandinavian town. In Europe *A. cotula* is frequent as an arable weed but is also recorded from villages, where it grows in farmyards, on roadsides and in goose-greens, near ponds and in chicken-runs (ibid., 628). Observations such as these illustrate well the dangers of relying solely upon recent British data concerning the habitats of plants as a basis for interpretation.

Characteristic of many of these urban weeds is their association with soils rich in nutrients, especially nitrogen and phosphates. Nutrient-enrichment would be expected in a town inhabited as densely (to judge from the archaeology) as was York in the 9th–12th centuries. Recent investigations by Steiner and Kinzel (1980) suggest, however, that *Chenopodium album*, considered by many workers to be a nitrophile, is, rather, an adaptable pioneer species. This illustrates how much further work needs to be undertaken before the full significance of even the commonest species is understood. (Despite the assertion of Kenward et al. (1978, 68), flixweed (*Descurainia sophia*) was not abundant in deposits at Pavement, nor is its presence surprising. It occurred abundantly in only one sample (IV 7), and its presence is readily explained as it is a colonizer of waste ground.)

The uppermost part of the Trench II succession at Pavement, i.e. layers, 9, 8, 12, 11 and 10, is rather distinctive and seems likely on the botanical evidence to have formed as yard deposits. All the layers are laterally extensive. Three of them gave pollen spectra with startlingly higher Compositae (Liguliflorae) (Fig. 32) than any of the others investigated, and most of them have higher concentrations of *Sambucus* seeds. These large numbers of elder seeds possibly also represent plants growing around buildings, although interpretation of this species is difficult; its durable, woody seeds and its predisposition towards well-drained soils giving poor preservation of other taxa may result in misleadingly high concentrations of elder. A second group of samples, at the base of this succession (samples 27–33), may also represent yard deposition. One of them (29) gave 45% *Sambucus* pollen (82% of sum excluding

Sambucus), while its seeds made up 39% of the plant macrofossil assemblage. It seems very likely that elderberry grew on or near the site from time to time. The botanical evidence does, however, contradict that from the archaeological record and the insect remains (p. 196 ff.).

There is a good number of insects which might have exploited an urban weed community, although none is abundant. *Heterogaster urticae*, *Brachypterus glaber*, and *Cidnorhinus quadrimaculatus* are associated with nettles, for example, though there are records of them from the closely-related pellitory-of-the-wall, *Parietaria diffusa* Mert. & Koch (Davis and Lawrence, 1974). Preliminary studies of the insect corpses associated with modern beds of stinging nettle (*U. dioica*), suggest that nettle feeders, together with a group of ground- and litter-dwelling species including dromiine ground beetles, are normally abundant, but that soil around small groups of plants may be devoid of nettle-feeding insects (Kenward, unpublished).

The only regularly present beetles associated with weeds are *Phyllotreta nemorum/undulata* (recorded from 27 samples but never abundant) and *Chaetocnema concinna*, the former feeding on a variety of cruciferous plants and the latter on Polygonaceae and *Beta*. Some of the less frequent species, for example *Ceutorhynchus quadridens*, also feed on Cruciferae, while several others, for example the *Sitona* species, have Papilionaceae, mainly clovers and vetches, as hosts. None of these species is, however, any more abundant than in assemblages formed on modern roofs (Kenward, 1976b); they may therefore have originated far from the site of deposition as 'background fauna'. *Sitona* spp., for example, formed a substantial proportion of a roof-gutter assemblage from Osbaldwick, York (Kenward, unpublished).

These insects are therefore inconclusive as evidence concerning the growth of weeds at the sites. Certainly observations of derelict areas in York today suggest that the plant communities can become established within one season, whilst associated insects may require rather longer to colonize. This probably reflects the reservoir of dormant seed in the soil; insects must invade from elsewhere. Most of the weed taxa are also prolific seed-producers, so that a few plants, growing perhaps in sheltered corners, or even on roofs, may have been sufficient to account for the large numbers of propagules recorded.

Livestock on the sites

A further factor when considering the possible urban flora is the likely presence of domestic animals, particularly pigs, goats and chickens, all of which are able to eradicate plants completely if confined in small areas. Chickens, moreover, would probably even feed on plants on roofs. How much the seed content of their diet would pass undigested through their guts, perhaps to be deposited indoors, is uncertain. Both chickens and pigs were probably kept in the town at this period. It is possible that much of the pollen from grasses and cereals originated in hay and straw used in the husbandry of domestic animals. The summary (Fig. 45) indicates a number of samples from Trench II at Pavement where there may be evidence for these materials. In particular, the records for *Trifolium* spp. (probably red and white clovers — *Trifolium pratense* and *T. repens*) may reflect importation in hay.

It seems from the insect assemblages that, whatever their vegetation, nearby open areas contained foul rotting matter. Species associated with such substrates are moderately abundant in the samples from Coppergate (Figs. 38–9). Dung beetles (*Aphodius* spp.) are consistently present in small to moderate numbers throughout the deposits at both sites. Although most of the species recorded as more than single specimens may be capable of breeding in moist plant matter, it is perhaps more likely that they originated in dung. Since these beetles fly freely and sometimes in large numbers, they may originate as background fauna; the numbers likely to originate in this way cannot yet be determined but they are present in modern assemblages of background fauna (Kenward, 1975b, 1976b). There is no clear evidence for abundant animal or human faeces, but it is quite possible that animal droppings in the open would quickly be trampled or devoured by livestock; pigs and dogs will certainly eat faeces, and chickens would disperse such material.

Health and hygiene

Several of the recorded remains point to aspects of the health and hygiene of Anglo-Scandinavian populations in York. The entire stool (p. 225), apart from suggesting that at least occasionally human faeces were deposited on the ground surface, rather than in pits, shows that the individual producing it carried a substantial burden of parasitic worms. Worm eggs were present in a number of the pollen preparations, suggesting that some faecal matter found its way into general accumulation layers. This may have been a result of redeposition from pits, however, so the eggs may have been dead and not a health hazard. The insect remains, and the nature of some of the deposits, clearly show that there was foul rotting matter on the ground, and the abundant fly puparia indicate that bacteria would readily have been transferred to food. There was at least some infestation by fleas as evidenced by the single record of *Pulex irritans*. It is possible that many disassociated fragments of fleas were overlooked during sorting, since fleas are abundant in the samples from 16–22 Coppergate.

As mentioned above (p. 207), the records of seeds of plants such as henbane and deadly nightshade, widely used in herbal medicine in later medieval and post-medieval times, do not stand as very good evidence that they were so used at the present sites. The continued association of some of them with human habitation perhaps indicates that they found favourable habitats there or were encouraged by man.

