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Whitefriars, Norwich : 421N.

Environmental Studies

Introduction by Peter Murphy.

Although Late Saxon and medieval occupation on reclaimed peaty marsh surfaces in the floor of the Wensum valley has been investigated at several sites (Carter et al. 1973; Roberts et al. 1975), the majority of excavations undertaken by the Norwich Survey in the 1970's were at sites on dry fluvial and glacial gravels where conditions were generally unsuitable for the preservation of most biological material. The excavation at Whitefriars in the late summer of 1979 provided the first opportunity to examine sediments and refuse deposits directly associated with the river itself, in which excellent preservation conditions might be expected. The results obtained at this excavation are of considerable interest in their own right, providing a wide range of information relating to the economy and ecology of the site; but the work at Whitefriars was also seen as a 'pilot study' to assess the state of preservation of different categories of biological remains in these waterlogged layers and to determine which were most informative in terms of the environment and economy of the late Saxon city. To these ends, as wide a range of material was examined as was possible, given the available expertise and resources. Besides their intrinsic interest the results have proved to be invaluable at the stage of planning environmental investigations for the 1981 excavation season at the '~~Foundry Cars~~ Magistrates Courts' site in Norwich where comparable preservation conditions are expected.

Methods

To avoid repetition, the methods used to recover macroscopic biological remains are described here. Large mammal bone and wood samples were collected by hand during excavation, but the remaining material was recovered from soil samples. Samples were taken from cleaned surfaces, wherever possible as intact blocks of sediment, and those destined for temporary storage were packed in two layers of polythene. Each sample was accompanied by a standard form in which were entered a description of the deposit, its archaeological context and the purpose for which the sample had been taken. Far more samples were taken than could possibly be examined; detailed documentation was therefore necessary to avoid confusion and to help in deciding which samples should be studied in detail.

Two separate sample series were taken: one for the extraction of larger biological remains, particularly fishbone, which were to be processed on site; and a second for the extraction of smaller and more fragile material in the laboratory.

The extraction of larger macroscopic remains occurring in relatively small numbers per unit volume of soil is most conveniently done on site, thereby obviating the need to transport the very large bulk soil samples required. These samples were processed at the site in a tank of the type described by Williams (1973). The flot was collected in a 500 micron mesh and the non-floating residue retained in a 1mm mesh. The flots and residues were dried and sorted, extracting only large material, i.e. fishbone and other small vertebrate remains, marine molluscs, fruitstones, nuts and large seeds.

In the laboratory, sub-samples were taken from the second sample series for more detailed examination. The sediments were disaggregated using hot water initially and hydrogen peroxide where necessary, and were then washed out over a 250 micron mesh sieve. Repeated manual water flotation was then used to separate the organic 'flot' fraction from the predominantly mineral non-floating residue. The 'flots' were collected in a 250 micron mesh sieve and sorted in a wet state under low power of a binocular microscope, extracting fruits, seeds, leaves and mosses as well as any freshwater and land molluscs which had floated. The non-floating residue was washed over a 500 micron mesh sieve and dried. Molluscs, small vertebrate remains, and the few remaining identifiable plant remains were then extracted under the microscope.

Further samples, taken for the recovery of insect remains, have been sent in an unprocessed state to Dr M. Girling. Methods used for the extraction of microscopic biological remains (pollen, diatoms, parasite eggs) and for the examination of a soil monolith from the upper excavated levels are described below in the appropriate sections.

Williams, D (1973) 'Flotation at Siraf' Antiquity 47, 288-292

~~WHITEFRIARS, NORWICH~~ - The Animal Bones by Judith Cartledge

INTRODUCTION

The aim of this report is to reconstruct the man-animal relationships that led to the formation of the faunal sample recovered at Whitefriars. The results will be compared, at a later date, with other samples from Norwich in order to distinguish between purely local features and those features of relevance to Norwich as a whole. The first section sets out the theoretical basis underlying the methodological approach adopted for the material. In the second section preliminary analysis and results are described (summarized in the data tables). In the concluding discussion the results so far are assessed; it is discussed whether the Whitefriars material can be seen to conform to a recognisably urban pattern; and prospects for future work are considered.

I. FAUNAL ANALYSIS - PROCESSES/PREDICTIONS

a. general bone processes - All faunal samples arising from animal populations involved in man-animal relationships have undergone the faunal processes, set out in Table I. The selective factors within each process modify the variable attributes of the faunal sample.

TABLE I CATEGORIES OF POTENTIAL INFORMATION IN A BONE SAMPLE

FAUNAL ATTRIBUTES

1. type and relative number of species
2. range of breeds/types of each species
3. age range of each species
4. sex range of each species (male/female/castrate)
5. size range of each species
6. state of health - indications of disease or dietary deficiency
7. range and proportions of bone types from each species
8. nature and extent of fragmentation
9. robustness/hardness/density of each bone and bone type

PROCESS ONE	animal production and/or growth and capture	selects and modifies: 1.,2.,3.,4.,5.,6.
PROCESS TWO	post-slaughter activities	selects and modifies: 1.,2.,3.,4.,5.,6., 7.,8.,9.
PROCESS THREE	post-depositional activities	primarily selects: 8.,9. which will secondarily modify particularly: 1.,2.,3.
PROCESS FOUR	excavational retrieval	primarily selects: 8.,9. which will secondarily modify particularly: 1.,2.,3.

b. <u>urban processes</u> – The Whitefriars sample is dated to a period when Norwich was undergoing urban and economic growth. It could be expected that changes in the types of bone samples deposited would result from the change of a subsistent economy to a market economy. These samples should thus reflect not only the developments in agricultural systems (Process one), but also urban animal-associated activities where these differ from those of non-urban activities (Process two).

PROCESS ONE   Animal Husbandy and/or Growth and Capture

An animal population raised for urban consumption would be subjected to an agricultural regime in which the demands of the urban market would override regional variation. Urbanisation, with the combination of a market and a large population, stimulates agricultural intensification. The role and extent of intensification depends upon the extent to which production capacity of the original agricultural system fails to meet urban demands. Initially animal husbandry, which selects the faunal attributes, would be adapted to the regional ecology; increasing adaptation to suit urban requirements might subsequently cause such husbandry to lose its regional identity to the extent that it would be recognisable only as a regime typical of that supplying an urban market. Table I shows that this stage tends to select six attributes. It seems ~~possible~~ probable that an increasingly urbanised animal regime would modify an animal population in the following way:

I.1   type and relative numbers of species

The increase in the number and turnover of domestic animals would proportionally reduce the number of wild animal bones present in urban samples compared with samples dated to an earlier period or in a non-urban context. A change in the relative numbers of different domestic species might also be espected as it became profitable to exploit different animals.

I.2   range of breeds/types of each species

These might be expected to change or develop, either by an improvement in existing breeds or also by a change over to types capable of greater productivity or of a more economical constitution.

I.3 and I.4   age and sex range of each species

In regimes geared towards intensive meat production a large proportion of male stock animals would be slaughtered at a relatively young age, 'at the transition from the juvenile to the sub-adult age when rapid growth has ceased and the meat output no longer increases relative to the food weight' (Uerpmann, 1973 : 315).

The level of wool production may also have intensified. This would change the patterns of age and sex ranges.

> "If wool production is the aim ... emphasis shifts to the adult animal. Lamb production is limited to the replacement needs of the flock, males not needed for breeding are castrated and run as a whether flock. As the quality of wool given by older animals falls off adults may be killed rather younger" (Payne, 1973 : 281).

In fact, this sort of pattern cannot be ascertained unless the sheep and goats can be satisfactorily separated since, for instance, where the former were bred for wool and the latter for meat, any patterns would be totally blurred by their association.

I.5 size range of each species

If the breed improvement results in increased uniformity, the size range might become more limited. Moreover there might be an increase in actual size over the long term. A ready market together with a quick turnover of animals makes the use of fodder crops not only feasible but profitable, which in turn would improve the general nutrition.

I.6 state of health

With proper feeding and better management a decrease in the incidence of deficiency diseases might be expected. If cattle were being raised for meat a decrease in the incidence of arthritic joints arising from draft work would also occur.

PROCESS TWO . Post-slaughter activities

Though the urban bone remains will reflect the urbanised economic regime through which the animals passed, once the animals had been slaughtered and their parts dispersed through-out the town, no single set of bones will reflect the entire economic regime. Thus, to reconstruct the economic regime, samples from a variety of urban contexts have to be regrouped so that variations or consistencies can be compared. For though the attributes of the animals are again selected and modified by Process Two, the animal population is only that which has been existed in Process One. Thus, if the effects of Processes Two, Three and Four can be identified some assessment can be made of the modifications that took place in Process One. Conversely, by establishing the variations amongst samples from the same town, the modifications resulting from Processes Two, Three and Four can be determined.

The archaeozoologist is intent on distinguishing between Processes One and Two because these modify many of the same attributes and involve man/animal relationships. Thus the sample comparison is vital to determine which modifications are taking place at which stage. Other means of interpretation can be used but their validity may be unreliable. For instance, the context itself may explain the stage at which a specific attribute was modified or an attribute is sometimes such that it could only have been selected for a specific purpose (for example, large assemblages of horn cores in an area known to have been used for ~~char-cooking~~ hornworking). The effects which Process Two has on the characteristics of the bone sample will be predicted on the assumption that selection was dependent upon origin as butchers' waste.

II.1 Types and relative numbers of species

The types and relative numbers of species need not necessarily be altered overall but a reduction in species or an alteration of their relative numbers in any one context is probable. The animals would have been principally sheep, goats, cattle, pigs and poultry which had entered the town for slaughter. Some animals, particularly game and animals whose flesh was to be salted, would have been slaughtered outside the town. Bones of animals which had further industrial usage were less likely to be dumped in the river.

II.2 Range of breeds/types of breeds

These will be from the same range as those entering the town.

II.3 Age range of each species

Age range would vary from site to site. For instance, the bones of young animals would not have been suitable for bone-working because of their comparative fragility and lack of density, so that higher proportions of young animal bones would probably be deposited as market waste. This would bias the proportions of species, except in the unlikely event of an equal proportion of each species being young. It might also affect the sex range of each species, since the age of death might be gender-related. (Table I).

II.5 Size range

This should not be unduly altered.

II.6 State of health

If there were laws about the sale of tainted meat, or the flesh of unhealthy animals, then it is possible that entire carcasses might be deposited. However, most diseases do not manifest themselves in the bone and, in any case, diseased bones do not necessarily taint the flesh.

