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Insect and other invertebrate remains from excavations at four sites in Lincoln (site codes: WN87, WNW88, WF89 and WO89): Technical report

by

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Summary

Analyses of remains of insects (and some other invertebrates including eggs of parasitic nematodes) from four sites in the waterfront area of the City of Lincoln are described. The sites were: Waterside Foreshore (WF89); Waterfront North (trial excavation) (WN87); Waterside North West (WNW88); and Woolworth's Basement (WO89). The sampled deposits were of post-medieval to Roman date, and many of them were dumps.

Preservation was generally quite to very good in terms of chemical erosion, but some of the samples contained numerous very fragmentary remains, limiting the extent to which it was practicable to identify them.

The general nature of the assemblages from Roman, Saxon and post-Conquest deposits was consistent with that observed for deposits at other, contemporaneous, sites. Many layers at Lincoln were distingished by the presence of abundant insects from aquatic and other 'natural' habitats, however. This accorded with the topograpical position of the sites.

Records of late Roman grain pests and other strong synanthropes, including an oriental cockroach Blatta orientalis*, are significant. The grain pests indicate organised storage, and the wide range of grain and 'stored products' pests suggest a high level of social organisation and trade, and the presence of buildings of reasonable quality. The evidence suggests either continuity of high-quality occupation and social systems from the height of the Roman period, or the re-introduction of insects by trade on a large scale after a hiatus.*

Keywords: LINCOLN; WATERFRONT; ROMAN; SAXON; MEDIEVAL; CLADOCERA; INSECTS; PUPARIA

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Insect and other invertebrate remains from excavations at four sites in Lincoln (site codes: WN87, WNW88, WF89 and WO89): Technical report

Introduction

This report deals with analyses of remains of insects (and some other invertebrates including eggs of parasitic nematodes) from four sites in the waterfront area of the City of Lincoln: Waterside Foreshore (WF89); Waterfront North (trial excavation) (WN87); Waterside North West (WNW88); and Woolworth's Basement (WO89). The excavations penetrated deposits of post-medieval to Roman date. For the Waterside Foreshore and Woolworth's Basement sites, many of these were dumps. An account of the archaeology of the four sites is in preparation by CLAU. Milles (1995) discusses the marine molluscs, and the vertebrate remains have been studied by Dobney *et al.* (1995).

The study proceeded in two stages. In the first, selected samples of sediment ('GBAs' *sensu* Dobney *et al.* 1992) were supplied by the City of Lincoln Archaeological Unit (CLAU) for assessment of their content of invertebrate remains (Carrott *et al.* 1994). The numbers of samples were as follows: WF89 - 15; WN87 - 1; WNW88 - 18; WO89 - 15 (plus one from a modern dump). At this stage, priorities were attached to each assemblage of insect remains (table 2 of Carrott *et al.* 1994) and the potential of the material as a source of archaeological information was identified. In the second stage, the groups designated priority P1 or P2 (i. e. those which it was considered essential or desirable to record) were examined in more detail.

The objectives of the present study included: clarification of the depositional regime of the waterfront dumps; identifying the materials contributing to them; determining the nature and origin of pit and other cut fills and the consequent implications concerning hygiene and living conditions; consideration of the special characteristics of the late Roman assemblages and their contribution to a definition of late Roman life in Lincoln; obtaining a view of the sites as a whole through time; and the accumulation of data for synthesis at a higher level (for Lincoln as a whole, and in the context of studies of the development and implications of the insect fauna of occupation sites in Britain and north west Europe).

Methods

Practical methods

Analysis for eggs of parasitic nematodes was carried out using the 'squash' method of Dainton (1992). Other microfossils (for example phytoliths, diatoms, pollen and fungal spores) were also noted.

For the insect analyses, subsamples of 1 kg were employed in each case, following methods of Kenward *et al.* (1980) as modified by Kenward *et al.* (1986). Identification of the insect and other remains was either carried out from the entire flots (i.e. with the fossils in methylated spirit) or with the remains picked out on to damp filter paper. In the former case, specimens which could not immediately be identified were removed to damp filter paper for further consideration. The level of recording of the P1 and P2 assemblages was 'scan recording' as defined by Kenward (1992), i.e. most remains of adult beetles and bugs were recorded with considerable precision, while most other fossils were recorded semi-quantitatively using a five-point scale (Kenward *et al.* 1986), abundance for each taxon being estimated as 1, 2, 3, `several' or `many'. Although it was originally intended that the P3 groups would also be scan-recorded, this was not possible within time constraints as the identification of the large number of fragmentary remains in the higher priority groups took longer than estimated at assessment and was clearly more important. No significant archaeological information will be lost as a result of this.

The manuscript lists and notes made during recording were entered to the University of York VAX mainframe computer and processed using a Pascal system written by HK, producing 'main statistics' and species lists in rank and taxonomic order for each assemblage, together with files of main statistics, species records and notes for the

whole group of sites. These were interrogated using the DATATRIEVE system.

Interpretative methods

Interpretative methods used here are essentially those employed for many other sites (see, for example, Kenward 1978; modifications are discussed by Kenward 1982; 1988 and Hall and Kenward 1990). Assemblages are interpreted on the basis of the 'main statistics' of the groups of adult beetles and bugs, in combination with the recognition of groups of ecologically-related species. These main statistics include the following: a mathematical estimate of species-richness ('diversity'), α, of Fisher *et al.* (1943), for the whole assemblage and for components of it; proportions of 'outdoor' species, aquatics, waterside species, phytophages (plant feeders), species associated with dead wood, moorland/heathland taxa, grain pests, and decomposers (species associated with decomposing matter of some kind). The decomposer group is further divided into: (a) species associated primarily with relatively dry habitats, (b) those found mostly in moister, often foul, habitats, and a residual group not easily placed in one of the first two categories.

The separation of an 'outdoor' component in what may be natural or semi-natural assemblages, although on the face of it irrational, is in fact useful when examining any kind of deposits associated, however indirectly, with human occupation.

An index of diversity offers clues as to the presence (or absence) of remains of insects which bred in or on the developing deposit, and to the degree of development and mixture of the communities represented. Low values generally can be taken to indicate breeding communities, high ones groups of mixed origins. However, 'significantly' low values of α are not the same in the various components of assemblages. The more inherently rich in species an ecological component, the higher the value of the index of diversity for a living community of that type. 'Outdoor' insect communities associated with stands of natural or semi-natural vegetation generally give a high value of α, for example, while relatively or very low values are found for specialised or artificial communities, such as those in rotting matter deposited by humans (e.g. Roman and Anglo-Scandinavian organic waste, Hall and Kenward 1990; Kenward and Hall in press), or stored grain (e.g. Roman grain pest assemblages documented by Kenward and Williams 1979).

'House fauna' is mentioned in this report. This is a group erected on the basis of experience with archaeological assemblages, regarded as typical of crude structures housing people or stock, or used for the storage of organic material, particularly hay or straw. It is not suggested that they formed a single coherent community; timber, wattle, thatch, floors and stored products may be represented by the fauna in any particular assemblage. The species assigned to this group will rarely, if ever, all be found together in modern habitats, since the habitats harbouring them no longer occur together; the duration of the complex of habitats may also be an important factor. The 'indoor' component of archaeological insect assemblages is considered by Hall and Kenward (1990), Kenward and Hall (forthcoming) and, *passim*, by Kenward and Allison (1994).

Insects believed to stand as evidence of stable manure are frequently referred to; such assemblages have now been recorded from a substantial number of sites (e.g. Allison *et al.* 1991a, b; Allison and Kenward, forthcoming; Hall and Kenward 1990; Kenward *et al.* in press a, b; Kenward *et al.* 1991; Kenward, Allison *et al.* 1992; Kenward, Dainton *et al.* 1992a, b; Large *et al.* 1994; Osborne 1971). These groups include species considered indicative of rather foul open-textured rotting material such as mouldering straw or stable manure. Usually accompanying them are small numbers of plant-feeding species which may have been imported in hay-like cut vegetation; these included some *Apion*, *Sitona*, *Gymnetron* and *Hypera* species and a variety of others (see, for example, Large *et al.* 1994, table 5). In assemblages dated to the Roman and post-Conquest periods grain beetles are often present or abundant, and believed in many cases to have originated in cereals used as feed for horses or other equines.

Results

The samples processed and the recording methods applied to them are listed in Table 1. A complete list of invertebrate taxa recorded from the site is given in Table 2. Species lists (in rank order) and main statistics for the first and second priority assemblages are presented in the Appendix. In Table 3A, main statistics for the combined assemblages from the groups of samples from each site are presented, while in Table 3B the statistics are broken down by broad phases.

Notes on some of the species

Preservation was generally quite to very good in terms of chemical erosion, but some of the samples contained numerous very fragmentary remains, particularly of beetles, and these could not always be identified within time constraints. Some of the listed records are based on identifications of tiny pieces of cuticle (resulting in many provisional or genus/family records); some were made from parts not often identified, including tarsal segments of water beetles (a first hind tarsal segment of *Dytiscus* sp. in one case, and a left fourth hind tarsal segment of *Acilius ?sulcatus* in another).

A marked inequality of the numbers of left and right elytra for some taxa in some assemblages (e.g. Sample 31 from Context 57, WO89) seems inexplicable unless brought about by sorting in flowing water: conceivably rotating eddies may have concentrated left or right sclerites in patches. The possibility that this separation occurred during laboratory processing must be entertained.

Modern contaminants: Modern contaminants were very rare in these samples. The only ones recognised were a single *Aridius bifasciatus* from one sample, and parts of three individuals of a ciid in another. These are noted below.

Trichuris eggs: The eggs of whipworms, *Trichuris* sp. were recorded from some of the parasite squashes, but none of the squashes from these deposits contained sufficient entire eggs to permit measurements to be carried out on a large scale to establish the species, and thus the likely host. The eggs were probably of *T. trichiura* (found principally in humans), and may in view of the range of other evidence tentatively be regarded as evidence of contamination at low to rather high levels by human faeces.

Blatta orientalis: a large wing fragment with the multi-veined structure typical of primitive insects proved very similar to reference material of the common (or oriental) cockroach, *B. orientalis*. Specimens of the other common 'pest' cockroaches were available for comparison, and the material was too large for the native species. The biology of *B. orientalis* is considered at length by Ragge (1965). He suggests that it was probably introduced to Britain in the sixteenth century, and that it was fairly widely distributed by the end of the eighteenth century. Its geographic origin is unknown, although Ragge (*loc. cit.*) offers North Africa as a possibility, adding that it is found under natural conditions in southern central Asia, suggesting an alternative source. In either case, it is not surprising that it should have been imported to Britain by the Romans together with the wide range of other aliens, including grain pests and some of the more common decomposers, recorded from archaeological deposits. *B. orientalis* is almost entirely confined to heated buildings in Britain, although populations occur on rubbish tips and may exceptionally survive in the open; this is presumably a result of the heat generated by decay in such places. Hayhurst (1940, 40) suggests temperature requirements in a range only encountered in the open in Britain for a few days each year. Shipley (1916) gives an account of the species, including its ability to spread diseases of humans, and Smith (1973, 403) gives useful references in respect of the latter.

Heterogaster urticae: Single individuals of the nettle bug were recorded from four samples (three of late to very late Roman date, one of 12th-13th century date). Lincoln is to the north of the main range of the species at the present day (Southwood and Leston 1959). *H. urticae* is very often recorded from archaeological deposits of Roman and Anglo-Scandinavian date in York and is considered to be of significance as an indicator of higher temperatures in those periods (Addyman *et al.* 1976; Hall *et al.* 1983, 219; Kenward and Hall in press).

Cimex lectularius: Remains of two bedbugs were recorded, an adult from ?late Roman Waterside North West and a nymph from Saxon deposits at Woolworth's Basement. It is hard to distinguish fossil remains of the two subspecies of *C. lectularius*, one associated with pigeons and the other with humans, but it seems most probable that these records are of the latter. Kenward and Allison (1994, 69) discuss the apparent paucity of records of the human bedbug in the archaeological record, noting that it is stated in the literature that it was introduced in the 16th century. As with some other pests (the black rat and the strongly synanthropic grain pests, for example) bedbugs may have been imported in the Roman period, subsequently to become extinct or at least extremely rare. The Lincoln records and some others reviewed by Kenward and Allison (*loc. cit.*) strongly suggest its presence in Roman and Saxon/Anglo Scandinavian towns, however; it may be that the rarity of records to date has been largely a matter of chance.