The surroundings of the town

Urban deposits are, clearly, not ideally suited to investigations of the rural environs of a town, although they may yield wind-blown pollen and remains of crops and raw materials imported from the countryside and a 'background' component of insects from the surroundings (Kenward et al., 1978, 60). Obviously there is evidence from the biota for woodland, for heathland, marshland, arable land and perhaps hay meadows, and for grazing land for the abundant cattle and sheep. The timber (which, to judge from its quality, came from immature trees or coppice) may, however, have been imported from far away; the evidence for forest from tree pollen is likewise weak, since grains may have travelled great distances on the wind, or shorter distances with imported materials like brushwood and bark. Studies of urban man cannot be complete without investigations of the rural system which supports the town and further work like that at Askham Bog (Kenward et al., 1978; Fitter and Smith, 1979) must have a high priority.

Climate and distributional changes

A number of the insect species recorded from the sites are rare in or absent from the York area today. The nettle-feeding bug *Heterogaster urticae* was present in at least nine samples. Its present distribution does not extend as far north as Yorkshire. There is a single 19th century record and one of a corpse, probably a migrant, from Spurn Peninsula (Hincks, 1951). It was suggested by Addyman et al. (1976) that this species represents good evidence for climatic change, mean summer temperatures in the Anglo-Scandinavian period having been a degree or so higher than at present. Such an apparently small difference may have had a profound effect on crops.

Some of the less frequent species from the present sites suggest climatic deterioration since the Anglo-Scandinavian period. *Anthicus bifasciatus* is a very distinctive species, recorded from two samples from 5–7 Coppergate and tentatively from one from Trench IV at Lloyds Bank. *A. bifasciatus*, which was added to the British list only in the second decade of the 20th century (Fryer and Fryer, 1914), has been recorded from manure heaps and may be abundant when present (Donisthorpe, 1931). Buck (1954) recorded it from Leicestershire, Oxfordshire, Cambridgeshire and Rutland, and Williams (1979) cites a record from a large compost heap on council allotments near the centre of Bristol. *Acritus homoeopathicus* was identified from a single sample, II 10, on the basis of a joined head and thorax. The beetle has a very south-eastern distribution, extending from Kent to Dorset and Huntingdonshire (Halstead, 1963; Cooter, 1974; Welch, 1968; Massee, 1950). Kryzhanovskii and Reichardt (1976) list a variety of habitats for it, but the consensus is that the beetle is associated with burnt ground (see especially Welch, 1968). Habitat destruction appears unlikely to have been the cause of its apparent restriction in range.

Three specimens of the weevil *Apion difficile* have been recorded, two from Trench II and one from Trench IV. Morris (1982) summarized its distribution; there appear to be no records from as far north as Yorkshire. The host of *A. difficile* is *Genista tinctoria* L., dyer's greenweed (and, according to Hoffmann (1958), *G. anglica* L., petty whin). *G. tinctoria* is now quite common and widely distributed (Clapham et al., 1962; Perring and Walters, 1962) and, indeed, has been found at Askham Bog, near York (Fitter and Smith, 1979) so the beetle's distribution is unlikely to be limited by its host.

The northernmost modern record of *Pediacus dermestoides* is for Nottinghamshire, while amongst the *Platystethus* spp. recorded, *P. degener* appears to have been well north of its main present-day distribution and *P. nitens* appears to have become very much rarer (Hammond, 1971).

According to Lindroth (1974, 128), *Dromius longiceps* is recorded from the Fens from Cambridgeshire to Lincoln. The species is present in a single sample from Trench II, Pavement. Its disappearance from the York area has been ascribed to habitat destruction rather than climatic change (Addyman et al., 1976). This is confirmed by recent records of the species living in reedswamps in southern Yorkshire (Aubrook, 1972; Crossley, 1977, 1978).

Similarly, 'sedge' (*Cladium mariscus*) is likely to have declined through habitat change (as suggested by Godwin, 1975, 392). Recorded with some regularity from these Anglo-Scandinavian deposits, it is today a rare plant in the York area, occurring for example at Askham Bog, a few miles south-west of the city, in a fragment of relict wetland.

The four most abundant beetles (*Aglenus brunneus, Anotylus nitidulus, Carpelimus bilineatus* and *Ptenidium punctatum*) all appear to be very much less numerous at present than they were when these deposits were laid down. This, too, is probably largely the result of habitat changes — the disappearance of extensive tracts of rotting organic matter around human habitation and perhaps of rubbish dumps by water — rather than climatic deterioration. It seems possible, however, that one factor in the restriction of *A. brunneus*, now seemingly mainly confined to stored products, has been reduced temperatures (Kenward, 1976b).

At least two of the arable weed taxa common in the deposits at Pavement and Coppergate are now much restricted; they are corncockle (*Agrostemma githago*) and stinking mayweed (*Anthemis cotula*), victims of improved farming techniques such as the use of clean seed grain and herbicides (Salisbury, 1961, 145–7). Such is their frequency in archaeological deposits of medieval date that they were evidently serious weeds of cultivation, and this is borne out by later evidence from herbals and manuals of plant husbandry.

Discussion

An evaluation of the preliminary report of Buckland et al. (1974)

Although the preliminary interpretation of results from four samples from the Lloyds Bank site by Buckland et al. (1974) was explicitly speculative, many of the ideas put forward have been widely quoted as fact. The points raised in that paper must therefore be reviewed in the light of subsequent investigations. Of the four insect assemblages, that from sample 3 has proved to be strikingly different from any other from the site, containing quite large proportions of aquatic and heathland species. It should be emphasized that all four assemblages used in the pilot study were very small and came from samples in which the concentrations of insects and seeds were low.

To deal with specific points: no further evidence of 'reeds, probably *Phragmites communis*' (ibid., 26) has been found. Cyperaceae fruits were interpreted as additional evidence of waterside vegetation used for flooring; it now appears equally likely that they represent material used for roofing, or arrived by natural dispersal. Aquatic insects are now seen as having probably originated as background fauna rather than as a component of strewn vegetation.

A number of insects accidentally marked with an asterisk in Buckland et al.'s table 1 are not associated with rotting matter, while many of those unmarked are. The observation (ibid., 26) that 'a considerable number of the insects ... comprise a rubbish-living community' is, however, strongly sustained though the proportion 'characteristic of wet rotting vegetation' is quite small. While it is true that the insect associations 'could well be found in a compost heap', further work has suggested that the house interiors were not foul.

The speculations concerning leather preparation must be re-examined. Sample 3 has proved atypical of the Lloyds Bank site in its content of fly puparia. Elderberry seeds are now seen as more likely to have entered the deposits from plants on or around the site (p. 216) than 'to make an acid ferment for treating hides', especially as there are no references in standard texts on tanning to the use of elderberries in this way. The original account was optimistic in assuming that all insects (e.g. *Tenebrio obscurus*, then determined as *T. molitor*) occupied the same typical habitats in Anglo-Scandinavian York as in 20th century England.