11.7 Range and proportions of bone types from each species

This has been obliquely referred to already under attribute 1. At the marketing stage, the animals are slaughtered and cut up. Bones can be included in the meat sold into the domestic establishments, or in the hides sent to the tannery, or taken to the glue or bone tool manufacturers. These activities may be located in proximity to each other for convenience. Thus the amount of waste bone deposited with the offal will depend to the extent which meat is sold on the bone and the efficiency with which the bones are put to industrial use. If the manufacturers are located near to the market, then the waste products from these activities might be expected to occur. This would mean that the bone types, likely to be found in reduced proportions, will be those bones that support most flesh in the skeleton.

II.8 The extent of fragmentation versus intactness

The primary butchery process will not be performed uniformly on each bone type. Moreover secondary butchery will have taken place with manufacturing activities and domestic preparation of foods. This will have modified the fragmentary proportions of each species.

II.9 The robustness/hardness of each bone

Harder bones (also of a suitable shape) would be selected for manufacture. Ruminant ulnae and metapodials tend particularly to be favoured. A market deposit would tend to include younger and less hard bones.

PROCESSES THREE AND FOUR Post-depositional activities and excavational retrieval

Both these processes are more likely to destroy or remove those bones that are small and/or fragile and/or not dense. The degree of such modifications within the main species can be assessed to some extent by comparing the observed numbers of small bones with the expected number of small bones. A similar proceeding should be adopted for the large bones. The absence of species, where all the bones are small and/or fragile, cannot be dealt with, likewise those animal bones that are small due to immaturity.

c. predictions for Whitefriars - The next task is to relate the Whitefriars to the processes outlined above. Whitefriars is an urban site within Saxon and Medieval Norwich. Any development of the stock economy, caused by urban growth, may be detected in those attributes likely to be modified in Process one (Table I). The specific context, at or near the commercial waterfront in the Late-Saxon period, would suggest that the sample from this period may have been derived from a particular sort of waste, probably butcher's waste; that is the bone disposed of in the primary stage of butchery. Such selection would probably produce a high incidence of skull bones and metapodia. However, it is probable that deposits of a more mixed nature could also have been incorporated, having been washed down from higher up the river.

2. THE WHITEFRIARS ANALYSIS

a. analytical approach

For the purposes of analysis the sample was divided according to the four periods:

Period I	Mid to Late Saxon
Period II	10th to 11th century
Period III	Late 11th to early 12th century
Period IV	12th century onwards

The following types of analysis have been carried out :

1. quantification – i. total number of fragments (TNF)
   ii. total numbers and percentages of Main Mammalian Species (MMS)
   iii. epiphyses only of MMS
2. measurements of MMS long bones.
3. ageing patterns of the MMS based on the states of epiphyseal fusion described by Silver (1969).
4. estimation of relative proportions of bone types for the MMS. The categories of bone types are listed in TABLE II.

TABLE II

CATEGORIES OF BONE TYPES

Number of category	bone types
1.	mandible, maxilla, tooth, skull
2.	humerus, femur, scapula, pelvis
3.	radius, ulna, tibia, fibula
4.	metacarpal, metatarsal, metapodial
5.	tarsals, carpals, patella
6.	phalanges

b. state of preservation and method of retrieval

The state of preservation of the bones varied, two major states being distinguished. Firstly, those bones which were heavy and hard and had undergone very little attrition from weathering; secondly, those which were still in good condition but were more brittle and had suffered a greater degree of fragmentation.

c. <u>quantification</u>

1. Range of species (TABLE ~~IV~~ III)

The TNF of the sample was 3,333. Of these, approximately 47% were identifiable. The bird bones have not yet been assigned to species. 91% of the identifiable fragments came from pig, caprovines and cattle, the highest percentage, 39.5%, coming from cattle. There was also a range of other species that occurred, sporadically and in fewer numbers. These were hare, dog, cat, horse, and red and roe deer. The emphasis on major stock animals suggests that the sample derives mainly from animals slaughtered for meat. The dog, cat and possibly the horse fragments are the exception to this. The animal population, therefore, from which the Whitefriars bone sample derived, underwent an agricultural regime which included meat production amongst its objectives. Moreover the post-slaughter processes that led to the bones being dumped at Whitefriars were probably also associated with meat production and other industries associated with the carcasses of stock animals.

2. Percentages of the main mammalian species (TABLE IV)

i. total numbers of fragments

According to the TNF percentage of the MMS, cattle fragments dominate in phases 1, 3 and 4, though the degree of dominance is not consistant. In phase 2, caprovine fragments are most frequent. In the other phases, they take second place. Pigs are the least frequent, averaging 25%, except in phase 1, where they form only 11.5% of the MMS fragments.

ii. epiphyses only

This calculation was made by adding up all those fragments which supported epiphyseal endings. This includes mainly long bones but also the scapula, calcaneum and the phalanges. Where the long bones were intact and therefore had two epiphyses, they were counted as two. This method is designed to exclude bones that are inclined to fragment excessively and which may therefore have been over emphasized in the TNF calculation. The percentages differ from the TNF of the MMS in that they reduce the cattle percentages. This seems to be due largely to the quantity of fragmented cattle skull-bones, which is included in the TNF, but is excluded from the epiphyses only. Otherwise these two methods of calculation basically confirm each other. There is a change of percentage in the later phases, which increases the pig and decreases the caprovine percentages.

TABLE III. TOTAL NUMBER OF IDENTIFIABLE FRAGMENTS FROM SINGLE-PHASED LAYERS

		PIG	CAPRO -VINE	CATTLE	BIRD	HARE	DOG	CAT	HORSE	RED DEER	ROE DEER	IDENT FRAGS
Period I. ~~PHASE 1~~	no	11	32	52	3	/	/	1	/	/	1	100
	%	11	32	52	3	/	/	1	/	/	1	100
Period II. ~~PHASE 2~~	no	78	105	92	12	/	1	/	1	2	1	292
	%	26.7	36	31.5	4.1	/	0.3	/	0.3	0.7	.3	99.9
Period III. ~~PHASE 3~~	no	216	269	412	77	/	/	3	1	13	3	994
	%	21.7	27.1	41.5	7.7	/	/	0.3	0.1	1.3	0.3	100
Period IV. ~~PHASE 4~~	no	37	57	59	20	2	1	/	/	/	/	176
	%	21	32.4	33.5	11.4	1.1	0.6	/	/	/	/	100
TOTAL	no	342	463	615	112	2	2	4	2	15	5	1562
	%	21.9	29.64	39.37	7.17	0.13	0.13	0.26	0.13	0.96	0.26	100

TABLE IV PERCENTAGES OF THE MAIN MAMMALIAN SPECIES

i. total number of fragments

	PIG		CAPROVINES		CATTLE	
	no	%	no	%	no	%
Period I ~~PHASE 1~~	11	11.5	32	33.5	52	54.5
Period II ~~PHASE 2~~	78	28.5	105	38	92	33.5
Period III ~~PHASE 3~~	216	24	269	30	412	46
Period IV ~~PHASE 4~~	37	24	57	37	59	39
TOTAL	342	24	463	32.5	615	43.5

ii. epiphyses only

	PIG		CAPROVINES		CATTLE	
	no	%	no	%	no	%
Period I ~~PHASE~~	6	13.	20	43.5	20	43.5
Period II ~~PHASE~~	22	19.1	51	44.4	42	36.5
Period III ~~PHASE~~	108	28.7	126	33.5	142	37.8
Period IV ~~PHASE~~	19	32.2	20	33.9	20	33.9
TOTAL	155	26.	217	36.4	224	37.6

d. <u>measurements of the main mammalian species</u>

Measurements have so far been taken from the following MMS long bones :

humeri, radii, tibiae and metapodia.

Data has been used from King's Lynn (Noddle, 197) and Yarmouth (Gebbels, 1976), for comparing measurements from the same region, and from Exeter (Maltby, 1979) for data from another urban medieval context. The measurements are here summarized and tables giving quantitative data are available in the Excavation Archive together with full details of the location of the measurements.

PIG

The pigs fall within the same range as the measurements from the other areas. The distal tibiae demonstrate a wide range but are evenly spread.

need figures-here to show range.

CAPROVINE

The caprovine measurements produced larger means than those from King's Lynn and are also slightly larger than those from Yarmouth. The King's Lynn radii are distinctly smaller and the Yarmouth radii just smaller than those from Whitefriars whilst, with the tibiae, the Whitefriars and Yarmouth measurements only just overlap each other.

CATTLE

There are two clear groups in the radii, though from the modest number of measurements, their significance is not assured. The metacarpals also show this double grouping but the group of larger measurements contains fewer examples compared with the radii.

e. <u>ages of the main mammalian species</u>

Thus far, age estimates have only been carried out on the stages of epiphyseal fusion of the bones in the appendicular skeleton. The stages have been estimated period by period as well as overall. The purpose of the period by period analysis is not so much to detect minor anomalies, which may be apparent but not necessarily statistically significant, but to ensure that each of the phases follows the general trend that occurs in the overall estimation: it is also designed to detect any major inconsistencies that might have been caused by changes in the Processes One and Two.

PIG

The age range of the pig remains is broad and may explain the wide range of tibia measurements. Some died at less than 1/1½ years but the majority died upwards of this age, with a few even dying over 3/3½ years.

CAPROVINE

There was only a single 6/10 month fusing fragment that was unfused. The caprovines began to die from the age of 1½ years onwards, the majority dying at 2½/3½ years, but several lived on beyond that age.

CATTLE

As with pig, there seems to have been a range of deaths - a few dying at less than 1/1½ years, about the same quantity surviving until 2/3 years, and perhaps over half living beyond their 3/4th year.

f. <u>proportions of the main mammalian species</u>

For all of the MMS the smaller bones are poorly represented. A change in the sizes of different categories occurs for the cattle and caprovines from Period 1 to Period 4. In Period 1, for both animal types, there is a large proportion of skull bone and, in the caprovine group, there is also a high proportion of metapodials. Thus, the emphasis in these bone remains seems to be on waste fragments. In Period 4 the numbers of the categories which include long bones increase, and the relative numbers of waste bones, both skull and metapodial, are considerably reduced. In the pig bones, a pattern of change is not apparent.

3. DISCUSSION AND CONCLUSION

The aim of this report was to reconstruct, from the recovered animal bone assemblage, the man-animal relationships prevalent on a waterfront site in Late Saxon Norwich. Quantifying the bones in various ways has demonstrated that, although there was a range of species, the vast majority came from the major stock animals. This thus reflects the agricultural regime, since it could be expected that the bulk of animals raised for urban dwellers was intended for consumption. However, the proportions of MMS are not necessarily indicative of the proportions in which they entered Norwich since the range at Whitefriars is only a selection of the range entering the town. They may as easily be merely the proportions of waste produced from each animal type in this part of the city. Cattle fragments dominate the TNF, followed by caprovines, but it is possible that, for instance, pig carcasses may have been cured or converted into sausage meat in another area. The Whitefriars' remains in this case, therefore, would only come from those animals consumed as pork. Likewise, deer may have been sold intact so that their remains would not have been found in a general waste area. The presence, however, in varying quantities of pig, cattle, caprovines, hare, dog, cat, horse, red and roe deer shows a minimum range of the species present in the town. If the stock animal proportions are an approximate representation of the animals entering the city it appears that cattle were providing the most meat, pig contributed a comparatively small amount and horse was possibly not even regarded as a source of edible flesh.