Fleas (Siphonaptera): Many of the flea remains, particularly heads, could be confidently named to species; all were *Pulex irritans*, the human flea. All the remaining fragments resembled this species, but to have named all the free thoracic and abdominal segments would have been too time consuming.

?Craspedolepta nervosa nymphs: Several psyllid (whitefly or jumping plant-lice) nymphs were recovered from a late Roman dump at Waterside North West (Context 425). These proved difficult to identify since they appeared on the basis of their fused tibiotarsi (linked with their large size) to be fourth instars; the identification manual of White and Hodkinson (1982) applies only to fifth instars. However, the remains may be of *Craspedolepta nervosa,* a species whose nymphs have occasionally been identified from Roman archaeological deposits (e.g. at Annettwell Street, Carlisle, Allison and Kenward, forthcoming). They are suspected of being imported attached to their host with hay or turf, or in the dung of grazing animals. *C. nervosa* has *Achillea* species as hosts, and perhaps also *Artemesia vulgaris* L. (Hodkinson and White 1979). Adults have rarely been recorded from archaeological sites, perhaps because they quickly leave the host when disturbed, an option not available for the nymphs.

Shieldbugs: In terms of natural history, the records of two species of shieldbugs from the Lincoln deposits are notable. *Sehirus luctuosus* was found in a sample from late Roman Waterside North West. It is associated with forget-me-nots (*Myosotis* spp., Southwood and Leston 1959, 28). The record is notable in view of the presence, in the same sample, of the lacebug *Dictyla convergens*, found on water forget-me-not (*Myosotis scorpioides* L., Southwood and Leston 1959, 151). A Saxon deposit from the same site yielded remains of the shieldbug *Eurydema oleracea,* which feeds on various Cruciferae (Southwood and Leston 1959, 47).

Carpelimus bilineatus and *C. rivularis:* the separation of fossil material of these two rather similar species can be very difficult, and there is often a proportion of specimens which appear to be intermediate. Both were definitely identified from the present group of samples; *C. bilineatus* frequently so*; C. rivularis* definitely from 5 samples and tentatively from 4. It appears likely that *C. bilineatus*, although a waterside species, has transferred to artificial habitats and was common on occupation sites in the past; *C. rivularis*, however, is probably indicative of waterside conditions (Hall *et al.* 1983, 212-4; Hall and Kenward 1990, 332; Kenward and Allison 1994, 59).

Crataraea suturalis: Only recently identified after many years of being recorded as 'Aleocharinae sp. X', this distinctive species is considered to be of considerable archaeological significance as part of the house fauna and stable manure communities (Kenward and Allison 1994, 64).

Hoplia philanthus: This small chafer beetle, decorated with delicate metallic scales, was noted from a layer of late Roman date at Waterside North West. It has now been recorded in small numbers from several archaeological sites. Records are summarised by Carrott *et al.* (1995), and it is suggested that *H. philanthus,* a root-feeder as a larva but highly mobile in the adult stage, may have been imported, as may have been another small chafer, *Phyllopertha horticola,* in turf or

cut vegetation, in the dung of grazing livestock, or as background fauna.

Bruchus rufimanus; The bean weevil *Bruchus rufimanus* was recorded from two samples of Saxon or early medieval date from Waterside North West. There were also single specimens probably belonging to this species from a medieval pitfill from the same site, and from a Saxon pit at Woolworth's Basement. Bruchids are rather difficult to identify as fossils, but there were abundant remains from one of the samples, enabling a confident identification to be made on the basis of many characters. According to Hoffmann (1945, 43), *B. rufimanus* is principally associated with field or broad beans, *Vicia faba* L., in whose seeds it develops, but has been found on some other *Vicia* species. He regards it as undoubtedly an alien of western Asian origin, introduced long ago and spread widely by the growing of beans; it has also been carried to North America in the same way. Remains positively or tentatively identified as *B. rufimanus* have been recorded fairly often from archaeological deposits; it has been suggested that specimens from Anglo-Scandinavian 16-22 Coppergate, York, originated from infested beans which had been eaten, the insect remains being voided with faeces (Kenward and Hall in press). This appears to be the likely mechanism at the present sites, too.

Lice: Preservation of lice varied greatly, but was in a number of cases too poor to allow confident identification, particularly of the animal lice *Damalinia*. Some strongly-decayed remains resembling lice may even have been larvae of some other group.

Scale insects: No attempt was made to name the remains of Coccidoidea as the numbers of fossils were too small for them to have much interpretative value. Scales from other sites have been interpreted as evidence of the utilisation of brushwood and branches, probably principally for construction, when abundant (e.g. Kenward and Hall in press).

Sample-by-sample account

This section is ordered by site, period and text section. Summaries are given where more than one substantial assemblage was recorded.

Assemblages were scan recorded (*sensu* Kenward 1992) unless stated. In general, remains were of adults unless otherwise noted and, in particular, in the following sample-by-sample account the statistics given refer to the assemblage of adult beetles and bugs (excluding Aphidoidea and Coccidoidea). Comparisons of statistics are with those for many other archaeological occupation sites, especially the large datasets available for Roman York (Hall and Kenward 1990), Anglo-Scandinavian York (Kenward and Hall, in press) and (mainly Roman) Carlisle (Allison *et al.* 1991 a, b; Allison and Kenward forthcoming; Kenward *et al.* 1991; Kenward *et al.* in press a, b). Species lists and statistics for around two thousand assemblages from these and other occupation sites are available.

WATERFRONT NORTH WN87 (Trial Excavation)

Medieval (11th-13th Century)

Text Section 20 - Pit [Vertical sided cut. Pottery date of 12th/13th century from another pit believed to be contemporary with this one]

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Context 30 [fill - above two, and below five other contexts] Sample 4/T (P2)

Wet to moist, black, crumbly charcoal with a little sand and silt. Marine molluscs were present.

Single individuals of eight beetle taxa were recorded, together with a few scraps of beetle cuticle and traces of other insects. In addition there were remains of three individuals of a ciid beetle, regarded as modern contaminants. Ciids live in fungi on trees. Clearly this group had little interpretative value.

This sample was not examined for parasites.

WATERSIDE NORTH WEST (WNW88)

Roman (Mid-late 3rd to early 4th Century)

Text Section 132 - dump [red brown organic peat]

Context 298 [organic] Sample 19/T (P1)

Moist, dark grey/brown, brittle (working crumbly to just plastic), moderately humic, very slightly sandy, clay silt. Twigs were common to abundant and mortar/plaster was present.

The parasite squash contained humic matter, diatoms and fungal spores.

The moderately large beetle and bug assemblage (N = 201) was notable for the large number of taxa recorded (S = 134) and the consequent high value of the index of diversity (= 175, SE = 24). Correspondingly, 'outdoor' forms were abundant, with 64 recognised taxa contributing 50% of the assemblage (OB). Within this group, aquatics were numerous (24 taxa, 38 individuals, %N W = 19) and there were appreciable numbers of waterside/damp ground forms (%N D = 16). *Daphnia* ephippia (water flea resting eggs) were abundant and several ephippia of a second water flea were noted, together with two ostracods and a nymph of a corixid bug. Still to slow-flowing water is indicated.

Decomposers contributed a very small part of the assemblage (%N RT = 29), relative to occupation sites in general. However, they included some synanthropes, and pests of stored grain were present in significant numbers. A single human flea (*Pulex irritans*) reinforces the impression of a component from human occupation.

The richness of the fauna represented by this assemblage is well illustrated by the records, in small numbers, of *eight* species of *Cercyon*, a genus of beetles associated with decomposing matter of various kinds, from dung to waterside organic mud. The beetle and bug remains were, however, rather fragmentary.

This deposit appears to have incorporated some human ejectamenta (or re-deposited occupation deposits), but its invertebrate fauna was primarily a natural one with a strong aquatic influence. Presumably there was dumping into water.

The record of *Silvanoprus fagi* requires further consideration. This very rare beetle is found under the bark of beech (*Fagus*) and pine (*Pinus*), with only four records from Britain, from Surrey, Kent and Hampshire; it is considered to be an endangered species (Hyman 1992, 411). The significance of the present record is uncertain; whether it originated locally, or perhaps was imported, can only be a matter for speculation.

Roman (late 4th Century)

Text Section 101 - peat layers

Context 441 [layer] Sample 22/T (P1)

Moist, mid to dark grey/brown, crumbly (working slightly plastic), slightly humic, slightly sandy clay silt. Wood, twigs, mammal bone and freshwater molluscs were all present.

A very humic parasite squash was obtained, with much plant debris. Also present were fungal spores, testate amoebae, some diatoms, and pollen grains. A single *Trichuris* sp. egg (with polar plugs) was recorded, insufficient to indicate a significant input of faeces.

Invertebrate remains were numerous. In addition to 157 individuals of 96 beetle and bug taxa, there were (among others): 'many' fly larvae and puparia, mites and beetle larvae; 'several' fly pupae and *Daphnia* ephippia; and an unidentified flea. The *Daphnia*, single individuals of 13 aquatic beetles and some obligate waterside taxa all attest to aquatic deposition (or, less probably, post-depositional flooding). The 'outdoor' component as a whole was large (%N OB = 34), but there was strong evidence of the incorporation of fauna from human occupation, presumably by dumping. Grain pests and 'house fauna' were present, and these components and some of the decomposers from fairly foul conditions may have originated in stable manure. The evidence here was not strong however, and decomposers were (relatively) not very abundant (%N RT = 38).

Context 472 [layer] Sample 26/T (P2/ P1 treated as P1)

Moist, mid to dark yellowish brown, brittle (working crumbly to plastic), moderately humic, slightly sandy clay silt. Twigs, pottery and ?mortar/plaster were present.

The parasite squash was slightly silty, with humic matter, fungal spores and phytoliths. Diatoms were abundant.

The assemblage from this subsample included some remarkable components, discussed below.

There were 164 adult individuals of 109 beetle and bug taxa, 'many' fly pupae and puparia, 'several' nymphs of corixid bugs, fly larvae, *Daphnia* ephippia, resting eggs of a second cladoceran, parasitic wasps, earthworm egg capsules and beetle larvae. Rarer elements of note included a cockroach wing fragment, two adult sheep keds (*Melophagus ovinus*) and two human lice (*Pediculus humanus*). Preservation was rather good chemically, although many remains were rather fragmented.

The group of adult beetles and bugs was of high diversity (= 142, SE = 22), and almost half of it was contributed by 'outdoor' forms (%N OB = 48, 79 individuals of 54 taxa). The value of the index of diversity () for the outdoor component (OB = 75, SE = 17) was low enough to suggest the presence of a coherent ecological group - and, indeed, aquatic and waterside taxa were strongly represented (S W = 14; %N W = 13; %N D = 17). The most abundant species was *Platystethus degener*, found in waterside mud, followed by *Carpelimus bilineatus*, a species of waterside plant litter which successfully transferred to 'dry land' habitats created by human occupation (see above), and *Ochthebius* sp. (perhaps *O. minimus*, an aquatic species found in still and sluggish water). Many of the 25 species of plant feeders were waterside taxa, or may have lived in waterside habitats. All were represented by single individuals, suggesting that they may have had a transported origin. Many may have been brought by flowing water

Decomposer species and synanthropes contributed recognisable components, but the proportions of RT individuals (32%) and of grain pests (%N G = 4) were low. Whether these components were brought in dumped material or had a 'background' origin is uncertain; the former is the intuitively preferred hypothesis.

This deposit thus appears to have been a dump of occupation-site debris into water (or, less probably, the product of flood deposition into a dump).

The most remarkable record for this subsample was a forewing fragment of a cockroach. This was identical to reference material of the Oriental cockroach *Blatta orientalis* and there is no reason to doubt that this is the species represented (see above). This is believed to be much the earliest record for the species (indeed, the only other archaeological record of a cockroach (not identified to species) known to HK is from an early modern pitfill at The Bedern, York, Hall et al. 1993, 32). The principal significance of the present record lies in its implication concerning the nature of human occupation in Late 4th century Lincoln, however (see below).

Text Section 103 - linear cut, possibly drain

Context 414 [fill] Sample 9/T (P1)

Moist, dark grey brown, crumbly (working just plastic), moderately humic, slightly sandy clay silt with 6-20 mm size stones present. Wood, twigs, mortar/plaster and marine molluscs were also present.

The silty parasite squash also contained humic debris, fungal spores, testate amoebae and one large *?Trichuris* sp. egg (possibly not *T. trichiura* of humans, but not identifiable further from one specimen).