The conclusion (ibid., 30) that the pollen spectrum was 'a derived one' (implying wind dispersal and human transport) is sustained and amplified by the subsequent analyses, and, indeed, the same is true for most of the interpretations presented on pp. 30–1 of Buckland et al.'s paper. However, an important exception is the reference (ibid., 31) to *Aglenus brunneus*, which has been widely read as implying that the beetle indicates the presence of chicken litter. This is, of course, only one of many habitats from which *A. brunneus* has been recorded. The assertion that *A. brunneus* is indicative of tanneries, sometimes attributed to Buckland et al., does not appear in the paper.

Sample 3 has been the only one from the entire site to contain more than one or two heathland insects. (*Myrmica scabrinodis* Nylander and *M. sabuleti* Meinert are not, however, 'usually associated with ... *Calluna vulgaris* and *Erica* spp.' (cf. Bolton and Collingwood, 1975).) While the heathland insects may, indeed, have been imported with bulk heather for bedding, sample 3 represents the only good candidate for a deposit containing the remains of turf roofing.

Lastly, in view of the wide misquotation of the paper it is worth repeating part of its concluding paragraph; 'It must be stressed that the environmental model, suggested on rather limited evidence ... requires detailed checking ... and ... practical experiments designed to test the validity of the conclusions'.

Comparison between 5–7 Coppergate and Lloyds Bank, 6–8 Pavement

A comparison of the plant macrofossil data for these two sites reveals a greater homogeneity in the assemblages at Coppergate than in those from Pavement. This is not, perhaps, surprising, in view of the very small area and depth of stratigraphy sampled at Coppergate.

Thus three taxa, *Anthemis cotula, Atriplex* spp. and *Chenopodium album* hold ranks 1 to 3 of the plant assemblages in almost all samples from Coppergate and there are generally fewer marked variations in the composition and structure of the FTRA tables than in the data for Pavement. Other notable differences, mentioned above, are the smaller component of waterside and aquatic species at Coppergate (particularly noticeable for *Ranunculus sceleratus*) and a more consistent occurrence of hemp and hop at this site. It is difficult to judge the significance of these differences, however, given the nature of the excavations and methodological procedures.

Some differences in the insect assemblages between the typical samples from Pavement and Coppergate have been mentioned above; *Carpelimus bilineatus, Aglenus brunneus* and *Ptenidium* spp. are strikingly more abundant at the former, and *Anotylus nitidulus* and *Platystethus* spp. at the latter. Values for the index of diversity are more consistently high for the Coppergate samples. Concentrations and percentages of 'dry compost' insects are much higher for Pavement, especially Trench II, while the values for 'foul' rotting matter species are generally higher at Coppergate. Thus Cw is equal to or higher than Cd in 72% of the Coppergate samples but only in 18% of those from Pavement. Of the latter, four of the nine cases are from the deposits in Trench III, possibly formed outdoors, and the remainder from Trench IV. It seems probable that the majority of the Coppergate samples came from deposits laid down outdoors. Possibly the abundant damp-ground and other 'outdoor' insects recorded from these samples were background fauna concentrated by eaves-drips or deposited in the 'dead space' behind a building or fences (see, for example, Lewis, 1966).

Comparison with other sites and periods

A detailed synthesis of changes in biota, and their archaeological implications, throughout York's history will be presented in later fascicules of *The Archaeology of York*. However, sufficient material of Roman date (*AY* 14/1–3; Hall, R.A. and Kenward, 1976) and from the Anglo-Scandinavian and medieval periods has now been examined to justify a few preliminary observations.

The nature of the archaeological build-up in Roman York contrasts strongly with that of the Anglo-Scandinavian and medieval periods. Surface-laid Roman deposits so far examined have never been found to consist of richly organic material. The fills of the Roman sewer (*AY* 14/1) were also almost entirely mineral and even the fills of the two wells, at Skeldergate (*AY* 14/3) and The Bedern (*AY* 14/5, forthcoming), where organic preservation was very good, had a relatively low organic content. The Skeldergate well fills did include blocks of peat, but these formed a discrete component, presumably imported for use as fuel, and cannot be seen as reflecting surface conditions. The Anglo-Scandinavian deposits, on the other hand, are thick, and are almost invariably rich in organic matter. Watching-briefs at roadworks throughout the city have confirmed this and work on sediments and pollen in York and elsewhere (Macphail, 1981; Greig, 1982) has shown differences between Roman and medieval deposits.

The contrast of a clean town and one in which organic rubbish must have been deposited at a much greater rate than it was cleared away or could have decayed, is strongly reflected in the insect remains and to a lesser extent in the plant macrofossil evidence. The insect assemblages from Roman York so far examined have been rich in stored products and domestic species. Two groups of samples, those from the 39–41 Coney Street store buildings and the Church Street Roman sewer, are of such specialized nature that they can hardly be used for comparison, but the large assemblages from the timber-lined wells at The Bedern and Skeldergate may provide a rather more representative sample. These well fills gave assemblages very rich in outdoor insects — those in the well at The Bedern indicating weedy grassland — and abundant grain pests, but only a small proportion of the assemblages were made up of species associated with decaying organic matter. For the plant macrofossils, comparison may be made between the assemblages recorded here and those for the well at Skeldergate (*AY* 14/3). Of the taxa occurring regularly in the FTRAs for Pavement and Coppergate samples, only *Carex* spp., *Stellaria* cf. *media* and *Urtica dioica* are also important in the Roman well. *Juncus* and *Rumex* spp. occur in large numbers in some samples from all three sites; it is likely that these genera were represented by different species in different samples, however. Taxa regularly occurring in FTRA lists from Pavement and Coppergate but rare at Skeldergate include *Anthemis cotula, Chenopodium* spp., *Polygonum hydropiper, Ranunculus sceleratus* and *Sambucus nigra* — good indicators of nitrogen- and phosphate-rich soils. Taxa well represented at Skeldergate but comparatively rare at the present sites include Gramineae, *Prunella vulgaris, Linum catharticum, Polygonum aviculare* and *Descurainia sophia* — perhaps more suggestive of better-drained soils, grassland or trampled vegetation. The available evidence thus suggests that at least parts of Roman York were kept remarkably clean, with open ground either sterile or supporting only mown, heavily grazed or short-lived plant communities. Probably there was much in common with modern urban and suburban areas.

The range of contexts examined from the Roman period is, however, limited both in type and location. Biological studies made so far have been for sites associated with the fortress and *colonia*. Much of the rest of the town, including those parts likely to have been less well kept, remains uninvestigated biologically.