The pig measurements suggest that the pigs were a similar size to those from other areas. It is interesting that there was a range of sizes. However, as was previously suggested (p.16), this could merely reflect the broad age range. It could alternatively be an indication of a non-intensive production-line which did not therefore emphasise uniformity. In fact the broad age range would tend to support this possibility. The measurements from other parts of Norwich will be useful here to clarify the extent of variation.

The analysis of caprovine sizes is difficult since sheep and goats have not been distinguished although it is apparent from the significant number of both sheep and goat horns that both were present. It is therefore likely that ~~we are encountering~~ two separate regimes are being encountered which may have produced two different age ranges. However, since most of the animals seem to have died in their second or third year, it is a possibility that meat production was a priority. It is also a possibility that young caprovines were sold intact, and that their bones therefore have been selected out.

The double grouping in the cattle measurements may well be sexual grouping which, with the acquiring of more data, will provide the relative numbers of females to males and castrates. However, as with the pigs, the size variation may also be related to the age range.

The low percentage of small bone types can be attributed to a sample bias consistent with a trowelled excavation.

The change in emphasis in bone types between the earlier and later phases for both cattle and caprovine requires an explanation. It is possible that the numbers in the individual phases are too small to be significant. However, the repetition of the trend in both cattle and caprovine seems more than coincidental. In Table I it has been suggested that post-slaughter and post-depositional activities are most likely to modify the proportions of bone-types. The post-depositional selection is unlikely to modify the proportions of cattle and caprovines without also affecting pig so a post-slaughter activity seems the likely modifier. The following explanations are possible :

i. The butchery traditions changed so that originally waste-bones were deposited but were later sold with the meat;

ii. In the later phases the waste bones were deposited elsewhere, possibly being taken for industrial use in another part of the city;

iii. The nature of the waste itself could have changed, being in the earlier stages butchery waste and, in the later phases, domestic waste.

Explanation iii seems most convincing since, in the later phases at Whitefriars, Palace Plan declined dramatically in commercial importance. Thus, it is possible that butchers ceased to use this part of the river for dumping their waste.

The results are exceedingly useful. The quality of the bone survival meant that there were good measurements and ageing data. The next step will be an attempt to obtain a ratio of sheep to goat, recording the tooth wear and relating it to the stages of epiphyseal fusion, and recording the degree of butchery in detail. It should also be emphasized that the conclusions expressed in this report will need to be re-assessed and possibly modified in the light of further research on animal bone from other sites within the city.

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Fish remains from excavations at Whitefriars, Norwich.

by [illegible]

Introduction

A large number of fish remains have been recovered from archaeological deposits by sieving soil samples and sorting the soil residues for fish bones, seeds and other biological and archaeological inclusions. The sampled deposits range in date from the eleventh century AD to the post medieval period. The deposits examined comprise mainly silty soils associated with brushwood platforms. It is thought that the platforms were laid to facilitate beaching boats on the banks of the river Wensum. It seems likely that both deliberately dumped domestic refuse and rubbish accumulated by the river form the basis of the deposits.

Methods and materials

The bones submitted for identification were retrieved by wet sieving soil samples through a tower of sieves with the finest mesh having 300 micron apertures. In addition, a small number of samples were processed through a 'bulk-sieving' tank as described by Kenward, Hall and Jones (1980). This sieving device is a modified version of the Siraf 'flotation' unit described originally by Williams (1973) and later by Renfrew, Monk and Murphy (1976). The soil residues were sorted using fine-pointed forceps and, where necessary, a low-power binocular stereo-microscope. It is particularly noteworthy that no fish bone was recovered from trowelled deposits during the course of the excavation.

Identifications were made by comparing the ancient material with modern reference skeletons in the collection of the Environmental Archaeology Unit, University of York. In addition to identifying the bones, an attempt has been made to size the fish represented in the deposits. Large individuals and rare specimens were sized by comparison with modern material. Common small fish, such as herring, are usually only caught in a rather restricted size range, and therefore do not warrant sizing. Fish nomenclature follows Wheeler, (1969).

Results

Table 1 is a condensation of the analyses. A full catalogue of the identified bones is available from either the Environmental Archaeology Unit, University of York, the Fish Section of the British Museum (Natural History) or the Norfolk Archaeological Unit.

Approximately half of the bones collected from the soil samples were found to be unidentifiable, most were fin rays, ribs, interhaemals and branchiostegal rays. All these bones are insufficiently characteristic to allow specific determinations to be made. Seventeen fish taxa have been identified from 11 archaeological contexts. A number of remains have been identified to family while vertebral centra and dermal denticles testify to the presence of at least one member of the cartilagenous fishes (Elasmobranchii).

The identified species

Cartilagenous fish, Elasmobranchii

Cartilagenous fish (dogfish, sharks and rays) are, generally speaking, not very well represented in archaeological deposits because their main skeletal material, cartilage, rapidly decays once the animal dies. However, fish from this group produce resistant dermal structures and mineralized cores of vertebral centra which survive in archaeological deposits. Unfortunately such remains as are found are not usually identifiable to species; thus the amount of information likely to be gleaned from studying the remains of cartilagenous fish is likely to remain small.

Skate or ray, Rajidae

A small group of elasmobranch denticles were recovered which indicate the presence of rays. It is possible that these denticles are from the thornback ray (see below) but a large number of members of the ray family produce large denticles.

Thornback ray, _Raja clavata_ L.

The only cartilagenous fish regularly reported from archaeological excavations because it produces highly distinctive dermal denticles (bucklers). It is probably the most abundant ray in British waters where it occurs at depths between 2-60 metres. It is usually captured on hook and line or in trawls and can weigh up to 17 kg.

Herring, _Clupea harengus_ L.

This pelagic fish which formerly occurred in enormous shoals around much of the British Isles has been recognised by the presence of 287 bones, mainly vertebral centra, from 8 contexts. Herring rarely exceed 40 cm in length and can easily be taken in the lower reaches of estuaries and, at sea, at depths of up to 200 metres. Its value as a food resource relies on its ability to be caught in large numbers and to be readily preserved by salting and/or smoking. Herring remains are by far the most abundant fish bones recovered from the site. There can be little doubt that they arrived in Norwich as a result of the famous East Anglian herring fishery, first recorded in the ~~which is known to have been in exsistence since 1086, when the~~ Doomsday Book wa~~s written~~. in 1086.

...lmon family, Salmonidae

In this family reside a number of highly valued food fish, including brown trout, the salmon and sea trout in addition to a few lesser species. The vertebral centra of these fish are so similar that specific identification is impossible. The single centrum recovered from Whitefriars is most likely to be from a trout as it size suggests a fish in the region of 40 cm total length is present.

Pike, Esox lucius L.

Pike is a carnivorous freshwater fish which lies in wait for its prey using aquatic plants as cover. It can grow to over 1 metre in length but the vertebral centrum recovered are of such a size that suggests that two of the specimens were approximately 40 cm long while one was only 15 cm long.

Cyprinidae, carp family

The carp family includes a large number of common British freshwater fish, including, roach, rudd, bream and chub. As a closely related group of fish the bones of many members resemble those of other species. Pharyngeal teeth plates are the only bones which can always be assigned to species. Other bones may be distinctive in one species but not in others. Vertebral centra are very similar from one species to the next and the one found has been identified to family. Unfortunately, the one fragment of pharyngeal tooth plate recovered is also impossible to identify to species.

Eel, *Anguilla anguilla* (L.)

As the eel spends some parts of its life in freshwater before returning to the sea to spawn it can be caught in salt, brackish or fresh water. It can grow to over a metre in length but the identified vertebral centra are from specimens approximately 50 cm long. A wide variety of methods are employed in the capture of eels; including hooks and line, nets, traps and eel spears. The eel is one of the few fish that is able to pass regularly through polluted waters and it seems likely that this fish has always been common in the London area. Twenty six vertebral centra were recovered from 7 contexts.

Cod family, Gadidae

This family contains many of the common marine fish which are of economic importance in the British Isles, for example, cod and whiting, and also ling, coley and haddock. A number of bones, chiefly vertebral centra have been ascribed to this family because they possess insufficient diagnostic features to allow more precise identification. While it is possible that species other than whiting and cod are present, it is most likely that the bones placed in this group are from either whiting or cod.

Whiting, Merlangius merlangus (L.)

Whiting is a very common fish in the southern North Sea inhabiting depths of 30-100 metres. It is not a large fish, rarely exceeding 40 cm in length, but is one of the most important fish caught bt small boat fisheries. Today it is most often taken in trawls, but drift nets, seine nets and hooks are also used. Whiting remains are one of the most abundant of fish remains recovered from the site being found in ten of the contexts examined.

Cod, Gadus morhua L.

Almost certainly, the cod has played the most important role of any fish in feeding the people of the British Isles. It is taken in both inshore and offshore waters. Today it is mainly taken in trawls but can be caught on baited hooks and in other nets. Cod can grow up to 150 cm and 40 kg. It is present in ten contexts and must be considered as one of the most important food fish because it grows to a much larger size than the other species present.

..s, Dicentrarchus labrax (L.)

.. exhibit seasonal migration, .. inshore into bays and the lower reaches of rivers in the .. and migrate into deeper waters in the winter. It can grow to 1 metre in length and is readily caught with hooks, nets or trawls. Bass was recognized in the deposits by a characteristic subopercular and .. vertebral centrum. It is therefore evident that bass .. as an important food fish but would have added variety to peoples diet.

Horse mackerel, Trachurus trachurus (..

This fish is very common in the .. North Sea and, like the bass, becomes more common inshore .. the summer as a result of seasonal migrations. It can be caught in trawls or floating nets in fairly large numbers as it forms shoals. A single vertebral centrum testifies to the presen e of this species.

Mackerel, Scomber scombrus L.

A pelagic migratory marine fish which forms shoals close to the surface. It can grow to 50 cm and 2 kg and is most often caught on hooks or in nets. Five vertebral centra from three contexts bear witness to the presence of this species. It is perhaps worth noting that, mackerel produce rather friable bones compared to other species of edible teleosean fishes, such as herring or cod. It may be that mackerel are thus under-represented in archaeological deposits.

Plaice, *Pleuronectes platessa* L., flounder, *Platichthys flesus* (L.) and other flatfish.