A very substantial group of beetles (and a few bugs) was recorded - 280 individuals and 102 taxa. There were also remains of a variety of other invertebrates, notably 'many' mites, fly puparia and unidentified insect immatures, 'several' cladoceran ephippia (plus three identified as *Daphnia* sp.), a probable sheep ked (*?Melophagus ovinus*) and two human fleas (*Pulex irritans*).

Grain pests were numerous (33 individuals including 21 *Oryzaephilus surinamensis*) and the following statistics relate to the assemblage left after subtracting these. Diversity was moderately high (= 61, SE = 6), indicating some mixture of ecological groups; almost a quarter of the individuals were from 'outdoor' habitats, including 12 aquatics and 27 damp ground/waterside beetles and bugs; and decomposers were well represented but not exceptionally so for an urban deposit (%N RT = 58).

Some beetles were abundant: *Carpelimus bilineatus* (23 individuals); *Oryzaephilus surinamensis* (21); *Acritus nigricornis* (20); *Platystethus arenarius* (13); *Carpelimus pusillus* group (10); *Neobisnius* sp. (9); *Falagria ?caesa* (8); and *Cercyon analis*, *Ptenidium* sp., *Oxytelus sculptus* and *Cryptolestes ferrugineus* (all 7).

These species are, on the basis of observation of many death assemblages from archaeological occupation sites, most likely to have occurred together in stable manure. The less abundant taxa confirm this, with a hint of grazing-land vegetation (hay, or direct ingestion) from a single pale individual of an *Apion* species.

This layer probably included stable manure, but the ?sheep ked may have originated from a domestic source together with the fleas. Aquatic and waterside taxa seem likely to have been incorporated during or immediately after dumping.

Text Section 104

Context 426 [layer] Sample 25/T (P1)

Moist, mid to dark grey/brown, crumbly (working slightly plastic), slightly sandy clay silt. Stones of the size 6-20 mm were present, as were freshwater molluscs, mammal bone, pot and brick/tile.

Humic matter, some silt, fungal spores and hyphae were present in the microfossil squash.

The large assemblage of adult beetles and bugs (N = 293, S = 120) was accompanied by numerous other invertebrates, among which were: 'many' fly larvae, pupae and puparia and beetle larvae; 'several' *Daphnia* ephippia and adult flies; and two human fleas (*Pulex irritans*). Grain beetles were fairly abundant (%N G = 15, with 20 *Oryzaephilus surinamensis* and 14 *Cryptolestes ferrugineus*) and these have been subtracted to give a clearer view of the nature of the residual assemblage. This (N = 250, S = 116) was of high diversity (= 84, SE = 9) and included a substantial outdoor component (%N OB = 29). This was of quite low diversity (OB = 48, SE = 11), suggesting there was an autochthonous or circumjacent component rather than a wholly transported origin. Aquatics were numerous (%N W = 7, 18 individuals) and a range of damp ground/waterside taxa was recorded (S D = 10, %N D = 10). This component, together with the *Daphnia*, indicates deposition into water.

The quite large decomposer component (%N RT = 62) and abundant synanthropes indicate that the dumped material originated from human occupation. The combination of grain pests, house fauna, characteristic decomposers and a single pale, crumpled *Apion* weevil (?from hay or grazing of Paplionaceae) suggest that stable manure was incorporated. However, the numerous dung beetles complicate the interpretation: there were nine *Aphodius ?prodromus*, four *A. granarius* and a total of three individuals of two other taxa. These hint at deposition in the open, perhaps in a yard, but the two named species are amongst the most eurytopic in the genus and may have lived in (or been attracted to) stable manure in a fairly open structure. 'House fauna' was present, but not in sufficient quantities to provide clear evidence of an origin in a structure.

That at least some of the debris came from a building occupied by humans is suggested by the fleas, but rather more by the bedbug (*Cimex lectularius*). Although there are two subspecies of this bug, one associated with humans and the other with pigeons (Southwood and Leston 1959), Occam's razor suggests that the specimen belongs to the former.

Diptera were represented by single specimens of a tipulid (pupal wing-sheath fragment) and a piophilid (puparium, c.f. *Piophila casei*) and two *Pullimosina* sp. puparia. Other taxa suggested a fauna similar to that recovered from the sample from Context 425, but with no *Musca* or *Stomoxys* species.

On balance, this appears to have been a deposit of material resembling stable manure, dumped into water or subjected to flooding. The 'stable manure' may have originated in the open (or in an open-sided structure), or have lain in the open for some time after removal from a building.

Text Section 106 - dump

Context 425 [very thin black burnt layer with 'charcoal clayey silt', in dump] Sample 24/T (P1)

Moist, dark grey/brown, crumbly (working plastic), moderately humic, sandy clay silt with some compressed fine organic detritus present. ?Concretions were also present.

The silty parasite squash contained some humic matter, insect fragments and fungal hyphae.

The numerous invertebrate remains included 'many' mites, fly puparia, pupae and adults, and beetle larvae. There were some psyllid nymphs, perhaps fourth instar *Craspedolepta nervosa* (see above), a

distorted flea head, and 151 adults of 83 beetle and bug taxa. Over a quarter of these (26%) were grain pests, with *Oryzaephilus surinamensis*, *Cryptolestes ferrugineus* and *Palorus ratzeburgi* the three most abundant taxa (16, 12 and 6 individuals respectively). A weak house fauna group was complemented by numerous individuals of taxa likely to have bred in rather foul, open-textured organic remains, and much the most likely explanation of this combination of ecological groups is the incorporation of stable manure.

There were significant numbers of puparia of the flies *Musca domestica*, *Stomoxys calcitrans*, a piophilid species (c.f. *Piophila casei*) and a probable ephydrid (resembling *Philygria* sp.), together with a few *Sepsis* sp. and single specimens of *?Meonura* sp. and *?Pullimosina* (c.f. *heteroneura*). This community suggest a mass of decaying matter in which fermentation was occurring (as in a manure heap). It was most probably in a sunlit situation. The ephydrid, if correctly identified, suggests alga-rich 'puddles' in the heap as the larvae of these flies feed on blue-green algae in such places. In north-west Europe, *M. domestica* and *S. calcitrans* require high temperatures resulting from bacterial fermentation. The piophilid implies the presence of carrion (or at least animal protein).

Roman (Late to very late 4th Century)

Text Section 108 - silt layers

Context 407 [layer] Sample 33/T (P0)

Wet, dark brown, slightly humic deposit containing fine fishe bones and a little charcoal.
The parasite squash consisted mostly of ?mineral particles with some fungal spores, silt and humic debris. There was thus no evidence that this was a faecal deposit.

No invertebrates were seen during assessment, but about 100 herring otic bullae were present.

Context 424 [layer] Sample 32/T (P1)

Dark grey/brown, crumbly (working just plastic), moderately humic, slightly sandy, clay silt with patches of amorphous to layered organic matter. Wood and coarse organic detritus were present and mammal bone was common.

The slightly silty parasite squash contained much fine humic detritus, some fungal spores and hyphae and a testate amoeba.

There were 'many' fly puparia, 'several' fly adults, larvae and pupae, beetle larvae, *Daphnia* ephippia, and a few other invertebrates, together with 105 individuals of 69 beetle taxa and a single adult bug. The diversity of the whole assemblage was high (= 87, SE = 17), and about a fifth of it was contributed by 'outdoor' taxa (%N OB = 22). There was only a single aquatic and a few waterside/damp ground forms. Grain pests were rather numerous (%N G = 14) and decomposers (RT) contributed 59% of the assemblage left after their subtraction. The mixture of grain pests and a characteristic suite of decomposers strongly suggests that stable manure (or just horse dung) was incorporated into the deposit. A single freshly emerged *Apion* may have originated in hay or been directly ingested by a grazing beast.

Roman (Very late 4th Century)

Text Section 109 - peat and silt layers

Context 310 [silt layer] Sample 13/T (P3)

Moist, dark grey/brown, crumbly (working just plastic), moderately humic, sandy silt with abundant stones (6-20 mm). Brick/tile and mammal bone were present.

Some insect fragments, fungal spores and a testate amoeba were present in the silty parasite squash.

A few insect remains were noted on assessment, insufficient for interpretation beyond indicating an origin from an 'occupation site'.

Context 329 [layer of concentrated fish bones] Sample 17/T (P3)

Moist, dark brown, 'crisp' deposit of fish vertebrae in a matrix of fine amorphous organic material and small lumps of silt.

This sample was not examined for parasites.

Only a trace of poorly preserved insect cuticle - some just identifiable - was noted during assessment. These remains probably represented a typical, but undiagnostic, 'urban' group.

Summary of Roman material from WNW88

Where enough remains were recovered for confident interpretation, a human influence of varying intensity was clear. The subsample from Context 298 (mid-late 3rd to early 4th centuries) gave a primarily natural or semi-natural insect fauna, but there was some evidence of human ejectamenta; presumably occupation material was being dumped into water. Contexts 441 and 472 appeared to represent dumping of occupation material into water. Contexts 414, 426 and 425 all seem to have included a significant component of stable manure, although this material may have formed, or lain dumped, on an open surface in the case of Context 426. The late to very late 4th century layer 424 also appeared to include stable manure, or conceivably just equine dung.

Grain pests were consistently present in these layers, and often abundant. Other synanthropes were present in significant numbers. A cockroach (*Blatta orientalis*) was recorded from Context 472. This, the grain pests and some of the other synanthropes depend on a high level of social organisation for long-term survival in north-west Europe. A few years of severe social disruption and dislocation of local trading and grain storage systems would be predicted to lead to their extinction.

Saxon (Early-late 10th Century)

Text Section 111 - sandy silt layers

Context 303 [organic layer] Sample 16/T (P1)

Moist, dark grey/brown, brittle (working crumbly), moderately humic, sandy silt with coarse plant fragments and wood and freshwater molluscs present.

Some humic matter and silt, abundant spores, numerous testate amoebae and one diatom were recorded from the parasite squash.

In addition to 103 individuals of 79 beetle and bug taxa, there were numerous other invertebrates including 'many' Cladocera ephippia (water flea resting eggs), of which some were identified as *Daphnia* sp.

The beetle and bug assemblages gave a high value for the index of diversity (= 154, SE = 35) and 35% of the individuals were 'outdoor' forms. Aquatics were present in significant numbers (10 taxa, %N W = 12). Only 43% of the assemblage was contributed by coded decomposers (RT) and this component appears to have had mixed origins (RT = 68, SE = 23).

Although the evidence thus pointed towards deposition from many sources in water, there were recognisable components from human occupation. Some 'house fauna' taxa were present, including a human flea (*Pulex irritans*) and two human lice (*Pediculus humanus*, one a male with genitalia, the other a nymph). Significantly, there were also remains of the sheep ked (*Melophagus ovinus*) and a very poorly preserved *Damalinia* sp., most likely to have originated *via* wool cleaning within a domestic building (see below).

A notable record was of the large, brightly coloured shield bug *Eurydema oleracea* (see above).

The evidence thus points to deposition of debris from within a building into water, with consequent intermixture of aquatic and waterside species.

Context 309 [layer] Sample 37/T (P1)

Moist, very dark grey/brown, brittle (working crumbly), very humic, sandy silt. Herbaceous detritus, twigs and brick/tile were present and mammal bone was common.

Two *Trichuris* sp. (one with polar plugs) were present in the parasite squash. Abundant diatoms, some insect fragments, fungal spores and humic matter were also recorded.

A substantial assemblage of beetles and bugs was recorded, notable for the large number of taxa (N = 167, S = 123). Diversity was thus very high in mathematical terms (= 210, SE = 35), but also in terms of the range of habitats represented. This variety extended to other groups - many other invertebrates were noted, among which were abundant remains of aquatic forms ('many'

Daphnia sp. ephippia and 'several' ostracods, for example) on one hand, and remains of five human fleas (*Pulex irritans*), and an adult and a puparium of the sheep ked (*Melophagus ovinus*) and two probable sheep lice (*Damalinia ?ovis*) on the other. There were also 'many' fly larvae and scale insects (Coccidoidea). Further work on the identification of some of the remains from the sample might have been productive, but was impossible within project constraints.

Returning to the beetles and bugs, the 'outdoor' component was very large (%N OB = 45, 59 taxa) and of high diversity (OB = 127, although SE = 34). Aquatics were numerous (26 individuals of 15 taxa; %N W = 16), as were waterside/damp ground taxa (21 individuals of 14 taxa, %N D = 13). Decomposers were relatively rare (%N RT = 32) and had no clear single origin. There were, however, several strong synanthropes, all in small numbers, and the fleas, keds and lice suggest an origin in a domestic building of the kind studied at 16-22 Coppergate, York (Kenward and Hall in press).