All Anglo-Scandinavian and early post-Conquest samples examined from York have given a preponderance of insects associated with rotting matter. While there would inevitably have been a bias in favour of species from such habitats, since the accumulations of filth provided the very means for their preservation, this bias would surely have operated equally in the Roman period. Species able to live in moderately clean conditions — spider beetles indoors, certain ground beetles and others outside — show a distinct resurgence in absolute numbers in the later medieval period. The spider beetle *Tipnus unicolor* provides a good example. It was abundant in the Skeldergate Roman well, present in small numbers in that at The Bedern, and has been recorded from Roman deposits at Barnsley Park (Coope and Osborne, 1968), Carlisle (Kenward, forthcoming c), and Farmoor, Oxon. (Lambrick and Robinson, 1979). It is also abundant in later medieval and post-medieval deposits, for example at 16–22 Coppergate, York (Kenward, unpublished), Berrington Street, Hereford (Kenward, forthcoming b), Worcester (Osborne, 1981), Mytongate, Hull (Miller et al., in press) and Germany (Cymorek and Koch, 1969). *T. unicolor* has not, however, yet been recorded from the intervening periods, for which the only known spider beetle is *Ptinus fur*. *T. unicolor* seems to be characteristic of somewhat neglected, poorly heated buildings but not of foul conditions; in Northern Ireland, O'Farrell and Butler (1948) found it to be associated with older warehouses. Some other species show a somewhat similar, though less clearly marked, archaeological record; published collecting records suggest that they too are rather characteristic of sound buildings lacking central heating, especially storehouses. It is likely that if long-lasting domestic buildings of good quality had been present in the Anglo-Scandinavian period they would eventually have been colonized by such insects.

Allied to this is the changing frequency of grain pests. These are abundant in Roman deposits and occur in increasing numbers in those dated to the 13th century and later. Records from Anglo-Scandinavian and early post-Conquest deposits must for the time being be regarded as doubtful (p. 185, above). These observations may reflect differences in grain-processing or storage techniques, or even in climate, or it may simply be that the grain pests became extinct at the end of the Roman period, when it is probable that centralized grain storage and mass-transport ceased. The insects might then only have become re-established as a result of rare chance introductions during the medieval period. The evidence at present rather suggests that centralized grain storage was not normal in Anglo-Scandinavian and Anglo-Norman York. The early history of pests of stored products is discussed by Buckland (1981).

The combined evidence from excavations throughout North West Europe shows a similar picture of a changing biota to that emerging from York. For each period, both the flora and the insect fauna seem to have been rather similar everywhere, in gross terms. Further work, probably involving multivariate statistics, will be required to clarify changes through time and to reveal any systematic differences from town to town. A striking difference between 6–8 Pavement and other sites from which insects have been examined is the generally low proportion of outdoor insects and of species associated with foul rotting matter. This almost certainly reflects the nature of the deposits (perhaps largely formed indoors), and the location of the sites in relation to semi-natural habitats, rather than any fundamental differences between town faunas (Kenward, forthcoming a).

Concluding remarks

The remains of plants and animals in archaeological deposits are examined for two main reasons: to investigate the organisms themselves, and their relationships, from a biological standpoint; and to obtain archaeological information, whether concerning the interpretation of the excavation record or wider themes such as diet or living conditions. At the time this study was begun, environmental archaeology was seen as one solution to the problems of watching-briefs and restricted rapid excavations such as those at 5–7 Coppergate and 6–8 Pavement. Such sites were difficult to interpret in the field and it was hoped that biological analyses would permit identification of the deposits. It has, however, become clear that although environmental archaeology is essential in the interpretation of urban sites, its full effectiveness depends upon extensive excavation and close co-operation between excavators and environmental archaeologists throughout. Few problems will be solved unless material is collected from large open-area excavations, where the relationship of the sample to the layer it represents is properly understood, and where sampling can be carried out using strategies appropriate to each context or group of contexts.

Some general problems (e.g. the ecologically mixed biota and overall uniformity of the sample assemblages), and others peculiar to the sites, have very much restricted the range of conclusions that can be drawn. It might be assumed that this does not augur well for the future. However, it is strongly felt that this is not so. The present study has produced much information of a general kind and has posed a great many questions for further investigation. When it was started, there was little substantial evidence for the nature of Anglo-Scandinavian towns in Britain; there is now a firm basis for more detailed studies and a better understanding of the archaeological problems appropriately addressed by environmental investigations. The examination of the abundant material from the site at 16–22 Coppergate will rest securely on this foundation.

A Coprolite from 6–8 Pavement

By A.K.G. Jones

Identification

Amongst the samples collected during excavation at 6–8 Pavement was an object (Plate Ia) of unusual preservation. The specimen, recovered from layer 36 in Trench IV, the deepest excavated, was first thought to be industrial slag on account of its hard, brittle nature. However, biological investigations have shown it unequivocally to be faecal, a mineralized stool, and almost certainly of human origin.

When found, the stool was approximately 195 x 55 x 28 mm and weighed 234 g; it was subsequently broken for examination and analysis. The cross-section showed two intergrading layers of different colour. The brown shiny outer layer bore the impressions of monocotyledonous plant tissue and a large fly puparium, and included a number of animal hairs. The core was pale buff and somewhat reminiscent of a canine coprolite. Both layers contained small irregular spaces which did not interconnect.

The tests made on the specimen are reported below. Concreted organic material can often be disaggregated using hydrochloric acid (Hall, Jones and Kenward, forthcoming). As a preliminary test, a small piece of the coprolite was placed in dilute acid for two hours, by which time the acid had digested part to produce a light brown solution with a suspension of particles of various sizes. A 200 μm mesh sieve was used to separate the coarse particles, which were examined using a low-power binocular microscope, and a 0.15 ml aliquot of the filtrate was mounted on a microscope slide and examined using a transmission microscope. Both fractions contained cereal bran fragments and unidentifiable organic detritus. Large numbers of the ova of intestinal parasitic nematodes, *Trichuris* (whipworm) and *Ascaris* (maw-worm) (Pl. Ib, c) were present in the filtrate, together with small numbers of pollen grains, including Cerealia. The trichurid ova were particularly well-preserved, nearly all possessing both polar plugs. Bran is a most characteristic constituent of ancient faecal material excavated in York (ibid.). It is little affected by passage through the gut and, once expelled, survives well in waterlogged deposits.