Plaice is a common marine flatfish living on sandy or muddy ground. It grows to 3.5 kg and is usually caught in trawls, seine nets, set nets or on hook and line. One left dentary showed that this species was present. Flounder has been recognized from an angular-articular and a quadrate. Flounder is the only flatfish able to live in freshwater although it is also taken in estuaries and inshore waters. It will grow to 2.5 kg and while it is eaten it is said to be less palatable than plaice. Forty four vertebral centra from 8 contexts have been assigned to the family Pleuronectidae which contains both plaice and flounder. Flatfish were a major element in the diet of those whose rubbish is being considered.

Discussion

Because the sampled deposits are likely to contain refuse from a large number of households over unspecified periods of time, it is unwise to attempt to make much of the assemblages of fish bones recovered from the Whitefriars site. Indeed, it is possible that the deposits, and therefore the groups of fish bones, are formed from a mixture of domestic, commercial or industrial rubbish and material, including the corpses of fish, carried by the river Wensum or its tributaries. Thus it is advisable to consider the assemblages of bones as a random collection of material. With this in mind the assemblages can be seen to provide a most interesting insight into the diet and ecomnomy of medieval Norwich. Clearly, a large number of different kinds of fish were being brought to the town for consumption. The majority are exclusively marine species, most of which are commonly eaten today. However, bass and horse mackerel are ~~not~~ [no longer] commonly found on the slabs of East Anglian fishmongers ~~today~~.

In addition to the marine component of the fish assemblage, estuarine and freshwater fish are also present. While it is most likley that the bones of these fish also represent food debris, it is possibile that some of them are remains of fish which died in the river and whose bones became incorporated with the other rubbish on the river bank.

The nature of the sampled deposits mean that detailed conclusions concerning the relative abundance of the various kinds of fish would be inappropriate. Nevertheless it is clear that certain species appear to be more important than others. Cod, whiting and herring with smaller amounts of cartilagenous fish, eel and flatfish seem to be rather more important than the freshwater fishes, mackerel, horse mackerel and bass. It is interesting to note that, with the exception of the freshwater fish, all the taxa recovered from this site were present in material recently excavated from deposits at Great Yarmouth (Wheeler and Jones, 1976).

Despite the limitations of the material, this group of fish bones is of considerable significance for relatively large numbers have been recovered by sieving soil samples. This procedure removes the bias in favour of large bones which is inherent in assemblages of bones which have been recovered by picking out bones from trowelled soil. While it is not possible to relate these particular bones to individual households or even to areas within the town, the assemblages provide an ~~useful insight~~ [illustration] into [of the variety of fish contained in] the diet of the medieval occupants of Norwich.

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Table 1

Phase [illegible] of fish	II		III		IV	
[illegible]	(2)	-	(4)	2	(3)	-
[illegible]	-	1	-	4	-	-
[illegible]	-	2	-	3	-	-
[illegible]	(46)	4	(281)	31	(5)	-
[illegible]	-	-	(1)	-	-	-
[illegible]	(1)	-	(2)	-	-	-
Cyprinidae	(3)	1	-	-	-	-
[illegible]	(18)	1	(26)	3	(1)	-
Gadidae	-	-	(3)	-	-	-
[illegible]	(15)	-	(27)	3	(1)	-
[illegible]	(16)	-	(24)	3	(1)	-
[illegible]	(1)	-	-	1	-	-
[illegible]	-	-	(3)	-	(1)	-
Scomber scombrus	(2)	-	(2)	-	(1)	-
[illegible]	(9)	-	(31)	1	(1)	-
[illegible]	-	-	-	1	-	-

Caption

Table 1

The distribution of identified bones in the three main archaeological phases of the site.
Bracketed numbers, e.g. (12) are the number of vertebral centra per taxon per phase.
Unbracketed numbers are the number of other identified bones per taxon per phase.

Marine mollusca and other invertebrates

by Peter Murphy

Shells and shell fragments recovered by wet-sieving ~~in the flotation tank~~ are listed in Table . Counts were made of gastropod apices and bivalve hinges. The mussel valves were frequently very fagmentary, and the counts of this species are based on intact hinges plus an estimate of minimum hinge numbers from fragments. 82 was a layer consisting almost entirely of badly crushed mussel shell and periostraca. Microscopically the sediment included a high proportion of calcareous prisms from decayed shells. Accurate counting was impossible, and the mussels from 82 have therefore not been included in the calculation of minimum numbers of individuals.

Species composition and shellfish exploitation

Fig. summarises the species composition of shell samples from four early medieval sites: Whitefriars; Fuller's Hill, Great Yarmouth (Jones 1976); Vernon St., Stoke, Ipswich and Brook St., Ipswich (both Jones, forthcoming). [illegible]. By comparison with the coastal sites the Whitefriars percentages seem to indicate relatively specialised exploitation, with a distinct emphasis on mussels (*Mytilus edulis*). In fact, the exclusion of 82 from the calculated percentages has resulted in mussels being under-estimated and in reality the mussel percentage should be still higher. Most modern commerical mussel-beds are just below low water in sheltered estuaries where food supply in the form of suspended organic material and phytoplankton is near-constant, and mussels thus grow to a size worth gathering (Tebble 1976, 41). The nearest suitable site for mussel gathering is the estuarine area now known as Breydon Water. The valves from Whitefriars are slightly under-sized by modern standards (mean 48mm; range 38-61mm; 21 measurable specimens): mussels are nowadays considered to be marketable at just over 2" (51mm) (Tebble ibid.).

Oysters (*Ostrea edulis*) account for only about a quarter of the molluscs from Whitefriars and Fuller's Hill, in marked contrast to the samples from the Ipswich sites where they were evidently the predominant shellfish species consumed. The reasons for this difference can only be conjectured but may simply be related to local variation in food preferences, or perhaps to a reduction in suitable habitats for oysters in the Yare estuary resulting from the development of the Yarmouth sand-spit (in the early medieval period) and consequent restriction of tidal range.

The remaining mollusc species identified at Whitefriars occur at very low frequencies. Indeed, it seems possible that the winkles (*Littorina littorea*) represent chance contaminants. Winkles are frequently associated with self-supporting clumps of mussels in sheltered intertidal areas (Funnell *et al* 1979, 514) and the few specimens from Whitefriars could easily have been accidentally collected during mussel harvesting. The higher frequencies of *Littorina* at Yarmouth and Ipswich, by contrast, do appear to indicate the consumption of winkles, and Jones (1976) has suggested that winkles were brought from the rocky coasts of Lincolnshire or Yorkshire by coastal trade. Only a single shell fragment of cockle (*Cerastoderma* sp.) was recovered at Whitefriars. At Yarmouth cockle valves were relatively common, (though the total percentage is inflated by a single large deposit of this species). This must reflect the proximity of intertidal sand-flats associated with the developing spit. The whelk (*Buccinum undatum*), a sublittoral mollusc, is, again, represented at Whitefriars by only a single fragment although it accounted for some 12% of the Yarmouth sample. Unlike the intertidal species, which can be harvested by raking at low water, whelks are nowadays collected from boats using iron-framed, rope-bound pots baited with fish, usually salted herring (Harden Jones 1976).

Meat Weights

Winder (1980), working with very large mollusc samples from Saxon Southampton, has calculated percentage meat-weights contributed by different species. Meat-weight calculations have not been made at the present site since shell counts could not be obtained for 82. The degree of shell fragmentation will determine whether such calculations may be attempted at the 1981 excavations.

Epifauna

Two species of Bryozoa were identified: *Callopora aurita* Prenant and Bobin and *Conopeum reticulum* (Linnaeus) (det. P.S. Whittlesea). The latter can occur both in the sea and in river mouths where salinities are low (O.E.C.D. 1965). Barnacles, *Balanus balanoides*, were attached to some of the oyster shells. *B. balanoides* is an intertidal species (Yonge 1949, 112). 82 produced remains of a hydrozoan, *Dynamena* sp. . Unfortunately the remains of these organisms are not directly informative so far as the location of shellfish beds is concerned.

Conclusions and prospects for future work

Comparison of the shell sample from Whitefriars with that from Fuller's Hill, must of necessity take into account the different collection methods used. However, the Yarmouth sample clearly reflects the exploitation of a relatively wide range of shellfish beds, including whelk grounds, cockle beds on intertidal sand-flats, and mussel and oyster beds probably in estuarine areas: in short a diversified shellfish 'industry'. By contrast, the Whitefriars sample is thought to indicate much more specialised exploitation of estuarine beds in the Breydon Water area. There remains, of course, the possibility that shells of other molluscan species were disposed of elsewhere along the waterfront, and that the present sample is biased twards mussels. The 1981 excavations will provide an opportunity to determine whether the sample is indeed representative.