This layer thus appears to represent dumping of occupation debris into water.

Saxon (Late 10th Century)

Text Section 126 - pit

Context 423 [lining] Sample 36/T (P1)

Wet, very dark grey/brown, fine herbaceous detritus, locally coarser and slightly compressed.

The humic parasite squash contained many *Trichuris* sp. (some with polar plugs) and *Ascaris* sp.. Also present were phytoliths, testate amoebae, fungal spores and a diatom.

There were 17 beetle taxa represented by adults (no bugs), giving an MNI of 34 individuals. Other remains were equally rare and included a puparium of the sheep ked *Melophagus ovinus*, 'several' other puparia and a few adult flies. The main statistics of the beetle assemblage have little meaning in this case, since half of the assemblage was contributed by the uncoded *Bruchus rufimanus* - a bean weevil. These must have originated in peas or beans used for food. There was much bran, and this deposit appears to have included a human faecal component on the evidence of this and the parasite eggs, the *Bruchus* doubtless having been eaten and voided with stools. The remaining beetle assemblage (all single individuals except for two *Anotylus sculpturatus* group, a likely rapid invader of foul matter) gives little information.

Text Section 144 - pit/wattle

Context 391 [pit fill] Sample 11/T (P1)

Dark grey/brown, crumbly, amorphous organic sediment with fruit stones present.

The parasite squash was silty, with a little humic debris, and contained many *Trichuris* sp. (all with polar plugs) and modest numbers of *Ascaris* sp.. There were also some fungal spores, testate amoebae and pollen grains present.

A substantial and characteristic group of adult beetles was recovered (together with a single adult bug: N = 202, S = 93), and other invertebrates were numerous. The latter included: 'many' beetle larvae, parasitic wasps and fly puparia, pupae and adults; 'several' aphids; and a single unidentified flea.

Diversity of the whole assemblage was rather high (= 67, SE = 8). Outdoor forms were present in moderate numbers (%N OB = 13), but only one taxon (*Platystethus cornutus* group) was represented by more than one individual (there were two). There were a few aquatics (all single individuals and possibly 'background fauna'). The 'waterside' component (D) was small, the percentage being exaggerated by the record of *Anotylus nitidulus*, which probably should be excluded from the group when considering occupation sites.

The decomposer group was substantial (%N RT = 65), the most abundant taxa falling in this group. There were 21 individuals of *Platystethus arenarius*, 14 of *Cercyon haemorrhoidalis*, eight of *C. terminatus* and *Anotylus complanatus*, seven *A. nitidulus* and six *Oxytelus sculptus* and *Neobisnius* sp. Together, these species filling the higher ranks indicate very foul, moist conditions, a picture supported by some rarer taxa (e.g. four *Cercyon unipunctatus*). Other taxa include species typical of buildings such as primitive houses and stables ('house fauna': not a large component, but probably significant rather than simply being background fauna).

Dominant taxa amongst the fly puparia were: *Themira* (c.f. *putris*), *Sepsis* sp., *Thoracochaeta zosterae*, and at least two further species of limosinine sphaerocerids - probably *Spelobia* sp. and *Telomerina* (c.f. *flavipes*). There were also between 1-5 individuals of *Scatopse notata*, *Limosina silvatica* and psychodid pupae, and a single agromyzid, together with a very large quantity of psychodid pupae. These flies suggest that this was a wet deposit, probably rich in faecal/urea contaminants and in darkness.

This deposit was clearly foul, and probably contained a large component of human faeces; this is supported by the presence of cereal bran and moss (the latter probably used for anal wipes).

A single modern contaminant *(Aridius bifasciatus*, a recent immigrant from the Antipodes) was recorded.

Summary of Saxon material from WNW88

The layers examined for invertebrate remains included components with strong similarities to the fauna of occupation sites of similar date in York and elsewhere (see particularly Hall *et al.* 1983; Kenward and Hall in press). Two layers (Contexts 303 and 309) appeared to include a component from within a building; there were sheep keds and lice, human fleas, scale insects and house fauna.

The remaining two contexts giving interpretable assemblages, both pit fills, doubtless included a substantial proportion of human faces. Both gave abundant eggs of intestinal parasites, and one (from Context 423) had numerous bean weevils (*Bruchus rufimanus*), presumably introduced in faeces following the ingestion of infested pulses. The other was typical of assemblages from cess pits of the period, and some bean weevils, cereal bran and moss (?used as anal wipes) were noted.

Medieval (Late 12th Century)

Text Section 116 - pit/wooden planks

Context 219 [possible redeposited river silt] Sample 18/T (P1)

Moist, mid to dark brown, brittle, (working crumbly), very humic, sandy, amorphous organic sediment (with gradations between the last two).

The parasite squash was sandy with some humic matter and contained diatoms, fungal spores and hyphae. Single specimens of *Capillaria* sp. (?from dog) and *Trichuris* sp. were recovered.

Preservation of this material was enigmatic: it was rather poorer than typical of the site (and 'waterlogged' occupation deposits in general) but there were some very delicate remains in good condition - e.g. larval and pupal cuticle and a cladoceran carapace (see below).

The concentration of beetle and bug remains was not particularly high (N = 48, SE = 41, from 1 kg), but there were large numbers of other invertebrate remains, notable among which were: 'many' fly larvae, mites, earthworm egg capsules, beetle larvae, other, unidentified, immature stages of insects, and Cladocera ephippia of at least three species.

Deposition seems to have been in water. In addition to the numerous water flea resting eggs already mentioned, there were some cladoceran carapaces, including head shields, remarkably similar to *Eurycercus lamellatus* (illustrated by Frey 1959), which is common and widely distributed in Britain.

Aquatic beetles and bugs accounted for about a fifth of the assemblage; these, together with a range of other 'outdoor' forms, some likely to have lived by water, made up over half of the assemblage. Decomposers were (relatively) rare - about a fifth of the individuals. Synanthropic species were rare (only the single *Acritus nigricornis* belonging in this category) and there can be little doubt that this was essentially a naturally deposited assemblage. An origin in redeposited waterlain silt thus appears plausible.

Medieval (Mid 12th - Mid 13th Century)

Text Section 153 - oval pit

Context 320 [fill - grey/brown sandy soil] Sample 38/T (P2)

Moist, dark grey/brown, crumbly (working plastic), humic, very slightly sandy silty clay with abundant concretions of a biscuity to glassy texture.

Eggs of a *Trichuris* species (none with polar plugs) were abundant in the microfossil squash, and a few *Ascaris* sp. were also present. This was thus a faecal deposit, probably human. A little silt, some humic detritus, fungal spores and hyphae and plant hairs were also recorded.

A very small group of poorly preserved remains was recovered, including 17 individuals of 14 beetle taxa and a tentatively identified fragment of a *Melophagus ovinus* puparium. A remarkable record was of a free set of male genitalia, apparently of the human louse *Pediculus humanus*: no abdomen or other remains were found. Little can be made of this group, beyond a clear human influence. Two *Bruchus ?rufimanus* probably had a faecal origin and the three *Anotylus complanatus* may have been colonisers of foul matter (as may a few other taxa).

Medieval (Late 12th - Mid 13th Century)

Text Section 125 - pit [badly damaged, relatively shallow, lined with small pieces of wood]

Context 308 [fill - loose grey sand] Sample 34/T (P1)

Moist, dark grey/brown, compressed, coarse herbaceous detritus with amorphous organic matter, concretions present locally and straw/hay present to common.

The microfossil squash consisted mostly of coarse plant material with a few fungal spores, diatoms, insect fragments and phytoliths. A few *Trichuris* sp. and a trace of *Ascaris* sp. were recorded, suggesting a faecal component.

Insect remains were fairly numerous and included 'many' fly adults, puparia and pupae, beetle larvae, mites and unidentified immature stages of insects. There were also single individuals of *Pulex irritans*, the human flea, and *Pediculus humanus*, the human louse. The very well-preserved assemblage of beetles and bugs included 123 individuals, but only 49 taxa. The value of the index of diversity was thus low (= 30, SE = 4), a statistic which was heavily skewed by the presence of 42 individuals of *Lathridius minutus* group. However, the assemblage was ecologically, as well as mathematically, of low diversity, almost all the recorded decomposers probably representing a community of 'compost heap'-like decaying matter - neither very wet nor very foul, but fairly open-textured. The outdoor component was (comparatively) small, suggesting an origin in a protected situation. This fauna may have colonised organic waste *in situ*, or at another location from which it had been carried. There were single specimens of *Pulex irritans* and *Pediculus humanus*, the human flea and louse respectively, and a few 'house fauna' elements among the beetles, suggesting an origin in a building. The two aquatics are highly mobile taxa, and these and other 'outdoor' forms may have been 'background fauna'.
A few dipterous puparia were recorded, the most abundant being of a limosinine (all emerged). There were at least two sciarid species (wings and pupal fragments) and one *Ischiolepta* sp. puparium.

On balance, it seems likely that this was a dump of floor material from within a building, the structure being a dwelling or perhaps a stable in which someone spent enough time to deposit ectoparasites.

Medieval (Mid 12th - Late 13th Century)

Text Section 168 - pit

Context 476 [fill - compact grey clayey silt] Sample 39/T (P3)

Moist, dark grey/brown, brittle to crumbly (working plastic), slightly humic, very slightly sandy, clay silt. Mortar/plaster, mammal bone and freshwater molluscs were present.

The slightly humic, silty parasite squash contained a few insect fragments, fungal spores and a few *Trichuris* sp., the last hinting at the incorporation of faeces.

A few terrestrial and aquatic insects were noted during assessment.

Summary of medieval material from WNW88

Four pitfill contexts gave remains of interpretative value. The assemblage from 219 (late 12th) appears to have been essentially a natural aquatic deposit, with almost no

synanthropes. The tentative identification as 'redeposited river silt' is thus supported by the insect remains.

Context 320 included human faeces and detritus from human occupation, while 308 may have contained a component of material dumped from a fairly dry accumulation of waste - perhaps on a house floor - as well as faeces. The subsample from Context 476 gave few remains but this layer probably contained faeces on the basis of the content of parasite eggs.

WATERSIDE FORESHORE (WF89)

Parasite eggs were not present in any of the squashes from these samples, so no further mention is made of them; remains other than sand and humic matter were sparse.

Roman (mid third Century)

Text Section 301 - peat and sand dumps [probably third century land reclamation]

Context 756 [dump] Sample 61/TA (P3)

Moist, mid grey/brown, crumbly, sandy clay silt with stones present in the size range 2-20 mm. Charcoal and mortar/plaster were also present.

A few, very badly decayed, arthropods were noted on assessment.

Context 757 [dump] Sample 60/TA (P2)

Moist, mid to dark yellowish grey/brown, crumbly, slightly sandy silt. Mortar, flecks of brick/tile and 20-60 mm stones were present.

Insect remains were rare (18 individuals of 16 beetle taxa and a few other remains including 'several' fly puparia). Although such a small assemblage cannot be interpreted confidently, at a subjective level it appeared to represent stable manure.

Context 758 [dump] Sample 58/TA (P1)

Moist, very dark grey/brown (with a slight yellowish cast), brittle and layered (working crumbly), sandy silt with fine/coarse and woody herbaceous detritus and amorphous organic sediment. Wood and ?mortar/plaster were present.

An assemblage of 69 adult beetles and bugs of the groups used for preparing statistics: 47 taxa were recorded. A few outdoor forms were present, half of them aquatic or waterside taxa. Coded decomposers made up about half of the assemblage - a rather low value for an urban site. Fly puparia were numerous.

Subjectively this assemblage consists of material brought from within a structure (house fauna taxa being present in small numbers, including a single nymph of the human louse *Pediculus humanus*). The presence of quite a substantial proportion of grain pests (a fifth, *Oryzaephilus surinamensis* being the most abundant species with ten individuals) and of some species typical of deposits interpreted as stable manure (e.g. *Oxytelus sculptus*, with four individuals, the second most abundant beetle) suggests that stable manure was incorporated, but this is not certain.

Context 759 [dump] Sample 59/TA (P1)

Black (with yellowish or reddish cast) crumbly, slightly brittle, somewhat layered locally, slightly sandy silty amorphous organic sediment. Wood (?wood-working debris) and fly puparia were present.

The assemblage of 105 beetles and bugs (S = 66) gave main statistics essentially like those for the smaller assemblage from sample 58/TA, Context 758, and although it differed in detail the species list had similar implications. Here, however, the evidence for stable manure (a characteristic suite of decomposers including seven *Oxytelus sculptus*, grain pests and house fauna) was reinforced by the presence of taxa likely to have originated in hay - particularly three *Apion* species, one of them represented by a pale, freshly emerged individual. Waterside and aquatic taxa were rare in this subsample and there were many fly puparia.