It's All [illegible]
[illegible]

Table 58 (a) Measurements and (b) concentrations of gut parasite ova from the stool from Lloyds Bank, 6–8 Pavement. SEM — standard error of the mean

(a) Measurements (μm)

Sample	Disaggregant	Total length			Width			Length minus polar plugs			No. meas- ured
		Range	Mean	SEM	Range	Mean	SEM	Range	Mean	SEM	
Trichurid ova:											
Inner	Water	47.0 – 60.1	54.4	0.3	24.6 – 31.6	27.3	0.2	43.1 – 56.2	50.7	0.3	51
Inner	10% HCl	50.0 – 60.8	54.2	0.2	23.9 – 30.8	26.7	0.1	46.2 – 56.2	50.7	0.2	99
Outer	10% HCl	48.8 – 61.3	55.2	0.4	22.5 – 30.0	26.7	0.2	46.3 – 55.0	50.9	0.3	49
Ascarid ova:											
Inner	10% HCl	63.8 – 72.5	68.8	0.9	47.5 – 56.3	52.5	0.8				10

(b) Concentrations (eggs g ^{1})

Sample	Disaggregant	Trichurid ova	Ascarid ova
Inner	10% HCl	68,100	9,600
Outer	10% HCl	66,800	12,000

The intestinal nematodes *Trichuris* and *Ascaris* are common parasites of the large intestine and caecum of a wide variety of vertebrates, but are only regularly found together in man and pig. They produce large numbers of readily identified ova, which are frequently found in ancient faecal deposits (Jones, 1982). Thus the evidence from the Pavement stool suggests that the object formed from faeces passed either by pig or man. Its form is reminiscent of stools passed by human beings enjoying a roughage-rich diet (Stephen and Cummings, 1980), so a human origin is more likely. The Pavement coprolite thus provides an opportunity to investigate the parasites of an individual.

Coprolites are often collected from British excavations; they are usually 15–20 mm in diameter, contain small fragments of animal bone and are thought to be dog droppings. Dimbleby (1968), for example, describes one from Ivinghoe Beacon, Buckinghamshire, which appeared to be canine. In a recent study of ancient coprolites from the Netherlands, Paap (1976) concluded that the majority were also probably canine. The Pavement stool contains no bone and its size is similar to that of coprolites excavated from dry cave sites in the Americas (Callen and Cameron, 1960). The latter material, however, has been preserved by desiccation rather than mineralization.

Both concreted and non-concreted faecal material is now quite regularly recorded from waterlogged urban sites (e.g. Greig, 1981; Hall et al., forthcoming). Although the bulk almost

Table 59 Comparison of the mean total lengths of trichurid ova recovered from the Pavement stool and those measured by Beer (1976)

	No. ova measured	Mean length (μm)	Difference of the means (μm)	Standard error of the difference of the means (μm)
Trichuris trichiura				
(Beer, 1976)	98	54.7		
Pavement stool, acid-			0.5	0.33
disaggregated core sample	99	54.2		
		7.9	0.57	
T. suis (Beer, 1976)	94	62.1		

certainly comprises human faeces, there is good evidence that small amounts of other waste materials (e.g. pottery, bone and broken tile) have been incorporated, possibly including animal faeces rich in parasite ova. The interpretation of parasitological evidence from cesspits will be misleading if ova from species other than parasites of man are present.

Further investigations

The analyses carried out on the parasite ova followed three lines of investigation. The first was to test the effect of various disaggregating reagents and to assess their influence on the size of the ova, recent work having shown that ancient nematode ova shrink when subjected to the rigours of pollen analysis (Hall et al., forthcoming). The second was to measure eggs to confirm their identification. The third was to compare ova from the core of the stool with those from the outer layer (this contained animal hairs and impressions of other materials unlikely to be found in a fresh stool; these remains probably became incorporated as the stool mineralized, when contaminant ova may also have been introduced).

Six 1 g samples were taken from the stool, three from the outer layer and three from the core. These were placed in 500 ml conical flasks and pairs of outer and inner samples disaggregated in deionised water, dilute (10%) hydrochloric acid or dilute (10%) sodium hydroxide solution. The flasks were placed on a shaker for periods of one to several weeks until disaggregated. The samples were then processed as described for the preliminary sample. Three measurements of the *Trichuris* ova were taken using a graticule eyepiece: total length, width, and length minus polar plugs. Maximum length and width were also recorded for the *Ascaris* ova. The results are given in Table 58(a).

It was found that neither water nor dilute sodium hydroxide were successful disaggregating reagents. Neither sample shaken with water disaggregated completely and it was therefore impossible to estimate the concentration of eggs. The water-disaggregated sample from the core did break up a little, however, allowing measurement of 51 trichurid ova. The samples in sodium hydroxide solution also failed to disaggregate thoroughly and while trichurid ova from these samples could be measured estimates of concentration were not attempted. Moreover, all the trichurid ova examined in the sodium hydroxide-disaggregated samples had lost their polar plugs.

Successful disaggregation was achieved using dilute hydrochloric acid, both inner and outer stool fragments eventually forming a suspension of fine organic particles in a brown solution. Trichurid ova were generally very well preserved in both samples and polar plugs were present in 83%. These samples also contained a number of ova of *Ascaris*. Both fertilized and unfertilized specimens were noted; their concentrations are given in Table 58(b).

Comparison of measurements of water- and acid-disaggregated eggs shows that size was not affected by treatment with dilute HCl, so that measurements of the large sample of acid-disaggregated eggs can be used as a basis for identification.

The measurements of ancient ova were compared with data from modern parasite ova in order to identify the eggs to species. Egg dimensions have been used by, for example, Beer (1976) in the separation of *Trichuris suis* (Schrank), the whipworm of pig, from *T. trichiura* (L.), the whipworm of man. However, the measurements of eggs of *T. trichiura* and *T. suis* given by various authors (and cited by Beer) are not identical, suggesting either that within each species different individuals or populations of adult worms produce eggs of slightly different sizes or that size was affected by experimental procedure or incorrect calibration. If the first is true, ancient trichurid ova need not be expected to be identical in size to modern ones. However, by comparing the differences of the mean total lengths of ancient and modern populations using the method given by Bailey (1974, 35), it is possible to obtain probabilities which suggest which species is present.

Table 59 gives the mean total length of *Trichuris trichiura* and *T. suis* ova as presented by Beer (1976), compared with the eggs from the acid-disaggregated core sample of the Pavement stool. The difference between the mean lengths of *T. suis* ova cited by Beer and those from the Pavement core is highly significant ($p<0.001$), being 14 times the standard error. By contrast, the difference between the mean lengths of *T. trichiura* (ibid.) and the Pavement core ova is of the same order as the standard error, and therefore not significant. Thus the trichurid ova found in the Pavement stool were almost certainly produced by *Trichuris trichiura*, which, under natural conditions in Britain, is only found in man. Egg dimensions for the two populations, from the samples of core and outer layer, appear to be identical, supporting the evidence from the morphology of the coprolite that the two samples are from the same stool.

Having established that one of the Anglo-Scandinavian occupants of York was parasitized by whipworm and maw-worm, it is interesting to consider the intensity of the infestation. Such a line of study is rarely possible with archaeological material because most parasite eggs are recovered from latrine pits or cesspits. It is essential to have evidence that the ova were derived from one individual, and thus finds of well-preserved corpses and coprolites provide the only opportunities.