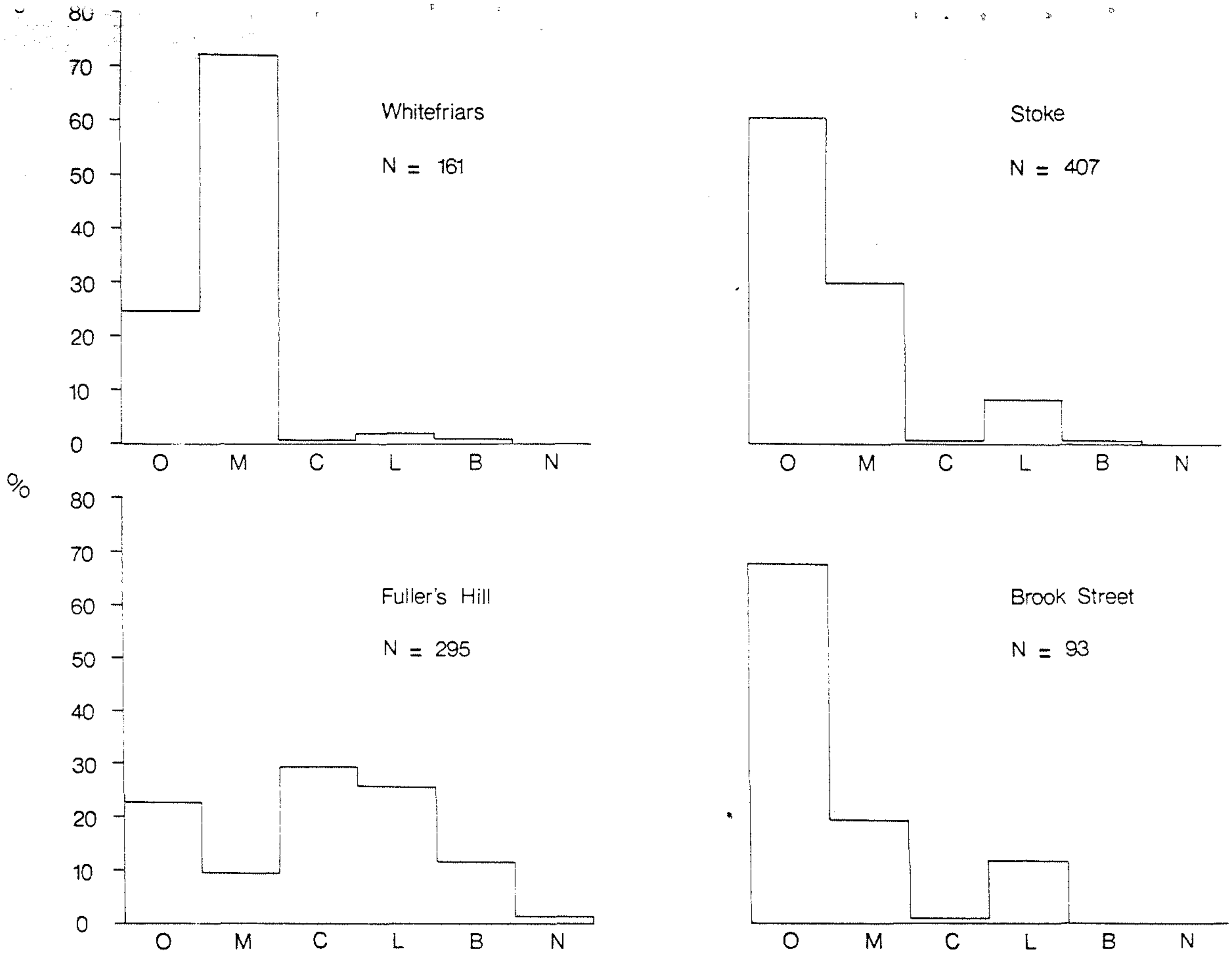
It also [illegible] to be established just how important shellfish consumption was in the diet of the inhabitants of the early city. Extensive layers of shell at this site certainly gave a subjective impression that shellfish were an important food source. Block sampling of mollusc deposits, combined with meat-weight calculations, should serve to quantify the importance of shellfish, although the complex factors influencing the composition of urban refuse deposits may invalidate direct comparison of shellfish meat-weights with those of domestic animals and fish.

Caption to figure

Fig. : Percentage composition of marine mollusc samples from four East Anglian sites.

O - Ostrea edulis L. M - Mytilus edulis L.
C - Cerastoderma edule (L) L - Littorina littorea (L)
B - Buccinum undatum L. N - Nucella lapillus (L)

Small estuarine species (Phytia myosotis, Hydrobia spp. and Assiminea grayana) are not included.



%
80
70
60
50
40
30
20
10
0
Whitefriars
N = 161
Stoke
N = 407
Fuller's Hill
N = 295
Brook Street
N = 93
O
M
C
L
B
N

Sample No.	1	2+3	4	5+6	7+8	9+10	11	12+13	14	15	15	15	16	Total MNI (excluding 82)
Context	60	55	67	68	52	75	84	86	74	82	92	93	113	
Ostrea edulis UV	2	4	4	1	6	1	1	4	3	1	1	-	1	38 40
LV	1	10	1	3	2	1	-	3	3	2	1	2	1	
Mytilus edulis	4	16	3	7	1	1	28	141	(1)	*	18	11	-	113 [illegible]
Cerastoderma sp.	-	-	(1)	-	-	-	-	-	-	-	-	-	-	1
Buccin um undatum	-	(1)	-	-	-	-	-	-	-	-	-	-	-	1
Littorina littorea	1	-	-	1	1	-	-	-	-	-	-	-	-	3

Table : Marine Mollusca

* - abundant - not counted

(1) - indicates non-hinge or non-apical fragment

82 and 92 are sub-divisions of 93

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Freshwater and land mollusca

by Peter Murphy

Only one deposit (114) produced significant numbers of shells; the remaining samples contained only a few specimens, insufficient for any ecological interpretation. This report is therefore concerned only with the mollusca from 114. Shells were identified initially using Macan (1969), and identifications were confirmed by comparison with specimens in the writer's reference collection and in the Natural History Department, Norwich Castle Museum.

Valvata piscinalis (Müller)	142
Valvata cristata Müller	18
Valvata sp.*	170
Bithynia tentaculata (Linné)	34
Lymnaea peregra (Müller)	20
Bithynia/Lymnaea *	180
Planorbis planorbis (Linné)	10
Anisus leucostoma (Millet)	1
Gyraulus albus (Müller)	43
Bathyomphalus contortus (Linné)	19
Planorbis sp. (*sensu lato*) *	53
Helicella sp. *	1
Discus rotundatus (Müller)	+
Pisidium spp. (individuals with paired valves)	18
Pisidium spp. (separated valves)	306
Ostrea edulis Linné	+
Cerastoderma sp.	+

Table : Mollusca from context 114 (sample 58): 1kg sample

\+ - indicates non-apical or non-hinge fragments

* - small fragments, including apex nepionic whorls.

Notes:

1. The *Pisidium* spp. include a large proportion of immature specimens. No attempt has been made to identify these bivalves to species.
2. Since the sediment was coarse many of the shells are very fragmentary and some are abraded. This has led to difficulties in the separation of several taxa and to a high proportion of approximate identifications. These do not, it is thought, invalidate the overall ecological interpretation of the assemblage.
3. The sieved fraction also contained fragments of arenaceous caddis-fly larval cases.

Sparks (1961) has distinguished four main groups of freshwater mollusca: a 'slum' group, a 'catholic' group, a 'ditch' group and a 'moving water' group. Anisus leucostoma is the only species in this assemblage which is characteristic of 'slum' habitats, subject to drying, stagnation and wide temperature variations and is represented by only a single shell. Lymnaea peregra, Bathyomphalus contortus and Gyraulus albus are 'catholic' species found in most freshwater habitats. The 'ditch' species in this deposit include Valvata cristata and Planorbis planorbis; these are often found in clean, slowly flowing water with abundant aquatic vegetation. Suitable habitats would have occurred in beds of water crowfoot, horned pondweed and perfoliate pondweed, fruits and seeds of which also occurred in 114. The final group of 'moving water' species includes Valvata piscinalis and Bithynia tentaculata.

All the freshwater species identified in this sample occur in East Norfolk rivers today and overall composition of the assemblage, in which 'ditch' and 'moving water' species predominate, serves to confirm the fluvial origin of 114.

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Insects

Soil samples were taken for the recovery of insect remains and have been sent to Dr M. Girling at the Ancient Monuments Laboratory, Department of the Environment. Unfortunately, due to pressure of work, Dr Girling was unable to complete the analysis of these samples in time for publication here. It is hoped that the results will be published in a subsequent report on the excavations at the nearby 'Magistrates Courts' site.

Diatoms

by Brian Moss, ~~(School of Environmental Sciences, University of East Anglia,)~~

A series of fifteen samples was taken, mostly from a vertical profile x metres from the north end of the trench (contexts 24, 27, 30, 46, 51, 52, but also from deeper deposits (58, 74, 82, 83) to the south where they were accessible at the time of sampling. Sample (74) comprised the sediment in the interstices of the twiggy layer at this horizon. (58), (82) and (83) are believed to be in situ natural deposits overlain by the sequence 52-24 which may have varied origins. All samples were dominantly inorganic with much sand and clay. Compared with those of lake sediments in eastern Norfolk, the deposits were sparse in diatoms and many of the remains were so fragmented as to be unidentifiable, particularly in the upper sequence (52-24). The samples were shaken vigorously with distilled water to dislodge fine particles and diatoms from aggregates then poured into a beaker and organic matter in them oxidized with hot chromic acid. They were then shaken and allowed to stand for 15s to allow sand grains to settle. The supernatant was centrifuged (3000g) for 5 minutes then washed with distilled water and recentrifuged. This was repeated three times. Aliquots of a suspension of the final residue were dried onto thin coverslips (thickness 0), dried and mounted in high refractive index mountant (Hyrax). They were examined using phase-contrast oil immersion microscopy (x1000).

Results are given in Table 1 and include an estimate, in arbitary units of abundance per unit, dry weight of sediment, and percentage contributions of particular species and genera to the total. Authorities for nomenclature are those quoted in Hustedt (1930).*

* Hustedt, F. (1930). Die Süsswasserflora Mitteleuropas. Heft. 10. Bacillariophyta (Diatomeae). 466pp. Fis[illegible]

Counts are based on all identifiable remains and indication is given of the degree, subjectively assessed, of fragmentation of the diatom frustules. (Diatom cell walls, which are of silica, comprise several parts, of which the valves, or frustules, are the larger. A species may be identified from the pattern of ornamentation on them. It is generally necessary to have at least the central and one terminal portion of the frustule for definite identification). Cysts, the silicious resting bodies of some members of another algal division, the Chrysophyta, were also recorded.

The diatom remains divide the deposits into two groups, 24-52 and 58, 74, 82 and 83. The latter group comprises sediments with a relatively abundant flora in which many diatoms were intact, and in which Chrysophycean cysts were absent. The diatoms are all freshwater ones and mostly species and genera associated with submerged surfaces such as those of higher plants, stones, and pilings (e.g. Achnanthes, Cocconeis, Epithemia, Cymbella, Rhoicosphenia) or sediments (Fragilaria, Pinnularia, Nitzschia, Navicula, Hantzschia, Campylodiscus, Diploneis). Some genera are found in both these habitats. There is a very small planktonic component (Coscinodiscus, certainly and potentially Synedra and Diatoma) but in general the diatoms tell of an insitu fertile river sediment with its own indigenous mud flora, but receiving also the frustules from nearby more solid substrata. The intactness of many frustules in such mineral sediments implies a quiet environment not vigorously disturbed. The freshwater nature of the diatoms in context 82 contrasts with the marine origin of the mollusc shells which are abundant in this layer.

Samples from contexts 24-52 have a broadly similar diatom flora to those of the lower group but contain many fewer frustules, a much greater proportion of which were fragmented. The low counts are dominated by Chrysophycean cysts and the most abundant diatom genera are those of sediment - living forms with those genera which grow attached to firm substrata less well represented than in the lower layers.