Context 760 [dump] Sample 56/TA (P3)

Moist, mid orange-ish brown, crumbly, slightly silty sand. Stones (2-60 mm) and wood were

present.

It was noted during assessment that insects were rare and of little interpretative value.

Context 761 [dump] Sample 57/TA (P1)

Moist, mid to dark grey/brown (with an orange cast), crumbly, slightly silty sand with 2-20 mm stones and glass present.

The present subsample gave quite a substantial group of beetles and bugs (N = 109, S = 79). Diversity was high (= 128, SE = 26), suggesting a variety of origins for the remains. A quarter of the individuals were of 'outdoor' taxa, including an appreciable aquatic component (%NW = 7). Coded decomposers accounted for 51% of the individuals, a fairly low value for 'urban" deposits. However, inspection of the species list showed, firstly, that all the 'outdoor' taxa were represented by single individuals, mostly from aquatic and waterside habitats and, secondly, that (subjectively) the remainder of the assemblage could have originated in a single habitat - somewhat foul but open-textured litter such as stable manure.

There were grain pests, a suite of decomposers believed typical of stable manure, and 'house fauna' taxa including two human fleas (*Pulex irritans*). It was noted that there were many parts per individual in the synanthropic component, good evidence of an autochthonous or bulk-transported origin of these remains.

It appears very likely that this deposit included fairly fresh stable manure, invaded by many taxa, none of which had time to breed and produce abundant individuals. This was probably dumped, aquatic and waterside taxa being mixed in during dumping into water or by a subsequent rise in water level. The former appears more probable.

Text Section 302 - inhumation

Context 749 [grave fill] Sample 43/T (P0)

Moist, light to mid grey, stiff (working crumbly to plastic), very stony (2-20 mm scale), ashy, sandy clay silt. Charcoal, brick/tile and mortar/plaster were present.

The flot from this sample was barren.

Roman (mid - late 4th Century)

Text Section 307 - limestone and mortar layer

Context 735 [layer] Sample 29/T (P0)

Mid to dark grey silty clay with abundant charcoal and mortar/plaster present.
The flot from this sample was barren.

Summary of Roman material from WF89

These deposits seem to represent a series of dumps of material including stable manure, in one case (Context 761) with hints of deposition into water. Similar dumps have been recorded from other sites, notably at Tanner Row, York (Hall and Kenward 1990), as well as from WNW88.

Saxon (early - mid 10th Century)

Text Section 317 - rubble dump

Context 707 [dump] Sample 12/T (P0)

Moist, mid to dark grey/brown, crumbly, silty clay with abundant marine molluscs and brick/tile and freshwater molluscs also present.

The flot from this sample was recorded during assessment as barren.

Text Section 319 - dump

Context 706 [dump] Sample 54/TA (P0)

Moist, very dark grey/brown, crumbly and soft, slightly sandy clay silt. Charcoal, stones (2-6 mm); marine molluscs were present.

Only traces of arthropod cuticle were found in the flot during assessment.

Saxon/Medieval (late 10th - mid 12th Century)

Text Section 320 - dump

Context 699 [dump] Sample 53/TA (P0)

Wet, mid greyish brown, plastic, slightly sandy clay silt. Charcoal, wood and marine molluscs were present.

The flot from this sample was barren.

Medieval (mid 11th Century)

Text Section 322 - hearth

Context 680 [?sandy clay fill or ?ash deposit] Sample 52/TA (P0)

Moist, mid to dark grey/brown, crumbly, sandy clay silt with 2-60 mm stones present. Marine molluscs and mortar/plaster were also present.

No invertebrate remains were noted during assessment.

Medieval (early - mid 14th to 15th Century)

Text Section 327 - layers

Context 647 [layer] Sample 51/T (P0)

Moist to dry, mid to dark grey, crumbly, slightly sandy silt (probably mostly ash), with small patches of reddish ash/burnt soil. Some mammal bone was also present.

The flot from this sample was barren.

Post-medieval (16th - 17th Century)

Text Section 330 - hearth

Context 664 [?] Sample 55/TA (P3)

Moist, light to mid (pinkish orange) ochre, brittle to crumbly (working plastic and sticky), ?silt-grade ash; highly calcareous (?lime). Charcoal flecks and small fragments of marine mollusc shell were present.

Few, poorly-preserved ancient insects and some possible modern contaminants were recorded during assessment.

Post Medieval (late 17th to early - mid 18th Century)

Text Section 335 - sealing layer

Context 636 [layer] Sample 50/T (P0)

Moist to dry, mid yellowish grey/brown, crumbly and unconsolidated, sandy silt with 2-60 mm stones present. Mammal bone and marine molluscs were also present.

The flot from this sample was recorded on assessment as barren.

WOOLWORTH'S BASEMENT (WO89)

Phase 3. Roman (Mid 3rd Century)

Text Section 201 - peat, sand and mortar dumps

Context 535 [peaty dump] Sample 19/T (P1)

Moist, mid to dark grey/brown, brittle (working crumbly to plastic), very humic, slightly clay sandy silt. Leather (largish pieces), charcoal and 2-20 mm stones were present.

The very silty microfossil squash contained only a few fungal spores, some plant debris and a ?testate amoeba.
Although not large (N = 94, S = 64), the assemblage of beetle and bugs was rather distinctive, the mixture of small numbers of 'house fauna', grain pests and decomposers from rather foul, mouldering matter, with hints of a 'hay' component, pointing toward the presence of stable manure. Almost a quarter of the individuals were of 'outdoor' taxa, however, and there were modest numbers of aquatics, suggesting eventual deposition in the open, into or by water. Dumping rather than accumulation of background fauna is the intuitively favoured mechanism here; the origin seems to have been from a location with a very rich decomposer fauna, perhaps an old and somewhat carelessly cleared-out building.

Text Section 202 - peat and sand dumps [two wooden structures associated with dumps, possibly used in land reclamation]

Context 570 [dump] Sample 30/T (P2)

Moist, mid orange-ish/brown, slightly brittle (working crumbly), silty sand with patches more or less sandy and others more strongly red.

Much organic debris, silt, fungal hyphae and spores and one damaged diatom were the only remains present in the microfossil squash.

Invertebrate remains were not very abundant, and only 33 individuals of 29 beetle and bug taxa were found. Three 'grain beetle' taxa occupied the first three ranks of abundance with three or two individuals; remaining taxa were all single individuals . It is possible that this group had very random origins, essentially representing 'background fauna'.

Context 571 [dump] Sample 31/T (P1)

Moist, mid to dark brown, brittle and slightly layered in places (working crumbly), slightly humic, silty sand. Locally patches were darker grey and strong brown or yellowish or greyish. Some evidence of early stages of mineralisation was noted. Twigs, pot and 2-20 mm stones were present.

The silty parasite squash contained fungal growths and spores and some organic debris.

There were few invertebrates other than the small group of beetles (and one bug: N = 56, S = 40). A large proportion of the remains probably originated in a building, the most abundant species being *Tipnus unicolor* (five individuals), a spider beetle associated with rather damp, old, buildings. There were weak hints that stable manure had been dumped (grain pests, typical decomposers and 'hay' taxa), but this cannot be regarded as certain.

Context 572 [dump] Sample 32/T (P2)

Moist, mid to dark brown (locally orange-ish), plastic sandy silt with some wood and pot present.

The parasite squash was sandy and humic with some fungal spores and hyphae.

The small (N = 31, S = 26) group of beetles could not be confidently interpreted, but perhaps represented dumping of organic waste from occupation, conceivably stable manure.

Roman (Late 4th Century)

Text Section 206 - road

Context 568 [make-up] Sample 27/T (P2)

Moist, dark grey/brown, brittle (working crumbly), humic silty sand. Twigs comprised over fifty percent of the deposit. A leaf was also present.

Diatoms and organic debris were abundant in the slightly silty microfossil squash. Other remains included phytoliths, fungal hyphae and spores and a testate amoeba.

Insect remains were numerous and there were also abundant mites and some other invertebrates. 'Many' beetle and fly larvae and scale insects were noted. The assemblage of beetles and bugs was only of moderate size (N = 69, S = 63) and dominated by outdoor forms (%N OB = 65). The whole assemblage and the outdoor component were very species-rich, and few taxa were represented by more than one individual (three of these were obligate aquatic or waterside forms). Aquatics were (relatively) numerous - 16 individuals of 14 taxa (there was also a statoblast of the bryozoan *Cristatella mucedo*). Decomposers were exceptionally rare (%N RT = 17). This fauna had every appearance of having been waterlain, and of being essentially of natural origin (no obligate or even strong synanthropes were recorded). Flooding appears to be a likely means of formation.

Summary of Roman material from WO89

Of the mid 3rd century deposits giving appreciable numbers of fossils, one (Context 535) appeared to include stable manure dumped into or by water; one (570) included insects which may have had largely random origins (probably at the point of origin of the dumped material rather than in situ?); and two (571, 572) included organic waste from occupation, perhaps stable manure.

A single late 4th Century layer gave an essentially natural fauna, suggesting that it had formed by flooding.

Saxon (Early-mid 10th Century)

Text Section 212 - dumps [compacted orange/brown peat, brown organic material and sand; also containing wood debris and reed/rush material]

Context 504 [dump/occupation] Sample 11/T (P3)

Moist, dark grey/brown, crumbly (working just plastic), very humic sandy silt. Twigs, wood, marine molluscs, brick/tile and 2-60 mm stones were all present.

Plant fragments, fungal spores, a fragment of an insect and a testate amoeba were present in the silty, humic microfossil squash.

Numerous unfamiliar insect remains were seen during assessment: these were probably from immature stages of aquatic species and it was considered unlikely that they could easily be identified. Few adult insects were present.

Context 543 [dump/layer] Sample 15/T (P1)

Moist, dark grey, brittle (working crumbly), sandy amorphous organic sediment. Herbaceous and woody detritus were common and marine molluscs and 2-60 mm stones were present.

The humic, slightly silty microfossil squash contained some very small diatoms and a few fungal hyphae.

Eighty-seven beetle and bug taxa were represented by 111 individuals. The outdoor component was very large (%N OB = 45) and diversity was high (= 185, although SE = 41). These statistics hint strongly at deposition in the open, something which is supported by the aquatic component (11 individuals, %NW = 10); there were also single individuals of two species of water flea. However, the decomposer component, although not large (%N RT = 45), seemed rather too coherent in nature to have had a wholly 'background' origin, and probably included an autochthonous (or bulk transported) component; in the latter case, the material was possibly brought from in or around a building. A record of *Damalinia ?ovis*, perhaps from wool-cleaning, rather supports this.

There were specimens of the heathland/moorland taxa *Ulopa reticulata* and ?*Micrelus ericae*, perhaps imported over some considerable distance with turf or peat. Another notable record was of two first hind tarsal segments, of the same side and thus from two individuals, of the honeybee *Apis mellifera*.
Sample 23 (NFA)

Moist, dark grey, crumbly, sandy, amorphous organic sediment with some wood, fragments of marine mollusc and herbaceous detritus.

Saxon (Early-mid 10th Century to late 10th/early 11th Century)

Text Section 229 - pit [with circular bowl and gulley]

Context 526 [clay deposit - ?pit bottom] Sample 10/T (P1)

Moist, very dark grey/brown, brittle (working crumbly to plastic), amorphous organic sediment with coarse herbaceous detritus on the 1 cm scale and local patches of pale sandy silt. Wood and marine molluscs were present.

The parasite squash from this sample was very humic, with abundant *Trichuris* sp. (some with polar plugs) and *Ascaris* sp.. Fungal spores, phytoliths and a testate amoeba were also recorded.

Fly adults and puparia, mites, beetle larvae and unidentified insect immatures were all abundant ('many'), and there were, as well as some other remains, 'several' parasitic wasps, four scale insects and a nymph of the bedbug *Cimex lectularius*.

Among the fly puparia, the most abundant taxa were *Spelobia* sp., ?*Telomerina* sp. (c.f. *flavipes*) and *Thoracochaeta zosterae*. Also present in smaller numbers were *Scatopse notata*, sepsids, psychodid pupae, *Scathophaga* sp. and *Copromyza* sp. There were large quantities of sciarid pupal fragments (and some adults).