Several medical workers have considered the problems of estimating the level of worm infestation from the concentration of eggs observed in stool samples. Burrows (1950), reviewing studies of whipworms, concludes that any estimation of the number of adult worms harboured by an individual is likely to be inaccurate for a number of reasons. His work showed that the number of *Trichuris trichiura* eggs found in stool samples varied with the age and intensity of the infection, the size of the worms and the size of the stool. These limitations should be borne in mind when considering this attempt to estimate the number of adult worms contributing eggs to the Pavement stool.

Since modern studies of worm infestations report their findings in terms of concentrations of eggs per unit fresh weight of stool, it is necessary first to calculate the fresh weight of the fossil stool. 13.9 g of stool displaced 7 ml of water, giving a density of approximately 2.0 g cm ^{3}. It has been assumed, on the basis of observations and the knowledge that the bulk of most faeces is water, that fresh faeces have a density of about 1.0 g cm ^{3}. This gives an estimated fresh weight for the whole stool of 117 g, which may be compared with figures for daily stool production of 250 g in modern British vegetarians and 470 g in modern Ugandans eating a fibre-rich diet (Burkitt and Painter, 1975, 76). The Pavement stool may thus be only a part of the individual's daily output. To calculate the concentration of eggs in the Pavement stool in terms of its original fresh weight, it is necessary to multiply the figures in Table 58(b) by 2. This gives an estimated production of eggs per gram fresh stool of at least 20,000 for *Ascaris* and 133,000 for *Trichuris* (figures rounded to nearest thousand). Experiments with human beings, monitoring faecal egg counts before and after treatment with anthelmenthics and counting the numbers of expelled worms, have shown that in excess of 2,000 *Ascaris* ova per gram faeces can be produced by a single adult female maw-worm (Chandler and Read, 1961, 451). Egg counts of around 130,000 *Trichuris trichiura* ova per gram faeces were obtained by Burrows (1950) while investigating people harbouring between 600 and 2,500 whipworms. It is therefore reasonable to conclude that the individual who passed the Pavement coprolite was parasitized by at least a small number of maw-worms and several hundred whipworms. Such an infestation today would certainly be classed as a heavy infection, although well within the limits of human tolerance.

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Summary

The results of biological and pedological analyses of series of samples from richly organic deposits from two Anglo-Scandinavian sites in York are described. The deposits at 5–7 Coppergate were represented by 18 samples from four 'columns' cutting through layers seen only in section in a builder's trench. Those at 6–8 Pavement were represented by 65 samples taken from various points in a layered sequence in four trenches; here, the excavations revealed a series of timber and wattle structures. Both investigations took place under difficult circumstances in cellars.

Plant remains in general and insects and some other invertebrates have been examined, and provide the basis for reconstruction of many aspects of ecology and human activity. The assemblages of both plant macrofossils (mainly fruits and seeds) and insects (mainly beetles) have proved superficially uniform throughout both sets of samples, although systematic variation in the insect assemblages permitted provisional interpretations to be made. Pollen and the mineral component of the deposits were also essentially uniform in the limited numbers of samples examined. Where deposits built up, there was rotting plant and animal matter and, in particular at 6–8 Pavement, large quantities of leather. The deposits appear to have been rather moist and foul out of doors. While there were abundant habitats for rotting-matter insects indoors, conditions there may not have been too unpleasant. There is not yet good biological evidence to show whether people worked or lived (or both) in the structures at Pavement, or whether accommodation was shared with livestock, although beasts seem to have deposited their dung nearby. Meat was important in the diet, with some fish, shellfish and birds; cereals, fruits and nuts were also consumed. A coprolite gives the clearest evidence for cereals in the diet as well as for infestation by gut parasites belonging to two species of nematode worm. Charred cereal grains occurred regularly but at low concentrations in the deposits. The remains of food — bones, shells, fruitstones, nutshell — found their way in some quantity into general accumulation layers; whether this was because refuse was thrown directly on the ground, indoors and out, or whether these durable remains were redeposited from pits and middens, could not be established for the present sites.

The nature of the material has placed serious constraints both on the way the results could be treated and on the conclusions that could be drawn, but the investigations have proved of great value in developing practical and analytical techniques for use in further investigations of urban archaeological deposits. It is concluded that, with rare exceptions, 'environmental' investigations will be much more useful when carried out on sites excavated by open-area techniques and recorded in great detail. Biological information may, however, be gathered in abundance from relatively poorly provenanced material, providing dating is good.

Résumé

Ce rapport présente le résultat des analyses biologiques et pédologiques d'une série d'échantillons provenant de riches dépôts organiques découverts à York sur deux sites anglo-scandinaves. Le dépôt du 5–7 Coppergate est représenté par dix-huit échantillons prélevés en quatre colonnes verticales coupées à travers les couches telles qu'elles ont pu être identifiées dans la paroi du terrassement; celui du 6–8 Pavement par une série de soixante-cinq échantillons prélevés en divers points de la séquence stratigraphique de quatre tranchées. Sur ce site, les fouilles ont montré l'existence de structures en bois et en clayonnage. Dans les deux cas, les recherches furent menées au fond de caves, dans des conditions difficiles.

Les éléments nécessaires à la reconstitution de nombreux aspects de l'écologie des sites et de l'activité humaine, proviennent de l'examen des restes végétaux dans leur ensemble, ainsi que des restes d'insectes et de quelques autres invertébrés. Les associations de macrofossiles végétaux (fruits et grains) et d'insectes (coléoptères) se sont révélées globalement similaires sur l'ensemble des deux groupes d'échantillons bien que des variations systématiques des associations d'insectes aient permis de proposer des interprétations provisoires. Les minéraux et pollens présentent également de grandes constantes dans le nombre réduit d'échantillons traités. Les dépôts d'accumulation contenaient des végétaux en décomposition et des matières animales, ainsi, en particulier au 6–8 Pavement, que de grandes quantités de cuir. A l'extérieur des habitations, les dépôts en formation paraissent avoir été plutôt humides et nauséabonds, mais, alors que les intérieurs semblent avoir favorisé le développement d'insectes vivant de matières en décomposition, les conditions générales de vie ne semblent pas avoir été trop désagréables. Nous ne possédons pas encore de bon indice biologique permettant de savoir si les structures de Pavement servaient d'habitat ou d'atelier ou encore si ces deux fonctions étaient simultanées, ni si elles servaient d'abri commun aux hommes et au bétail, bien que l'on ait des traces d'excréments animaux à proximité.