The comparatively greater fragmentation of the frustules in these layers suggests a mechanically disturbed habitat, but the presence of diatoms at all in such sandy sediments is not consistent with this being natural vigorous wave action on a sandy beach which would probably remove all fine remains. The presence of genera of firm substrata, e.g. *Cocconeis* suggests wash-in and deposition at water levels which covered the sediments, but the greater abundance of *Nitzschia* and *Navicula* suggests a greater predominance of an indigenous sediment flora. These genera are often very tolerant of extremes in their environment; they are frequent in wet soils. With the predominance of Chrysophytan cysts, which are life cycle stages capable of carrying rather delicate otherwise naked-walled species through unfavourable conditions such as drying out, they suggest an environment periodically flooded and alternately exposed. Such conditions could be consistent with natural deposition by the flooding river, but in that case the deposit might be expected to have included elements of a diatom flora washed from a greater range of river habitats by the floods. Alternatively the habitat could have been onein which the water supply to the surface of the sand might have been mostly by capillary action in artificially placed deposits, with only occasional river flooding. The relatively greater abundance of both Chrysophyte and diatom remains in contexts 46 and 51 might be consistent with a suggested period of increased flooding in the fifteenth century. However the large amounts of fine inorganic material in the samples made the finding and counting of the diatoms very difficult and the number of diatoms examined were small compared with those available in lake sediments. Such conclusions must be regarded therefore as tentative.

Table Diatoms and other algal remains from the Whitefriars excavation. Percentages given for individual taxa are those of the total count of diatoms and chrysophytan cysts combined. The degree of intactness of the diatoms is indicated by the number of + signs.

Context	24	27	30(1)	30(2)	30(2)	41(1)	46(2)	51(1)	51(2)	52(1)	52(2)	58	74	82(2)	83
Code for sample	A	B	C	D	E	F	G	H	I	J	K				
Absolute abundance	10	15	19	9	11	24	5	21	9	4	5	35	37	29	49
Intactness	-	-	-	-	-	±	-	-	-	-	-	+++	+	+++	+++
Coscinodiscus						4.2				25					2
Chrysophycean cysts	30	46.7	26.3	22.2	27.3	41.7	0	9.5	0	25					
Achnanthes minutissima	10							4.8					2.7		2
A.lanceolata												17.1		3.4	16
A.l.rostrata													5.4		8
A.sp														3.4	
Cocconeis placentula	10	6.7	0	11.1	0	4.2	0	4.8	0	25	40	37.1	37.8	17.2	16
C.Scutellum			5.3			4.2									
C.sp												2.9			
Fragilaria sp			15.8									11.4	2.7		4
F.construns			5.3											20.7	
F.brevistriata			10.5					4.8						3.4	
Synedra sp			5.3			4.2			22.2					3.4	2
Diatoma elongatum				11.1	9.1										
Epithemia zebra	10				27.3		40								
Rhopalodia gibba					9.1			4.8							2
Cymbella brehmi									22.2			5.7	2.7		
Cymbella sp													5.4		
Rhoicosphenia curvata															2
Amphora ovalis var pediculus													5.4		
Amphora sp													2.7		
Gomphonema sp													2.7		
Pinnularia sp. 1	10	6.7						4.8		25					
P. sp. 2	10														
Nitzschia sp	10		21.1	22.2		8.4	40	19	33.3				18.9	20.7	
N. palea														3.4	2

Table 1 (Continued)

Context	24	27	30(1)	30(2)	30(2)	41(1)	46(2)	51(1)	51(2)	52(1)	52(2)	58	74	82(1)	83
Code for sample	A	B	C	D	E	F	G	H	I	J	K				
Navicula sp 1	10	13.3	10.5	22.2	18.2	29.2	20	23.8	33.3	25		25.7	8.1	24.1	30.6
N. tuscula		26.7			9.1			4.8	11.1						
N. sp 2															6.0
N.hungarica var capitata															2
N. schonfeldi								4.8					5.4		2
Hantzschia sp			5.3			4.2									
Campylodiscus noricus								4.8							
Navicula bacillum								4.8							
Diploneis ovalis								4.8							

Mosses   by Peter Lambley

Remains of mosses were extracted both from samples processed in the laboratory and from the larger samples processed on site in the flotation tank. Only small quantities were present, and there is no firm evidence for the utilisation of moss. The bulk of the material comes from the permanently wet deposits of periods I and II. Specimens identified are listed in Table

Species from several types of habitat are present. Thuidium tamariscinum is a woodland moss characteristic of heavy clay soils, common in the woods of central Norfolk. Thamnium alopecurum is a common moss of dry calcareous woodlands. 92 produced moss fragments tentatively referred to Leptodictyum riparium, a common waterside species. This deposit is interpreted as a layer of litter or flooring material, dumped at the riverside. The remaining mosses have not been closely identified due largely to poor preservation, but appear to be common species of widespread distribution in gardens, woodland and grassland.

Context number	52	74	75	86	88	92	93	100	113	114
? Bracythecium rutabulum B. and S.	-	-	+	-	+	-	-	-	-	-
Eurynchium confertum Milde or Bracythecium velutinum B. and S.	-	-	-	-	-	-	-	+	-	+
? Leptodictyum riparium	-	-	-	-	-	+	-	-	-	-
Thamnium alopecurum B. and S.	-	-	-	-	-	-	+	-	-	-
Thuidium tamariscinum (Hedw) B.S and G.	+	-	+	-	-	-	-	-	+	-
Unidentified	-	+	-	+	-	+	-	-	-	-

Table : Mosses

Samples from context numbers 90 (sample I, II4 cm.) , 74 (sample 2, IIO cm. and 3, I06 cm.) and 30 (sample 4 cm.), have been analysed for pollen. Samples I-3 are from the relatively more organic basal deposits, whilst sample 4 is from the 'dark earth'.

Standard pollen extraction procedures were used to concentrate the sub-fossil pollen and spores present. Pollen taxonomy follows that given in the pollen key of Moore and Webb (I978). The pollen sum varied between IOO and 350 depending upon the absolute pollen frquencies present. These results are given in Table I, where pollen has been calculated as a percentage of total pollen , and spores as a percentage of total pollen plus spores,

The pollen spectra are dominated throughout by herbaceous types. Tree and shrub pollen percentages in contrast are much lower, being dominated by Quercus and Corylus type pollen. This may be suggestive of a regional input of pollen from oak-hazel woodland outside of the town.Other arboreal taxa may similarly result from a regional/ more long distance element rather than localised pollen input. The herbaceous pollen assemblages are possibly representative of three main groups of plant communities and/or mode of origin and deposition. These are:

i) Ruderal pollen from many of those plants which typically grow on waste ground in urban areas. Although recognition to species level is not possible with many types, this category appears to be dominant. The following might be included in this group: Ranunculus type, Chenopodium type, Papilionaceae, Rosaceae , Rumex, Urtica type, Solanum nigrum, Plantago lanceolata , Galium type and Compositae types.

ii) Pollen from marginal aquatic plants might be expected from such riverine/estuarine situation. These were present but, however, not in abundance. Taxa recorded include Alnus,Salix , Hydrocotyle, Typha angustifolia type (which includes Sparganium) and Cyperaceae. As in category (i), pollen from such genera as Mentha may have been produced by plants from this niche.

iii) Cereal type, Sinapis type, Centaurea cyanus and possibly other types are indicative of arable agricultural environments. This raises the problem of interpreting pollen spectra obtained from urban archaeological contexts. The presence of arable pollen types does not necessarily indicate cereal cultivation in proximity to the site sampled for pollen analysis. It is more likely that the presence of these pollen types is due to secondary anthropogenic causes. These may be varied and include the possibility of human faecal material being present in the sediments sampled. The transport of cereal pollen in bracts has been shown (Robinson and Hubbard 1977)and results in the presence of pollen in cess pits and river sewage channels indicating that wholemeal bread has been consumed (Greig 1978, Scaife 1980a, 1980b). The presence of the intestinal parasite/nematode eggs , Trichuris to some extent substantiates this view. Alternatively cereals may have been used in animal feed. Animal dung may have been incorporated into floor sweepings which were later dumped at the site. The unloading of grain crops from boats at this point on the river bank is a further plausible explanation. The interpretation is therefore problematical in that one or more factors other than normally associated with natural pollen transfer and deposition are involved.

It is apparent from Table I that Gramineae pollen is dominant . This similarly may be interpreted as regional pollen incoming from extensive pastoral areas outside of the urban area. Conversely, and equally likely, the use of grasses in thatching, animal fodder and as floor covering may be the contributory factors.

Pollen sample 4 is taken from the 'dark earth' deposits at this site. Pollen analytical investigations have been carried out on other such materials (Scaife in MacPhail forthcoming). Low absolute pollen frquencies, poor preservation and the relatively high totals of pollen having thicker exines (Taraxacum type and Sinapis type) indicate that differential preservation may have occurred in this sample. It seems likely therefore that less robust pollen taxa may have been destroyed, suggesting that sample 4 is similar to the lower more organic samples 1-3.

It is unfortunate that a more detailed regional environmental picture cannot be obtained from this series of pollen samples. The diverse herb pollen assemblage is one which is largely associated with plants growing in urban waste ground areas and from the useage of plant materials brought into the urban area for use by man.

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Sample	I	2	3	4
Betula	0.3		I.3	
Pinus			I.0	I.0
Quercus	9.4	I2.5	7.0	2.0
Tilia	0.3			
Alnus	2.3	I.3	2.7	
Fraxinus		0.7		
Fagus	0.6	0.7		
Corylus type	8.5	7.2	7.7	
Salix	I.7	3.3	3.3	
Ranunculus type	0.3	0.7	0.7	
Sinapis type	I.4	2.6	3.3	7.0
Hornungia type	0.6		I.0	
Caryophyllaceae undiff.				I.0
Dianthus type			0.7	
Chenopodium type	0.3		0.7	I.0
Papilionaceae undiff.	0.9	0.7	I.3	I.0
Ononis type	0.6			
Medicago type	I.I			
Trifolium type	I.7	0.7	0.3	
Lotus type		0.7		
Lathyrus type			0.7	
Rosaceae Undiff.	I.7		0.3	I.0
Filipendula	3.4	2.0	0.7	
Potentilla type	0.3		0.3	
Umbelliferae	0.9	0.7	I.3	
Hydrocotyle			0.7	
Cannabis type	0.3	0.7		
Rumex	I.I	I.3	3.7	
Urtica type	0.6	0.7		
Erica	0.3			
Calluna	I.I	2.0		I.0

TABLE I Pollen counts from Whitefriars calculated as a percentage of total pollen.

Table I continued

	I	2	3	4
Solanum nigrum	0.6			
cf. Digitalis type			0.7	
Melampyrum		0.7	0.7	
Mentha type	I.4		I.3	
Lamium type	0.6			
Plantago lanceolata	4.6	4.6	5.3	3.0
Campanula type	I.I	0.7		
Galium type		I.3	0.7	
Bidens type	I.I		0.7	
Aster type			0.7	
Anthemis type	0.3			
Centaurea nigra type	0.6	0.7		I.0
C. scabiosa type			0.7	
C. cyanus				4.0
Taraxacum type	6.8	3.9	7.7	30.0
Gramineae	38.2	42.I	32.3	3I.0
Cereal type	6.8	3.9	6.7	I.0
Typha angustifolia type		0.7		
Cyperaceae	3.I	3.3	7.7	I0.0
Unidentified	0.3			3.0
Pteridium	2.4		4.3	4.7
Dryopteris type	I.9	I0.6	I.6	I.9
Polypodium	0.3		0.3	
Trichuris eggs		I	6	6
Pollen Sum	35I	I52	300	I00
Spore total	I7	I8	20	7

Plant macrofossils (excluding wood) by Peter Murphy.