The assemblage of beetles and bugs was of modest size (N = 104, S = 69). Diversity was high (= 89, SE = 17) and 'outdoor' forms fairly well represented (%N OB = 18). Decomposers were moderately abundant (%N RT = 62, not far from the mode for occupation site assemblages such as those from 16-22 Coppergate, York (Kenward and Hall in press). Within this component, species typically associated with both foul (coded rf) and rather drier (rd) decaying matter were both quite well represented. This mixture was reflected

in the high value of for the decomposers (RT = 40, SE = 9). Inspection of the species list showed the presence of 'house fauna' (e.g. *Atomaria nigripennis*, with seven individuals the most abundant taxon, *Anobium punctatum* (3) and single individuals of several others). However, there was also a foul-matter component, with *Oxytelus sculptus* (4), *Cercyon haemorrhoidalis* (3) and small numbers of some other taxa. It is possible that these beetles simply invaded heterogeneous decaying matter *in situ*, the variations in fauna reflecting spatial differentiation by moisture content or a succession in time. The intuitively preferred explanation is that foul matter - presumably faeces on the evidence of the parasite eggs - was invaded *in situ* and that 'house fauna' was introduced as floor sweepings or in some other way.

Sample 18 (NFA)

Moist, dark brown, compressed, fine and coarse woody and herbaceous detritus

Sample 20 (NFA)

Moist, dark grey/brown to dark olive, compressed, fine and coarse woody and herbaceous detritus with layers of a 'glassy' concretion.

Saxon/Medieval (Mid-late 10th Century)

Text Section 222 - pit [oblong, capped by wooden planks]

Context 533 [fill] Sample 24/T (P1)

Moist, dark grey, plastic and locally somewhat compressed, very humic, sandy silt. Marine molluscs and 6-20 mm stones were present and herbaceous detritus common.

A few *Trichuris* sp. (some with polar plugs) and *Ascaris* sp. were recorded in the very humic, slightly silty, parasite squash. Fungal spores and a testate amoeba were also present.

A fairly substantial group of beetles and bugs (N = 137, S = 91) was accompanied by the other invertebrate remains which included 'many' fly puparia and beetle larvae and a human flea. Diversity was high and the outdoor component substantial (= 118, SE = 20; %N OB = 26). An aquatic influence was evident from single individuals of five aquatic taxa - perhaps invaders of open water *in situ*.

The decomposer component was of moderate size (%N RT = 53) and included a group of taxa which have been assigned to a tentative 'oxyteline association' during work on the 16-22 Coppergate site (Kenward and Hall in press); this group is of uncertain significance. There were also hints of house fauna and some foul-matter taxa. Puparia included one sepsid, five *Thoracochaeta zosterae*, a few psychodid pupae and at least two sphaerocerids - *Trachyopella* sp. and *Pullimosina* sp. (c.f. *heteroneura*).

This insect assemblage probably included a mixture of invaders of fairly open-textured plant litter (?dumped from a building), invaders of a variety of habitats *in situ* including fairly foul conditions (at least some faeces), and background fauna.

Sample 26/T (P3)

Moist, dark grey/brown, soft to plastic, very humic, sandy silt with pot and marine molluscs present.

Very few invertebrate remains, of no interpretative value, were recovered by paraffin flotation; no parasite squash was made for this sample.

Summary of Saxon material from WO89

The dump layer 543 appeared to have formed in the open, probably in or by water. The dumped material perhaps included a component from in or around a building. The two pitfills giving substantial assemblages (526 and 533) both appear to have included faeces, but also to have received floor sweepings or other litter from buildings.

Modern (19th - 20th Century)

Text Section 220 - layer

Context 501 [layer] Sample 4/T (P0)

Moist, dark grey/brown, compressed, fine and coarse woody/herbaceous detritus. Pot, twigs, moss and marine and freshwater molluscs were present.

Material from this sample was processed during assessment but no further action taken in view of the nature of the material.

Discussion

The general nature of the synanthropic and decomposer assemblages from Roman, Saxon and post-Conquest deposits at these sites was consistent with that observed for many other sites; especially good comparanda are offered by material from Roman and Anglo-Scandinavian York (see particularly Hall and Kenward 1990 and Kenward and Hall in press, respectively). A notable difference, not surprising in view of the nature of the deposits, was the presence in many layers at Lincoln of abundant insects from aquatic and other 'natural' habitats.

The preservational condition of the remains from the waterfront sites was generally not far from that normal in occupation sites with anoxic waterlogging of deposits rich in organic matter. However, a few contexts from each of the sites gave large numbers of highly fragmented remains, usually of species from natural or semi-natural habitats (e.g. Contexts 414 and 298 at WNW88). These require further consideration. Firstly, they could not all be identified closely within the time restraints of the project; they had not been regarded as particularly significant during assessment, their importance in representing numerous *additional* taxa only becoming apparent during the detailed work. This suggests a weakness in the method of assessment, but it is reasonable to assert that the significance of such species-rich insect assemblages may only emerge during the stage of full identification, and such a level of identification is far too time-consuming to be a routine part of assessment.

The second reason for discussion of these highly fragmented fossils lies in their possible taphonomic significance. Fragmentation of insect remains may result from mechanical assault before or during deposition; from compression or drying in the ground; or from the sampling, storage or extraction processes. While any or all of these are likely to have caused some damage in the present case (laboratory extraction using conventional methods inevitably results in fragmentation of a proportion of fossils), there is a strong subjective impression that for at least some of the present assemblages the 'outdoor' fossils had undergone fragmentation, or weakening which made fragmentation more likely, before burial. In particular, a similar degree of damage was not apparent in the synanthropic component. This observation cannot be supported by systematically collected data; to record the exact nature of every fragment from such material, leading to an objective comparison of the condition of different ecological components, would not normally be practical in the context of a project such as this.

The sites gave some very rich insect assemblages, both in terms of absolute numbers of species and individuals and in terms of 'diversity' or 'species richness'. The components of insects from natural/semi-natural habitats were often very diverse (in the mathematical sense, giving high values of the index of diversity of Fisher *et al.* 1943), but the range of habitats represented was fairly restricted and most of the 'outdoor' species may have originated in, or from mud and vegetation along, the river. There was little evidence of substantial urban or rural weed floras or abundant woodland habitats from the insects, for example. The aquatics suggested still or sluggish water, with none of the beetles typical of swiftly running water (no Elminthidae, for example). While some layers contained low concentrations of aquatics, it appeared that a good proportion of the layers had formed by dumping into water. The aquatic components generally seem much more likely to have become mixed in from pre-existing bottom mud (by disturbance and subsequent settling, as posited for the Roman well at Skeldergate, York, Hall *et al.* 1980, 126 ff.) rather than to have been deposited by flooding. An exception in this respect was Context 219, a pitfill from late 12th century WNW88, which seems to have been redeposited river silt containing an almost pure 'natural' fauna.

The richness of the 'outdoor' components has been emphasised, but overall the decomposers (species associated with decaying matter of some kind) were represented by many species, too. Most were typical of occupation sites, some being very strongly tied to artificial conditions created deliberately or incidentally by human beings. It is postulated that such a range of taxa is typical of large, long-lived occupation sites with strong continuity, something which is not surprising for many of the deposits seen here, but rather less expected for the later 4th century layers (see below).

The Roman deposits produced the now-familiar grain pests, often in abundance; the most numerous were *Oryzaephilus*

surinamensis (the 'saw-toothed grain beetle') and *Cryptolestes ferrugineus*, typical rather than obligate grain pests, but there were plentiful records of *Sitophilus granarius* (the 'grain weevil', entirely restricted to whole cereal grains except under laboratory conditions). Other species likely to have lived in spoiling grain together with these three were *Palorus ratzeburgi* (the 'small-eyed flour beetle', a misnomer in view of its typical habitats) and *Tenebroides mauritanicus* (the 'cadelle') A range of other 'stored products' species were recorded, including *Tribolium castaneum* ('rust-red flour beetle'), *Stegobium paniceum* (the 'drug-store beetle'), *Tipnus unicolor* and *Ptinus fur* (two spider beetles), *Blaps* sp. ('churchyard beetle'), *Tenebrio obscurus* ('dark mealworm') and a variety of others. Although the line between 'stored products' species in a strict sense and those exploiting decaying matter in general in buildings is fairly easily made in most cases at the present day, for past faunas this is very much more difficult and variable according to the period and type of building. Thus, many species appearing in the modern literature of stored products pests are known to have been typical of domestic buildings in (for example) the Saxon/Anglo-Scandinavian periods, most 'house fauna' taxa (see above) falling in this group. Following a well-established pattern, the principal grain pests were absent from Saxon and early post-Conquest layers.
Stable manure is a likely source of many of the decomposers, as well as the grain and other storage pests. 'House fauna' (*sensu* Hall and Kenward 1990) was frequently clearly present, and there were (albeit weak) hints of hay taxa, too. The last group included freshly-emerged weevils, doubtless from imported hay or caught up in the food of grazing animals. It seems most likely that equines (horses or mules) were the animals being kept. This is an area of interpretation which would benefit from the evidence provided by plant remains.

Although some sheep parasites were recorded from certain of the Saxon deposits, these remains seem far more likely to have originated from wool-cleaning as argued for various other sites (see for example Kenward and Hall in press; Buckland and Perry 1989; Sveinbjarnardóttir and Buckland 1983) than from live animals in the town.

The records of late Roman grain pests and other strong synanthropes are significant and unexpected bearing in mind the broad tenor of evidence concerning the later Roman period in Britain (e.g. Wacher 1974) and evidence from work on bones from these sites (Dobney *et al.* 1995). A variety of such taxa highly dependent on a developed socio-economic structure were present. The grain pests indicate organised storage, and the wide range of grain and stored products pests strongly suggest a high level of social organisation and the presence of temperature-regulated buildings of reasonable quality. The oriental cockroach *Blatta orientalis* (recorded from a single sample) very probably would have required heated buildings, too. The presence of such diverse groups of decomposers and synanthropes is considered to imply either continuity of high-quality occupation and social systems from the height of the Roman period, or their re-introduction by trade on a large scale after a hiatus. The first of these explanations is the simplest and perhaps the most likely.

Could all of these biological remains indicating a high level of social organisation and buildings of reasonable quality have been redeposited wholesale from earlier deposits? Nothing in the insect and other invertebrate remains suggests this; where there were comminuted fossils, for example, they were amongst the 'outdoor' forms rather than the synanthropes, the opposite of what would be predicted had the latter been dug up and dumped into water.

Although very small, the moor/heath component in Sample 15 from Saxon Context 543 at WO89 is notable. There were specimens of the froghopper *Ulopa reticulata* and the weevil *Micrelus ericae*, both typical of *Calluna*, and perhaps imported over some considerable distance with turf or peat. The distance of the nearest likely source in the Saxon period is uncertain.

A single sample of Saxon date gave remains of two honeybees, *Apis mellifera*. This fits very well into the general pattern of remains from deposits of this date; remains of bees were recovered from many samples from 16-22 Coppergate, York, for example, and abundant in some layers (Kenward and Hall in press). It cannot be determined whether the remains

from Lincoln originated from locally-kept hives, however.

This study of the invertebrate remains from the Lincoln waterfront sites has been successful in providing routine information about the deposition and composition of many individual contexts, essential to the understanding of the sites when integrated with the full range of other evidence. It has also provided important comparanda for future synthesis, leading to refinement of archaeological interpretation of invertebrate remains in the future, and hence a clearer view of the human past.

However, in historical terms the most significant aspect of the work has been in providing information which, together with that from the bones and in relation to artefactual evidence, imply occupation and activity of a kind conventionally considered to have petered out considerably earlier in most parts of Roman Britain. This prompts a reconsideration of life in the later 4th century. Much of the value of environmental archaeology lies in the integration of evidence from a variety of sources; the synthesis of botanical and entomological data, including evidence from fly puparia, has proved particularly enlightening. It is to be hoped in the present case that botanical evidence will be available to set against that from other sources.

Archive

All fossils extracted from the test subsamples, and the residues and flots, are currently stored in the Environmental Archaeology Unit, University of York, along with paper and electronic records pertaining to the work described here.

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Table 1. List of samples examined with action taken, date, text section and phase letter used in these analyses (analysis group). Key: NFA - sediment described, no further action; P3 - low priority; P0 - barren; RM - recording method (A - assessment only; RS - rapid scan; S - scan, all as defined by Kenward 1992). Analysis group: A - mid 3rd century; C - late 4th century; D - late to very late 4th century; E - Saxon; F - medieval.