La viande représentait une part importante du régime alimentaire, avec un peu de poisson, fruits de mer et volatiles, complété par des céréales, des fruits et des noix. Une coprolite montre clairement la présence de céréales dans l'alimentation, ainsi que la présence de parasites intestinaux de deux espèces de nématodes. Les dépôts contiennent de faibles concentrations de graines de céréales carbonisées. Les restes de nourriture — os, coquilles, noyaux et fragments de coquilles de noix — se trouvent en relativement grande quantité dans les niveaux généraux d'accumulation, sans que l'on ait pu établir si cela est du à un rejet direct des détritus sur le sol à l'intérieur comme à l'extérieur, ou à une redéposition de ces déchets résistants lors de l'épandage de fumier ou du contenu de fosses à déchets.

De sévères contraintes furent imposées par la nature du matériel étudié, à la fois sur la façon de traiter les résultats et sur les conclusions que l'on peut en tirer, mais ces recherches se sont

révélées d'un grand intérêt dans l'élaboration de techniques pratiques d'analyses à mettre en oeuvre pour une ultérieure étude de dépôts urbains. Il ressort qu'à de rares exceptions près, les analyses d'environnement seront plus enrichissantes sur des sites fouillés par grands décapages et avec un enregistrement très détaillé. Bien que des informations d'ordre biologique puissent être collectées en grande quantité à partir de matériel relativement mal localisé, à condition toutefois que la datation soit assurée.

Zusammenfassung

Dieser Bericht beschreibt die Ergebnisse biologischer und pedologischer Analysen, die an einer Serie von Bodenproben aus an organischem Material reichen Schichten zweier anglo-skandinavischer Fundstätten in York durchgeführt wurden. Das Material von 5–7 Coppergate war durch achtzehn Proben aus vier Senkrechtschnitten durch Ablagerungen, die nur in einer Baugrube sichtbar waren vertreten. Das Material von 6–8 Pavement setzte sich aus fünfundsechzig Proben zusammen, die der Schichtenfolge an verschiedenen Stellen und an vier Grabungsstellen entnommen worden war. Hier hatten die Ausgrabungen eine Reihe von Holz- und Flechtbauten freigelegt. Beide Untersuchungen fanden unter schwierigen Umständen in Kellern statt.

Im Allgemeinen wurden pflanzliche Überreste, Insekten und andere wirbellose Tiere untersucht, und sie bilden die Grundlage für die Rekonstruktion zahlreicher Aspekte, welche die Umwelt und die Einwirkung des Menschen betreffen. Bei der Zusammenstellung der pflanzlichen Fossilien (hauptsächlich Früchten und Samen) sowie der Insekten (hauptsächlich Käfern) ergab sich eine äußerliche Einheitlichkeit in beiden Probengruppen. Jedoch erlaubte die systematische Variante in den Zusammenstellungen der Insekten vorläufige Interpretationen. Der Pollen und die Mineralkomponenten der Ablagerungen waren, in den wenigen Proben, die untersucht werden konnten, grundsätzlich einheitlich. An den Stellen, an denen die Ablagerungen sich angesammelt hatten, wurden verwesendes pflanzliches und tierisches Material gefunden. In 6–8 Pavement enthielt dieses Material große Mengen Leder.

Im Freien scheinen diese Ablagerungen sehr feucht und faulig gewesen zu sein. Obwohl die Ablagerungen unter Dach reichlich Lebensraum für Fäulnisinsekten boten, scheint der allgemeine Zustand hier nicht all zu schlecht gewesen zu sein. Schlüssige biologische Beweise dafür, daß Menschen die Bauten in Pavement zur Arbeit, als Wohnung oder als beides benutzt haben, oder sie vielleicht mit Vieh, dessen Mist in der Nähe gefunden wurde, geteilt haben, sin noch nicht vorhanden.

Fleisch war ein wichtiger Bestandteil der Nahrung; es wurden aber auch Fische, Muscheln und Vögel gegessen, ebenso Getreide, Früchte und Nüsse. Kotfunde ergaben klare Beweise für das Vorhanden sein von Getreide in der Nahrung, sowie für den Befall durch Darmparasiten. Dies waren zwei Arten von Nematoden. Verkohlte Getreidekörner kommen regelmäßig, jedoch in geringer Konzentration in den Ablagerungen vor. Nahrungsrückstände — Knochen, Muschelschalen, Fruchtsteine, Nußschalen — traten in beachtlicher Menge in verschiedenen Ablagerungen auf. Es konnte nicht geklärt werden, ob Abfall direkt auf den Boden geworfen wurde, ob nun im Haus oder draußen, oder ob es sich bei dem Material um die festen Rückstände aus Abfallgruben handelt, die hier neu abgelagert worden waren.

Durch die Beschaffenheit des Materials wurden die Möglichkeiten für die Verwendbarkeit der Ergebisse sowie der Schlußfolgerungen, die aus ihnen gezogen werden konnten stark eingeschränkt. Die Untersuchungen haben sich jedoch als sehr nützlich erwiesen, indem neue praktische und analytische Techniken entwickelt wurden, die sich in künftigen Untersuchungen archaeologischer Ablagerungen in Städten anwenden lassen. Es kann daher gefolgert werden, daß, abgesehen von wenigen Ausnahmen, Umweltanalysen ertragreicher sind, wenn sie auf Fundstellen durchgeführt werden, die als Flächengrabungen behandelt und sorgfältig aufgezeichnet worden sind. Biologische Informationen können jedoch in großer Zahl aus verhältnismäßig schlecht gesichertem Material gewonnen werden, vorausgesetzt, daß die Datierung gut ist.

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Contents of Microfiche

In this fascicule the longer tables, containing the detailed data referred to in the report (Tables **60–75**), are presented on Microfiche 1, inside the back cover. Smaller tables (53–9) are included in the text above. References to microfiche tables are distinguished by numbers in bold type. Tables **60–75**, with full captions and microfiche page numbers, are listed below, and an abbreviated list is included at the beginning of the microfiche.

Microfiche page no.