Fruits, seeds, spikelet fragments, leaves and stem fragments extracted from soil samples in the laboratory are listed in Table . Large plant remains recovered by means of the flotation tank on site are shown in Table The 'flots' and 'residues' produced by the flotation tank also contained large numbers of smaller seeds, but these have not been examined, because machine flotation is thought to be relatively inefficient in extracting these smaller plant remains from waterlogged samples and may result in differential recovery rates for different categories of material. Moreover, adequate assemblages of small seeds had already been recovered from samples in the more controlled conditions of the laboratory.

Identifications were made using Bertsch (1941), Beijerinck (1947), Katz et al (1965) and Renfrew (1973) and were confirmed by comparison with modern reference specimens. Well-preserved specimens have not always been identified to species level where this would have been excessively time-consuming for the information gained. Thus for example *Carex* nutlets and *Juncus* seeds have not been specifically determined and grass caryopses have generally been identified only to family level. Other tentative or incomplete identifications refer to specimens with ill-defined or obscured morphology or result from a lack of modern reference specimens. Measurements have been made only where they were thought to be of direct relevance for the separation of taxa.

Context No.	46	55	74	82	84	88	92*	98	100	102*	113*	114
Sample No.	3	14	23	29	17	30	38	32	54	52	55	58
Chara sp.	-	-	-	-	-	-	-	-	--	-	+	+
Ranunculus c.f. *repens* L.	-	-	1	-	-	-	-	1	1	-	-	-
Ranunculus c.f. *flammula* L.	-	-	-	-	-	1	1	-	10	-	2	-
Ranunculus sceleratus L.	-	-	-	-	-	-	-	1	-	-	-	-
Ranunculus subgenus *Batrachium*	-	-	-	-	-	-	-	2	-	-	-	31
Ranunculus sp.	1	-	2	1	-	-	2	2	1	2	2	24
Papaver argemone L.	-	-	-	-	-	-	-	-	-	1	2	-
Papaver somniferum L.	-	-	-	-	-	-	-	-	-	26	32	-
Brassica sp.	-	-	1	-	1	-	-	-	2	1	-	-
Raphanus raphanistrum L.(siliqua frag)	-	-	-	-	-	1	-	-	-	-	-	-
Thlaspi arvense L.	-	-	1	-	-	-	-	1	-	-	1	-
Reseda lutea L.	-	-	-	-	-	-	-	-	-	2	-	-
Reseda sp.	-	1	-	-	1	-	-	-	-	-	-	1
Hypericum c.f. *tetrapterum* Fries	-	-	-	-	-	1	-	-	-	-	-	-
Hypericum sp.	-	-	-	-	-	-	-	-	-	-	1	-
Silene c.f. *alba* (Miller) Krause	-	-	10	-	-	-	-	-	1	-	-	-
Agrostemma githago L.	-	-	c.f.2	-	-	-	-	-	7(fr)	2+fr	2+fr	1+fr
Dianthus c.f. *armeria* L.	-	-	-	-	-	-	-	-	-	-	2	-
Cerastium sp.	-	-	-	-	-	-	1	-	-	1	3	-
Stellaria media (L) Vill	-	-	-	1	1	2	5	13	8	42	49	-
Stellaria holostea L.	-	1	-	-	-	-	-	-	-	-	-	-
Stellaria c.f. *graminea* L.	-	-	1	-	-	1	1	-	-	5	-	-
Stellaria sp.	-	-	-	-	2	-	-	-	-	-	-	-
Spergula arvensis L.	-	-	-	-	-	-	-	-	-	1	-	1
Caryophyllaceae indet.	-	-	1	-	-	1	-	-	5	-	4	-
Montia fontana subsp. *chondrosperma*	-	-	1	-	-	1	-	-	-	-	-	-

[illegible] album L.	11	6	29	2	2	10	3	31	10	40	15	40
[illegible]plex patula/hastata	-	1	1	-	6	-	3	-	3	10	7	4
Suaeda maritima (L) Dumort	-	-	-	-	-	-	-	-	-	-	-	1
Chenopodiaceae indet.	-	3	4	-	3	6	-	2	2	3	1	3
Malva sylvestris L.	-	-	1	-	-	-	-	-	-	-	-	-
Linum usitatissimum L.	-	-	-	1	-	1(fr)	-	5(fr)	-	-	1	1
c.f. Geranium sp.	-	-	-	-	-	-	-	-	25	-	-	-
Ilex aquifolium L.	-	-	-	-	-	-	-	-	5	-	-	-
" " (leaves)	-	-	-	-	-	-	-	-	+(fr)	-	-	-
Vicia sp. (c)	-	-	-	-	1	-	-	-	-	-	-	-
Filipendula ulmaria (L) Maxim.	-	-	-	1	-	1	2	-	-	-	2	-
Rubus fruticosus agg.	-	8	1	-	2	2	-	-	210	62	17	25
Rubus c.f. idaeus L.	-	-	-	-	-	-	-	-	-	-	-	1
Rubus sp.	-	1(c)	-	-	-	1	-	1	-	-	-	-
Potentilla sp.	-	-	-	-	-	-	1	-	-	-	-	12
Fragaria vesca L.	-	-	-	-	c.f.2	1	-	2	31	85	6	-
Aphanes arvensis L.	-	-	-	1	-	-	-	-	-	-	-	-
Aphanes c.f. microcarpa	-	-	2	-	-	-	-	-	-	-	1	12
Prunus spinosa L.	-	-	-	-	-	-	-	-	1	1	-	-
Prunus domestica L.	-	-	-	-	-	-	-	-	2	1	-	-
Prunus domestica L. subsp. insititia	-	-	-	-	-	-	-	-	6	-	-	2
Crataegus monogyna Jacq.	-	-	-	-	-	-	-	-	-	1	-	-
Malus sylvestris Miller	-	-	-	-	-	-	-	-	-	-	1	-
Epilobium sp. (hirsutum-type)	-	-	-	-	-	-	1	-	-	2	3+cf.1	-
c.f. Myriophyllum sp.	-	-	-	-	-	-	-	-	-	-	-	1
Hydrocotyle vulgaris L.	-	-	-	-	-	-	-	-	-	-	1	-
Anthriscus sylvestris (L) Hoffm.	-	-	-	-	-	-	-	-	-	-	c.f.2	-
[illegible]nium maculatum L.	9	1	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-	31	84	32	2

Aethusa cynapium L.	-	-	-	-	-	-	-	1	-	-	-	-
c.f. Pastinaca sativa L.	-	-	-	-	-	-	-	-	c.f.2	-	-	-
c.f. Anethum graveolens L.	-	-	-	2	-	-	-	-	1	-	-	1
Umbelliferae indet.	-	-	-	-	-	-	-	2	1	2	4	13
Euphorbia helioscopia L.	-	1	-	-	3	-	-	-	-	-	-	-
Polygonum aviculare agg.	-	-	-	-	-	2	10	2	-	2	-	11
Polygonum lapathifolium L. (+perianth)	-	-	-	-	-	-	-	-	-	1	-	1
Polygonum lapathifolium/persicaria	-	-	-	-	-	1	3	2	22	11	1	-
Polygonum hydropiper L. (+perianth)	-	-	-	-	-	-	-	-	130	-	1	-
Polygonum convolvulus L.	-	-	13	-	-	1(fr)	-	2	1	3	-	3
Polygonum sp.	-	-	-	-	1	-	-	3	-	3	9	1
Rumex acetosella agg.	-	-	9	-	-	1	8	5	2	5	9	9
Rumex sp.	-	1	6	2	-	5	-	12	2	6	8	16
Polygonaceae indet.	-	-	6	-	2	1	-	1	-	6	2	4
Urtica urens L.	-	4	2	-	19	5	1	3	20	534	11	2
Urtica dioica L.	84	7	180	17	14	116	11	107	5	65	59	45
Humulus lupulus L.	-	1	-	1	2	-	-	3	-	8	12	1
Juglans regia L. (frags)	-	-	+	-	-	-	-	-	-	-	-	-
Betula sp.	-	-	-	-	-	-	-	-	1	-	-	-
Corylus avellana L. (frags)	+(c)	+(c)	+	+	+(c)	+	-	+	+	+	-	+
Calluna vulgaris (L) Hull (shoot tip)	-	-	-	-	-	-	+	-	-	-	-	-
Armeria [illegible] (calyx)	-	-	-	-	-	-	-	-	-	-	-	1
c.f. Anagallis arvensis L.	-	-	-	-	-	-	-	-	-	3	-	-
Menyanthes trifoliata L.	-	-	-	-	c.f.2	-	-	-	1	-	-	-
Hyoscyamus niger L.	-	1	-	-	1	1	-	6	-	-	-	13
Solanum nigrum L.	-	2	-	-	5	-	-	-	-	-	-	-
Mentha sp.	-	-	-	-	-	1	-	1	-	-	-	-
Prunella vulgaris (L)	-	-	-	-	-	-	1	-	3	4	2	-
Galeopsis tetrahit/speciosa	-	-	-	-	-	1	1	1	2	2	1	2