Context	Sample	Date	Nature of deposits in text section	Text section	Analysis group	RM
Waterside Foreshore (WF89)						
756	61	Roman (M 3rd)	dump	301	-(P3)	A
757	60	Roman (M 3rd)	dump	301	A	S
758	58	Roman (M 3rd)	dump	301	A	S
759	59	Roman (M 3rd)	dump	301	A	S
760	56	Roman (M 3rd)	dump	301	A	A
761	57	Roman (M 3rd)	ump	301	A	S
749	43	Roman (M 3rd)	inhumation	302	-(P0)	A
735	29	Roman (M-L 4th)	layer	307	-(P0)	A
707	12	Saxon (E-M 10th)	rubble dump	317	-(P0)	A
706	54	Saxon (E-M 10th)	dump	319	-(P0)	A
699	53	Saxon/medieval (L 10th-M 12th)	dump	320	-(P0)	A
680	52	Medieval (M 11th)	hearth	322	-(P0)	A
647	51	Medieval (E-M 14th - 15th)	layers	327	-(P0)	A
664	55	Post-medieval (16 th -17th)	hearth	330	-(P3)	A
636	50	Post-medieval (L 17th to E-M 18th)	sealing layer	335	-(P0)	A
Waterside North West (WNW88)						
298	19	Roman (M-L 3rd to E 4th)	dump	132	A	S
441	22	Roman (L 4th)	layer	101	C	S
472	26	Roman (L 4th)	layer	101	C	S

Context	Sample	Date	Nature of deposits in text section	Text section	Analysis group	RM
414	9	Roman (L 4th)	linear cut, possibly drain	103	C	S
426	25	Roman (L 4th)	layer	104	C	S
425	24	Roman (L 4th)	dump	106	C	S
407	33	Roman (L-VL 4th)	layer	108	-(P0)	A
424	32	Roman (L-VL 4th)	layer	108	D	S
310	13	Roman (VL 4th)	layer	109	-(P3)	A
329	17	Roman (VL 4th)	layer	109	-(P3)	A
303	16	Saxon (E-L 10th)	layers	111	E	S
309	37	Saxon (E-L 10th)	layers	111	E	S
423	36	Saxon (L 10th)	pit	126	E	S
391	11	Saxon (L 10th)	pit/ wattle	144	E/F	S
476	39	Medieval (M 12th to L 13th)	pit	168	-(P3)	A
308	34	Medieval (L 12th to M 13th)	pit	125	F	S
320	38	Medieval (M 12th to M 13th)	oval pit	153	F	S
219	18	Medieval (L 12th)	pit/wooden planks	116	F	S
Waterside North (trial excavation) (WN87)						
30	4	Medieval (11th to 13th)	pit	20	F	S
Woolworth's Basement (WO89)						
535	19	Roman (M 3rd)	dump	201	A	S
569	29	Roman (M 3rd)	dump	202	-(NFA)	-
569	25	Roman (M 3rd)	dump	202	?	?
570	30	Roman (M 3rd)	dump	202	A	S
571	31	Roman (M 3rd)	dump	202	A	S
572	32	Roman (M 3rd)	dump	202	A	S

Context	Sample	Date	Nature of deposits in text section	Text section	Analysis group	RM
568	27	Roman (L 4th)	road	206	C	S
504	11	Saxon (E-M 10th)	dump	212	-(P3)	A
543	15	Saxon (E-M 10th)	dump	212	E	S
543	23	Saxon (E-M 10th)	dump	212	-(NFA)	-
526	10	Saxon (E-M 10th to L 10th/E 11th)	pit with circular bowl and gulley	229	E	S
526	18	Saxon (E-M 10th to L 10th/E 11th)	pit with circular bowl and gulley	213	-(NFA)	-
526	20	Saxon (E-M 10th to L 10th/E 11th)	pit with circular bowl and gulley	213	-(NFA)	-
533	24	Saxon/Medieval (M-L 10th)	oblong pit	222	E/F	S
533	26	Saxon/Medieval (M-L 10th)	oblong pit	222	-(P3)	A
501	4	Modern (19th-20th)	layer	220	-(P0)	A

Table 2. List of invertebrate taxa recorded from four sites in Lincoln. For species lists sample by sample see appendix. Molluscs are listed by Milles 1995. Certain and probably (?) identifications are not distinguished where a certain identification was made. For explanation of ecological codes see caption to Table 3.

BRYOZOA: PHYLACTOLAEMATA	
Cristatella mucedo (statoblast)	
NEMATODA	
?Heterodera sp. (cyst)	
ANNELIDA	
Oligochaeta sp. (egg capsule)	
CRUSTACEA: CLADOCERA	
Daphnia sp. (ephippium)	
?Eurycercus lamellatus (Müller) (carapace)	
Cladocera sp. (ephippium)	
OSTRACODA	
Ostracoda sp. (valves)	
DERMAPTERA	
Dermaptera sp.	
DICTYOPTERA	
Blatta orientalis Linnaeus	
MALLOPHAGA	
Damalinia ?ovis (Schrank)	
Damalinia sp. indet.	
SIPHUNCULATA	
Pediculus humanus Linnaeus	
Pediculus humanus (nymph)	
HEMIPTERA	
Aneurus sp	l
Sehirus luctuosus (Mulsant & Rey)	oap
Eurydema oleracea (Linnaeus)	oap
Heterogaster urticae (Fabricius)	oap
Stygnocoris ?pedestris (Fallen)	oap
Drymus brunneus (Sahlberg)	oap
Scolopostethus sp.	oap
Lygaeidae spp. indet.	oap
Berytinus sp.	oap
Dictyla convergens (Herrich-Schäffer)	oaw
Tingidae sp. indet.	u
Lyctocoris campestris (Fabricius)	rd
Cimex lectularius Linnaeus	u
Cimex lectularius (nymph)	
Miridae spp.	oap
Saldula sp.	oad
Chartoscirta sp.	oaw
Saldidae sp. indet.	oad
Gerris sp.	oaw
?Micronecta sp.	oaw
Corixidae spp.	oaw
Corixidae sp. (nymph)	
Heteroptera spp.	u
Ulopa reticulata (Fabricius)	oapm
Ulopa sp. indet.	oap
Cicadella viridis (Linnaeus)	oap
?Craspedolepta nervosa (Förster) (nymph)	
Psylloidea sp. (nymph)	
Auchenorhyncha spp.	oap
Auchenorhyncha sp. (nymph)	
Aphidoidea sp.	
Coccoidea sp.	
Hemiptera sp. indet. (nymph)	
DIPTERA (puparia unless stated)	
Tipulidae sp. (pupal wing-sheath fragment)	
Psychodidae sp. (pupa)	
Bibionidae sp	
Syrphidae sp. (larva)	
Sciaridae sp. (adult wings and pupal fragments)	
Scatopse notata (Linnaeus)	
Themira c.f. *putris* (Linnaeus)	
Sepsis sp.	
Sepsidae sp. indet.	
Ischiolepta sp.	
Copromyza sp.	
Thoracochaeta zosterae (Haliday)	
Limosina silvatica Meigen	
?Pullimosina (c.f. heteroneura (Haliday)).	
Pullimosina sp. indet.	
Spelobia sp.,	
?*Telomerina* sp. (c.f. *flavipes* (Meigen))	
Trachyopella sp.	
Sphaeroceridae spp. indet.	
c.f. *Piophila casei* (Linnaeus)	
?Meonura sp.	
?Philygria sp.	
Agromyzidae sp.	
Scathophaga sp.	
Musca domestica Linnaeus	
Stomoxys calcitrans (Linnaeus)	
Melophagus ovinus ((Linnaeus) (adult and puparium)	
Diptera spp. indet. (adult, larva, pupa, puparium)	
SIPHONAPTERA	
Pulex irritans Linnaeus	
Siphonaptera sp. indet.	

TRICHOPTERA	
Trichoptera sp.	
Trichoptera sp. (larva)	
HYMENOPTERA	
Apis mellifera Linnaeus	
Proctotrupoidea sp.	
Chalcidoidea sp.	
Hymenoptera Parasitica sp.	
Formicidae sp.	
Apoidea sp.	
Hymenoptera spp. indet.	
COLEOPTERA	
Carabus sp.	oa
Notiophilus sp.	oa
Blethisa multipunctata (Linnaeus)	oad
Elaphrus cupreus Duftschmid	oad
Elaphrus riparius (Linnaeus)	oad
Dyschirius globosus (Herbst)	oa
Dyschirius sp. indet.	oa
Clivina ?fossor (Linnaeus)	oa
Clivina sp. indet.	oa
Trechus quadristriatus (Schrank)	oa
Trechus obtusus or *quadristriatus*	oa
Bembidion lampros (Herbst)	oa
Bembidion properans Stephens	oa
Bembidion guttula or *mannerheimi*	oa
Bembidion (*Philochthus*) sp.	oa
Bembidion spp.	oa
Pterostichus (*Poecilus*) sp.	oa
Pterostichus melanarius (Illiger)	ob
Pterostichus minor (Gyllenhal)	oa
Pterostichus nigrita (Paykull)	oad
Pterostichus spp. indet.	ob
Calathus sp.	oa
?Laemostenus sp.	u
Agonum sp.	oa
Harpalus rufipes (Degeer)	oa
Harpalus sp.	oa
?Bradycellus sp.	oa
Acupalpus ?dubius Schilsky	oa
?Acupalpus sp. indet.	oa
Carabidae spp. and spp. indet.	ob
Haliplus sp.	oaw
Haliplidae sp. indet.	u
Noterus ?clavicornis (Degeer)	oaw
Hydroporinae spp.	oaw
Agabus bipustulatus (Linnaeus)	oaw
?Agabus sp.	oaw
Agabus or *Ilybius* sp. indet.	oaw
Rhantus sp.	oaw
Colymbetes fuscus (Linnaeus)	oaw
Colymbetinae spp. indet.	oaw
Acilius ?sulcatus (Linnaeus)	oaw
Dytiscus sp.	oaw
Gyrinus sp.	oaw
Helophorus grandis Illiger	oaw
Helophorus spp.	oaw
Helophorus sp. (terrestrial)	oa
Coelostoma orbiculare (Fabricius)	oaw
Sphaeridium ?bipustulatum Fabricius	rf
Sphaeridium sp.	rf
Cercyon analis (Paykull)	rt
Cercyon atricapillus (Marsham)	rf
Cercyon haemorrhoidalis (Fabricius)	rf
Cercyon lugubris (Olivier)	rt
Cercyon melanocephalus (Linnaeus)	rt
Cercyon marinus Thomson	oad
Cercyon sternalis Sharp	oad
Cercyon terminatus (Marsham)	rf
Cercyon tristis (Illiger)	oad
Cercyon convexiusculus group indet.	oad
Cercyon unipunctatus (Linnaeus)	rf
Cercyon ustulatus (Preyssler)	oad
Cercyon spp. indet.	u
Megasternum obscurum (Marsham)	rt
Cryptopleurum minutum (Fabricius)	rf
Hydrobius fuscipes (Linnaeus)	oaw
?Anacaena sp.	oaw
Laccobius sp.	oaw
Helochares sp.	oaw
Enochrus sp.	oaw
Cymbiodyta marginella (Fabricius)	oaw
Berosus sp.	oaw
Hydrophilinae spp. indet.	oaw
Acritus nigricornis (Hoffmann)	rt
Gnathoncus nanus (Scriba)	rt
?Gnathoncus sp. indet.	rt
Histerinae sp.	rt
Ochthebius minimus (Fabricius)	oaw
Ochthebius sp. indet.	oaw
Hydraena sp.	oaw
Limnebius sp.	oaw
Ptenidium spp.	rt
Acrotrichis spp.	rt
Ptiliidae sp.	u
Catops sp.	u
Catopinae sp.	u
?Silpha atrata Linnaeus	u
Silphidae sp.	u
Scydmaenus tarsatus (Muller & Kunze)	rt
Scydmaenidae sp.	u
Micropeplus fulvus Erichson	rt
Megarthrus sp.	rt
Proteinus sp.	rt
Lesteva longoelytrata (Goeze)	oad
Lesteva sp. indet.	oad
Phyllodrepa ?floralis (Paykull)	rt
Dropephylla sp.	u