Table 60 Complete list of plant taxa recorded as macrofossils from all samples from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate … … … … 1:B1

Abbreviations: a — achene, car — caryopsis, ch – charred, f — fruit, fgt — fragment, fls — flowers, frst — fruitstone, m — mericarp, n — nut(let), s — seed, veg — vegetative. Taxa marked + were used in the compilation of Fig. 35. Nomenclature follows Clapham et al. (1962)

Table 61 Records of the more abundant plants recorded as macrofossils (FTRA list) in the samples from Lloyds Bank, 6–8 Pavement, Trench I.. … … 1:B5

All records for all species falling in the first ten ranks of abundance in any sample are included. The symbol indicates one of two or more taxa standing at the rank. + signifies that the taxon was present at <1% of the total recorded sum; * — present at 1–5%; u — present below rank 10. Full Latin names appear in Table **60**

Table 62 FTRA list for plant macrofossils from Lloyds Bank, 6–8 Pavement, Trench II. See Table **61**. Samples marked 'H' are duplicate samples examined by A.R.H. (see p. 165) … … … … … … … … … 1B7–8

Table 63 FTRA list for plant macrofossils from Lloyds Bank, 6–8 Pavement, Trench III. See Table **61** … … … … … … … … 1:B11

Table 64 FTRA list for plant macrofossils from Lloyds Bank, 6–8 Pavement, Trench IV. See Table **61** … … … … … … … … 1:B12

Table 65 FTRA list for plant macrofossils from 5–7 Coppergate. See Table **61** 1:B13–14

Table 66 Complete list of Coleoptera and Hemiptera recorded from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate… … … … … … … 1:C1–2

The table gives the number of samples in which each taxon was recorded. Nomenclature follows Kloet and Hincks (1964, 1977); where used, author abbreviations follow Joy (1932). Square brackets enclosure the abbreviations used in Fig. 46. The letter code indicates the ecological group in which the taxa were placed for the calculation of statistics shown in Figs. 36–43: OA — certain 'outdoor'; OB — certain-plus-probable 'outdoor' (*AY* 19/1, 14–15); W — aquatic/waterside; D — aquatic/waterside, also found in damp places; Cw — foul matter, dung; Cd — dry compost; Rt — decaying matter of all kinds; Rd — drier decaying matter; Rf — foul decaying matter; an oblique stroke indicates reclassification for decaying matter species, e.g. 'Cd/Rt' (see p. 168 and Kenward, forthcoming a); M — heath/bog/acid ground; + — modern contaminant; parentheses indicate taxa recorded only in the analyses of Buckland et al. (1974)

Table 67 List of invertebrates other than Coleoptera and Hemiptera recorded from Pavement and Coppergate … … … … … … … 1:D11

See p. 180 for further records of Diptera. a — abundant, f — frequent, p present

Table 68 FTRA list for Coleoptera and Hemiptera from Lloyds Bank, 6–8 Pavement, Trench I 1:E1–2

All records for all species falling in the first ten ranks of abundance in any sample are included. n — number of individuals; % — percentage of total sample assemblage; c — concentration (nos. per kg); R — rank position; f(f) — fragment(s). The symbol before a rank indicates one of two or more species standing at that rank. Taxa not bearing specific names are presented in what are believed to be monospecific groups. Percentage, concentration and ranks are based on certain-plus-probable identifications. The size of the sample assemblages may be read from Fig. 31.

Table 69 FTRA list for Coleoptera and Hemiptera from Lloyds Bank, 6–8 Pavement, Trench II. See Table **68**... ... ... 1:E5–6

Table 70 FTRA list for Coleoptera and Hemiptera from Lloyds Bank, 6–8 Pavement, Trench III. See Table **68**.. ... ... 1:F3–4

Table 71 FTRA list for Coleoptera and Hemiptera from Lloyds Bank, 6–8 Pavement, Trench IV. See Table **68** 1:F6–7

Table 72 FTRA list for Coleoptera and Hemiptera from 5–7 Coppergate, column N. See Table **68** 1:F11–12

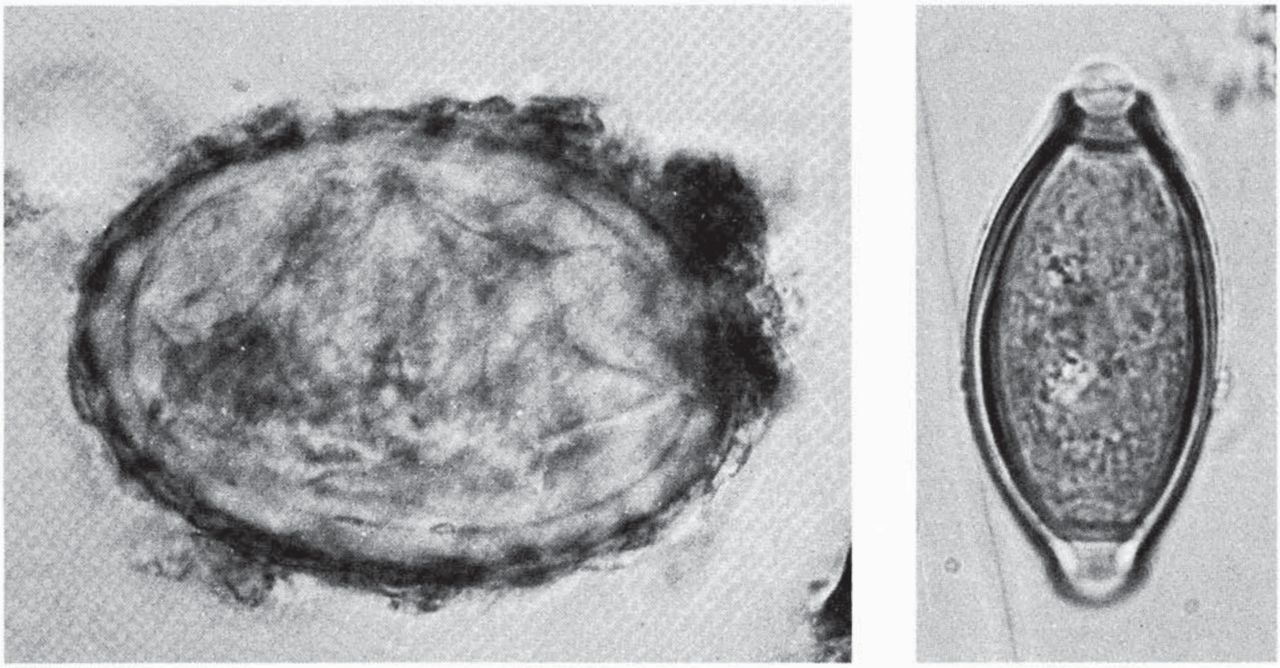
Table 73 FTRA list for Coleoptera and Hemiptera from 5–7 Coppergate, column S. See Table **68** 1:G1–2

Table 74 FTRA list for Coleoptera and Hemiptera from 5–7 Coppergate, columns E and B. See Table **68** 1:G5–6

Table 75 Coleoptera and Hemiptera from Lloyds Bank, 6–8 Pavement, and 5–7 Coppergate associated with trees and dead wood 1:G9

Sources (in addition to general works listed in text, p. 181): Balachowsky (1949), Duffy (1953), Hickin (1975), Palm (1959), Stark (1952). Species often found in other habitats are in square brackets. Eurytopic species occasionally recorded under bark (e.g. *Anotylus rugosus*) are omitted

a *The complete stool* *20 mm*



b *A single ascarid egg from the stool* *10 µm*

c *A single trichurid egg from the stool* *Scale as b*

Plate I Human coprolite from Lloyds Bank, 6—8 Pavement