Omalium ?rivulare (Paykull)	rt
Omalium sp.	rt
Xylodromus concinnus (Marsham)	rt
Xylodromus ?depressus (Gravenhorst)	rt
Omaliinae sp.	u
Coprophilus striatulus (Fabricius)	rt
Carpelimus bilineatus Stephens	rt
Carpelimus corticinus (Gravenhorst)	oad
Carpelimus fuliginosus (Gravenhorst)	u
Carpelimus ?pusillus (Gravenhorst)	u
Carpelimus pusillus group indet.	u
Carpelimus rivularis (Motschulsky)	obd
Carpelimus sp. indet.	u
Aploderus caelatus (Gravenhorst)	rt
Platystethus arenarius (Fourcroy)	rf
Platystethus degener Mulsant & Rey	oad
Platystethus cornutus group indet.	oad
Platystethus nitens (Sahlberg)	oad
Platystethus nodifrons (Mannerheim)	oad
Platystethus sp. indet.	u
Anotylus complanatus (Erichson)	rt
Anotylus nitidulus (Gravenhorst)	rtd
Anotylus rugosus (Fabricius)	rt
Anotylus sculpturatus group	rt
Anotylus tetracarinatus (Block)	rt
Oxytelus sculptus Gravenhorst	rt
Stenus spp.	u
Euaesthetus sp.	oa
Lathrobium sp.	u
Lithocharis ochracea (Gravenhorst)	rt
Lithocharis sp.	rt
Rugilus sp.	rt
Paederinae sp.	u
Othius myrmecophilus Kiesenwetter	rt
?Othius sp. indet.	rt
*Leptacinus ?pusillu*s (Stephens)	rt
Leptacinus sp.	rt
Phacophallus parumpunctatus (Gyllenhal)	rt
Gauropterus fulgidus (Fabricius)	rt
Gyrohypnus ?angustatus Stephens	rt
Gyrohypnus fracticornis (Muller)	rt
Gyrohypnus sp. indet.	rt
Xantholinus glabratus (Gravenhorst)	rt
Xantholinus longiventris Heer	rt
Xantholinus sp. indet.	u
Neobisnius sp.	u
Erichsonius cinerascens (Gravenhorst)	oad
Philonthus spp.	u
?Gabrius sp.	rt
Philonthus or *Gabrius* sp. indet.	u
Creophilus maxillosus (Linnaeus)	rt
Quedius spp.	u
Staphylininae spp. and spp. indet.	u
Mycetoporus sp.	u
Tachyporus sp.	u
Tachinus laticollis or *marginellus*	u
Tachinus ?signatus Gravenhorst	u
Tachinus subterraneus (Linnaeus)	u
Tachinus sp. indet.	u
Cordalia obscura (Gravenhorst)	rt
Falagria caesa Erichson	rt
Falagria sp. indet.	rt
Crataraea suturalis (Mannerheim)	rt
Aleochara sp.	u
Aleocharinae spp.	u
Euplectini sp.	u
Pselaphidae sp.	u
Trox scaber (Linnaeus)	rt
Trox sp. indet.	rt
Geotrupes sp.	oarf
Aphodius ater (Degeer)	oarf
Aphodius granarius (Linnaeus)	obrf
Aphodius luridus (Fabricius)	oarf
Aphodius ?prodromus (Brahm)	obrf
Aphodius spp. and spp. indet.	obrf
Oxyomus sylvestris (Scopoli)	rt
Onthophagus joannae Goljan	oarf
Hoplia philanthus Illiger	oa
Phyllopertha horticola (Linnaeus)	oap
Cetoniinae sp.	oa
Melolonthinae/Rutelinae/Cetoninae sp.	oap
?Calyptomerus dubius (Marsham)	rt
Clambus pubescens Redtenbacher	rt
Clambus sp. indet.	rt
Cyphon sp.	oad
Byrrhidae sp.	oap
Dryops sp.	oad
Elateridae spp.	ob
Cantharidae sp.	ob
Attagenus pellio (Linnaeus)	rd
Dermestidae sp. indet.	u
Grynobius planus (Fabricius)	l
Stegobium paniceum (Linnaeus)	rd
Anobium punctatum (Degeer)	l
Tipnus unicolor (Piller & Mitterpacher)	rd
Ptinus fur (Linnaeus)	rd
Ptinus sp. indet.	rd
Lyctus linearis (Goeze)	l
Tenebroides mauritanicus (Linnaeus)	rt
?Korynetes caeruleus (Degeer)	rt
Necrobia violacea (Linnaeus)	rt
Necrobia sp. indet.	rd
Kateretes rufilabris (Latreille)	oapd
Brachypterus sp.	oap
Meligethes sp.	oap
Omosita colon (Linnaeus)	rt
Omosita discoidea (Fabricius)	rt
Omosita sp. indet.	rt
Nitidulidae sp.	u
Monotoma bicolor Villa	rt

Monotoma longicollis (Gyllenhall)	rt
Monotoma picipes Herbst	rt
Monotoma spinicollis Aube	rt
Monotoma sp. indet.	rt
Cryptolestes ferrugineus (Stephens)	g
Pediacus dermestoides (Fabricius)	l
Oryzaephilus surinamensis (Linnaeus)	g
Silvanoprus fagi (Guerin-Meneville)	l
Psammoecus bipunctatus (Fabricius)	oad
Cryptophagus acutangulus (Gyllenhal)	rd
Cryptophagus scutellatus Newman	rd
Cryptophagus spp.	rd
Atomaria nigripennis (Kugelann)	rd
Atomaria spp.	rd
Ephistemus globulus (Paykull)	rd
Oulibrus sp.	oap
Phalacridae sp. indet.	oap
?Sericoderus lateralis (Gyllenhal)	rt
Orthoperus sp.	rt
Anisosticta novemdecimpunctata (Linnaeus)	oapd
Mycetaea hirta (Marsham)	rd
Lathridius minutus group	rd
Enicmus sp.	rt
Dienerella sp.	rd
Corticaria spp.	rt
Corticarina fuscula (Gyllenhal)	rt
Corticarina sp. indet.	rt
Cortinicara gibbosa (Herbst)	rt
Cisidae sp.	l
Typhaea stercorea (Linnaeus)	rd
Aglenus brunneus (Gyllenhal)	rt
Blaps sp.	rt
Tribolium castaneum (Herbst)	u
Tribolium sp. indet.	u
Palorus ratzeburgi (Wissman)	g
Tenebrio obscurus Fabricius	rt
Rhinosimus planirostris (Fabricius)	l
Anthicus bifasciatus (Rossi)	u
Anthicus formicarius (Goeze)	rt
Anthicus floralis or *formicarius*	rt
Anthicus sp. indet.	rt
Phymatodes alni (Linnaeus)	l
Bruchus rufimanus Boheman	u
Bruchus sp.	u
Bruchinae sp. indet.	u
Donacia sp.	oawp
Donaciinae sp. indet.	oawp
Gastrophysa viridula (Degeer)	oap
Phaedon sp.	oap
Prasocuris phellandrii (Linnaeus)	oapd
Chrysomelinae sp.	oap
Galerucella sp.	oap
Phyllotreta nemorum group	oap
Phyllotreta sp.	oap
Longitarsus spp.	oap
Altica sp.	oap
Chaetocnema concinna (Marsham)	oap
Chaetocnema sp.	oap
Halticinae sp.	oap
Apion (*Oxystoma*) sp.	oap
Apion spp.	oap
Phyllobius or *Polydrusus* sp.	oap
Sitona sp.	oap
Hypera punctata (Fabricius)	oap
Tanysphyrus lemnae (Paykull)	oawp
Sitophilus granarius (Linnaeus)	g
Bagous sp.	oaw
Dorytomus sp.	oap
Notaris acridulus (Linnaeus)	oadp
Micrelus ericae (Gyllenhal)	oapm
Ceutorhynchus ?contractus (Marsham)	oap
Ceutorhynchus sp.	oap
?Amalus scortillum (Herbst)	oap
Ceuthorhynchinae sp.	oap
Limnobaris pilistriata (Stephens)	oapd
Gymnetron ?pascuorum (Gyllenhal)	oap
Gymnetron sp. indet.	oap
Curculionidae spp. and spp. indet.	oa
Scolytidae sp.	l
Coleoptera spp. and spp. indet.	u
Coleoptera sp. (larva)	
INSECTA INDET.	
Insecta sp. (larva)	
Insecta sp. (pupa)	
ARACHNIDA	
Pseudoscorpiones sp.	
Acarina sp.	
Opiliones sp.	
Aranae sp.	

Table 3. Main statistics for the assemblages of adult beetles and bugs from scan- and rapid-scan recorded P1 and P2 subsamples from four sites at Lincoln. For P%NOB etc: P%Nx - 'site' or `period percentage', i.e. percentage based on all individuals from that site or phase and parameter. For `number of assemblages', the number in parentheses indicates the number of assemblages with 20 or more individuals. For thę values, the number in parentheses indicates the number of assemblages where the value of exceeded its standard error, or half its standard error; other values have been excluded from calculation of means, anď values have not in any case been calculated for assemblages of less than 20 individuals. Note the small number of cases available for some phases. Key: WF - Waterside Foreshore; WNW - Waterside North West; WN - Waterside North (trial excavation, not included in this table); WO - Woolworth's Basement.

Abbreviations for main statistics: N - number of individuals (MNI); S - number of taxa; - index of diversity (alpha) of Fisher et al. (1943); OB - index of diversity of 'outdoor' component; RT - index of diversity of decomposer component; P%NOB - percentage 'certain' (oa) plus probable (ob) outdoor individuals; P%NW - percentage of aquatic (w) individuals; P%ND - percentage of damp ground/waterside (d) individuals; P%NP - percentage of strongly plant-associated (p) individuals; P%NM - percentage of heathland/moorland (m) individuals; P%NL - percentage of dead-wood associated (l) individuals; P%NG - percentage of stored-grain associated (g) individuals; P%NRT - percentage of decomposer (rt + rd +rf) individuals; P%NRD - percentage of 'dry' decomposer (rd) individuals; P%NRF - percentage of 'foul' decomposer (rf) individuals..

For statistics by assemblage see appendix.

A. By site (all phases)

Phase	All	WF	WNW	WO
No. assemblages	27	4	14	8
mean S	67.1	52.0	80.6	58.5
mean N	110.0	75.5	146.0	79.2
Where SE alpha less than alpha:				
meaṇ	110.0 (24)	89.0 (3)	101.0 (13)	133.0 (8)
meaṇ OB	129.0 (15)	- (0)	105.0 (11)	196.0 (4)
meaṇ RT	35.4 (19)	37.0 (3)	35.4 (11)	34.6 (5)
Where SE alpha less than alpha/2:				
meaṇ	110.0 (23)	89.0 (3)	101.0 (13)	136.0 (7)
meaṇ OB	98.2 (9)	- (0)	86.1 (7)	140.0 (2)
meaṇ RT	35.4 (19)	37.0 (3)	35.4 (11)	34.6 (5)
Total individuals	2989	302	2045	634
Phase percentages				
P%NOB	28.8	19.5	29.1	31.9
P%NW	7.4	3.6	8.0	7.4
P%ND	9.1	5.3	10.0	7.7
P%NP	7.2	5.0	6.9	9.3
P%NM	0.1	0.0	0.0	0.3
P%NL	2.2	3.6	2.0	2.4
P%NG	7.1	9.9	7.6	4.3
P%NRT	47.2	50.7	46.1	49.1
P%NRD	9.9	10.9	8.8	12.8
P%NRF	8.5	10.9	8.1	8.8

B. By analysis group (all sites; see table 1 for groups)

Group	A	C	E	F
No. assemblages	9	6	5	4
mean S	55.6	95.5	74.8	28.0
mean N	79.6	185.0	103.0	49.0
Where SE alpha less than alpha:				
meaɲ	97.1 (8)	133.0 (6)	129.0 (5)	80.5 (2)
meaɲ OB	160.0 (2)	105.0 (6)	144.0 (3)	144.0 (1)
meaɲ RT	34.6 (6)	33.6 (5)	47.7 (4)	11.0 (1)
Where SE alpha less than alpha/2:				
meaɲ	95.1 (7)	133.0 (6)	129.0 (5)	80.5 (2)
meaɲ OB	115.0 (1)	64.2 (4)	144.0 (3)	- (0)
meaɲ RT	34.6 (6)	33.6 (5)	47.7 (4)	11.0 (1)
Total individuals	717	1114	518	196
Phase percentages				
P%NOB	29.7	29.9	36.1	21.9
P%NW	8.5	7.6	10.4	5.6
P%ND	8.5	10.2	9.3	8.2
P%NP	7.5	6.9	10.6	5.6
P%NM	0.0	0.0	0.6	0.0
P%NL	3.2	1.7	2.3	0.5
P%NG	8.9	11.9	0.0	0.0
P%NRT	45.2	44.4	42.3	59.7
P%NRD	10.3	6.6	10.2	26.5
P%NRF	8.9	7.5	6.4	2.6