Labiatae indet.	1	1	-	-	-	-	1	5	-	8	6	-
c.f. *Plantago major* L.	-	-	-	-	-	-	2	-	-	-	-	-
Galium sp.	-	-	-	-	-	-	-	-	1	-	-	-
Sambucus nigra. L.	48	7	-	1	4	7	1	12	1	2	-	56
Valerianella cf. *dentata* (L) Poll.	-	-	-	-	-	-	-	-	-	1	-	-
Bidens cernua L.	-	-	-	-	-	-	-	-	10	-	-	-
Bidens tripartita L.	-	-	-	-	-	-	-	-	-	-	1	-
Senecio sp.	-	-	-	-	-	-	1	-	-	-	1	-
Anthemis cotula L.	-	-	-	-	-	2	39	-	25	38	12	54
Achillea millefolium L.	-	-	-	-	-	-	-	-	-	-	2	-
Arctium sp.	-	-	-	-	-	-	1	-	-	-	-	-
Cirsium sp.	-	-	-	-	-	-	-	-	1	-	2	-
c.f. *Onopordum acanthium* L.	-	-	-	-	-	-	-	-	-	-	-	1
Centaurea cyanus L.	-	-	-	-	-	-	5	-	-	-	-	-
Lapsana communis L.	-	c.f.1	-	-	-	-	-	-	1	2	5	-
Sonchus arvensis L.	-	-	-	-	-	-	2	-	-	-	c.f.1	-
Sonchus oleraceus L.	-	-	-	-	-	-	-	-	1	-	2	-
Sonchus asper (L) Hill.	-	-	-	-	-	-	-	-	-	-	2	-
c.f. *Hieracium* sp.	-	-	-	-	-	-	-	-	6	-	-	-
Compositae indet.	-	-	-	-	-	-	-	3	-	4	3	2
Alismataceae indet.	-	-	-	-	-	-	-	-	1	-	2	2
Triglochin maritima L.	-	-	-	-	-	-	1	-	1	-	2	1
Potamogeton c.f. *perfoliatus* L.	-	-	-	-	-	1	-	-	-	-	4	34
Potamogeton sp.	-	-	-	-	-	-	-	-	1	-	-	1
Zannichellia palustris L.	-	-	-	-	-	1	-	3	5	3	34	34
Juncus spp.	+	+	+	-	-	+	+	+	+	+	+	+
Iris pseudacorus L.	-	-	-	-	-	-	1	-	-	-	-	-
Typha sp.	-	-	-	-	-	-	-	-	-	3	3	-
Eleocharis sp.	-	1	-	-	38	-	29	3	13	6	3	12

Scirpus sp.	-	-	-	-	3	-	-	-	-	-	1	-
Cyperaceae indet.	-	1	-	-	-	-	1	-	-	-	1	-
Cereal indet. (c)	1	2	-	-	-	-	-	-	-	-	-	-
Triticum aestivum s.l. (c)	-	-	-	-	-	-	-	1	-	-	-	-
Hordeum sp. (c)	14	-	-	-	1	-	-	-	1	-	-	-
Avena sp. (c)	2	-	-	-	1	-	-	-	-	-	-	-
Secale cereale (c)	-	1	-	-	-	-	-	-	-	-	-	-
c.f. *Secale cereale* (rachis frags)	-	-	-	-	-	-	-	-	-	-	1	-
Avena sp.	-	-	-	-	-	-	4+cf.3	-	-	-	-	-
Gramineae indet.	1(c)	-	-	-	2(c)	3	78	-	31	16	25	-
Gramineae indet. (culm frags)	-	-	-	-	-	+	++	-	+	-	-	+
Vitis vinifera L.	-	1(c)	1	-	-	-	-	-	-	-	-	-
Indet.	4	2(c) +2	9	4	15	8	9	8	29	15	15	15
Sample weight (Kg.)	2	1	1	1	1	1	1	2	3	1	1	3

Table : Plant macrofossils recovered from samples in the laboratory
All taxa represented by fruits or seeds unless otherwise indicated.

* not completely sorted + present ++ abundant (c) charred. fr fragments.

		Context No.	60	55	67	68	52	52	75	75	84	86	86	74
		Machine flotation sample no.	1	2	4	5+6	7	8	9	10	11	12	13	14
Cereals		*Triticum aestivum* s.l.	-	-	-	-	-	1	-	-	-	-	-	-
Cereals		*Hordeum* sp.	1	1(median)	3(median)	-	-	2(median)	-	-	1(lateral)	-	1	1(germn.)
Cereals		*Avena sativa*	-	-	-	-	-	-	-	-	-	-	-	-
Cereals		*Avena* sp.	-	1	-	-	-	-	-	-	2	1	-	-
	Bean	*Vicia faba* var *minor*	-	-	-	-	-	-	-	1	-	-	-	-
Succulent fruits		*Prunus avium*-type	-	-	-	-	1	-	-	1	1	-	3	-
Succulent fruits		*Prunus spinosa*	1	1	1	-	-	7+fr	3+fr	}	}	}	}	-
Succulent fruits		*Prunus domestica* s.l.	-	1	-	-	}15	-	1	}14+fr	}577+fr	}249 +fr	}305 +fr	-
Succulent fruits		*Prunus* sp.	-	-	2	5+fr }	}	-	-	}	}	}	}	-
Succulent fruits		*Crataegus monogyna*	-	-	-	-	-	-	-	-	-	-	-	-
Succulent fruits		*Rubus fruticosus*	5	9	12	8	-	-	2	13	67	54	88	-
Succulent fruits		*Rubus* c.f. *idaeus*	-	-	-	-	-	-	-	3	12	-	7	-
Succulent fruits		*Sambucus nigra*	3	-	1	-	-	-	-	8	-	3	-	-
Nuts		*Corylus avellana*	-	+	+	+	+	+	+	+	-	+	+	+
Nuts		*Juglans regia*	-	-	-	-	-	-	-	-	-	-	+	-
	Hemp	*Cannabis sativa*	-	-	3	-	-	-	-	-	-	1	-	-
	Hop	*Humulus lupulus*	1	-	-	-	-	-	-	1	-	-	6	-
	Marigold	*Calendula officinalis*	-	-	-	-	-	-	-	-	-	-	1	-
	Parsnip	*Pastinaca sativa*	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: Fruits and seeds recovered by machine flotation

fr - fragments

germn - germinated

52	75	75	84	86	86	74	82	92	93	113
8	9	10	11	12	13	14	15	15	15	16
1	-	-	-	-	-	-	-	-	-	-
2(median)	-	-	1(lateral)	-	1	1(germn.)	-	1(germn)	-	-
-	-	-	-	-	-	-	-	1	-	-
-	-	-	2	1	-	-	-	1	1	-
-	-	1	-	-	-	-	-	-	-	-
-	-	1	1	-	3	-	-	6	1	-
7+fr	3+fr					-	-			
-	1	14+fr	577+fr	249 +fr	305 +fr	-	-	946+fr	23	70
-	-					-	-			
-	-	-	-	-	-	-	-	1	-	-
-	2	13	67	54	88	-	-	205	22	48
-	-	3	12	-	7	-	-	-	6	5
-	-	8	-	3	-	-	-	2	-	1
+	+	+	-	+	+	+	+	+	+	+
-	-	-	-	-	+	-	+	-	-	-
-	-	-	-	1	-	-	-	3	-	-
-	-	1	-	-	6	-	-	-	-	1
-	-	-	-	-	1	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	1

Caption to figure:

Fig : Prunus spinosa and Prunus domestica sensu lato

Scattergrams showing dimensions of 100 fruitstones from context 84. These were randomly selected from the specimens extracted by wet-sieving and measured after slow gentle drying. Note particularly large fruitstones of *P. domestica* subsp. *domestica* forming a distinct group on the basis of their thicknesses. Dimensions of *P. spinosa* cluster around length 7.5-10.0mm; breadth 6.0-8.0mm; thickness 4.5-6.5mm. The intermediate forms are of *Prunus domestica* subsp. *insititia*, and small varieties of subsp. *domestica*.

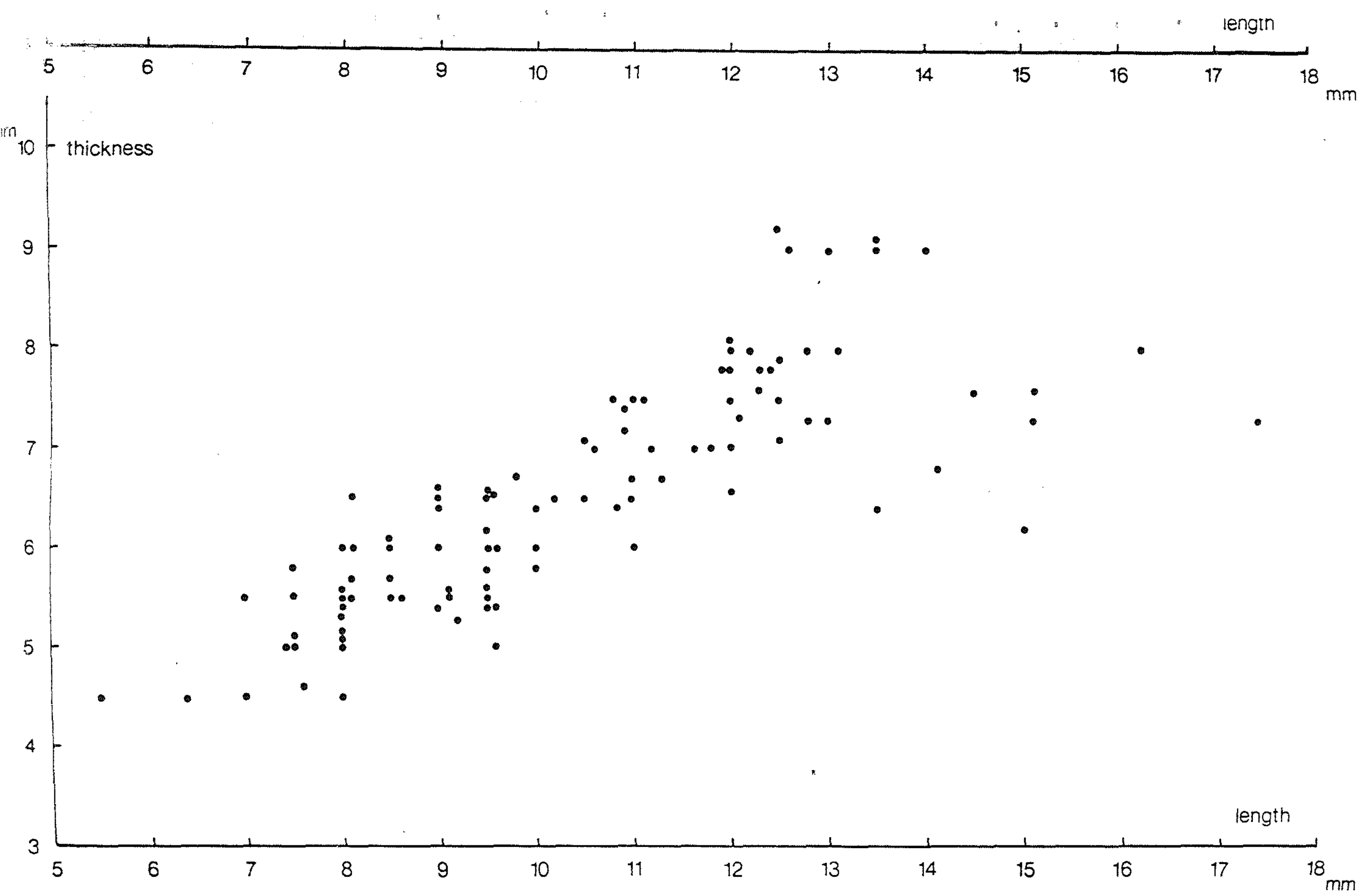
Caption to plates:

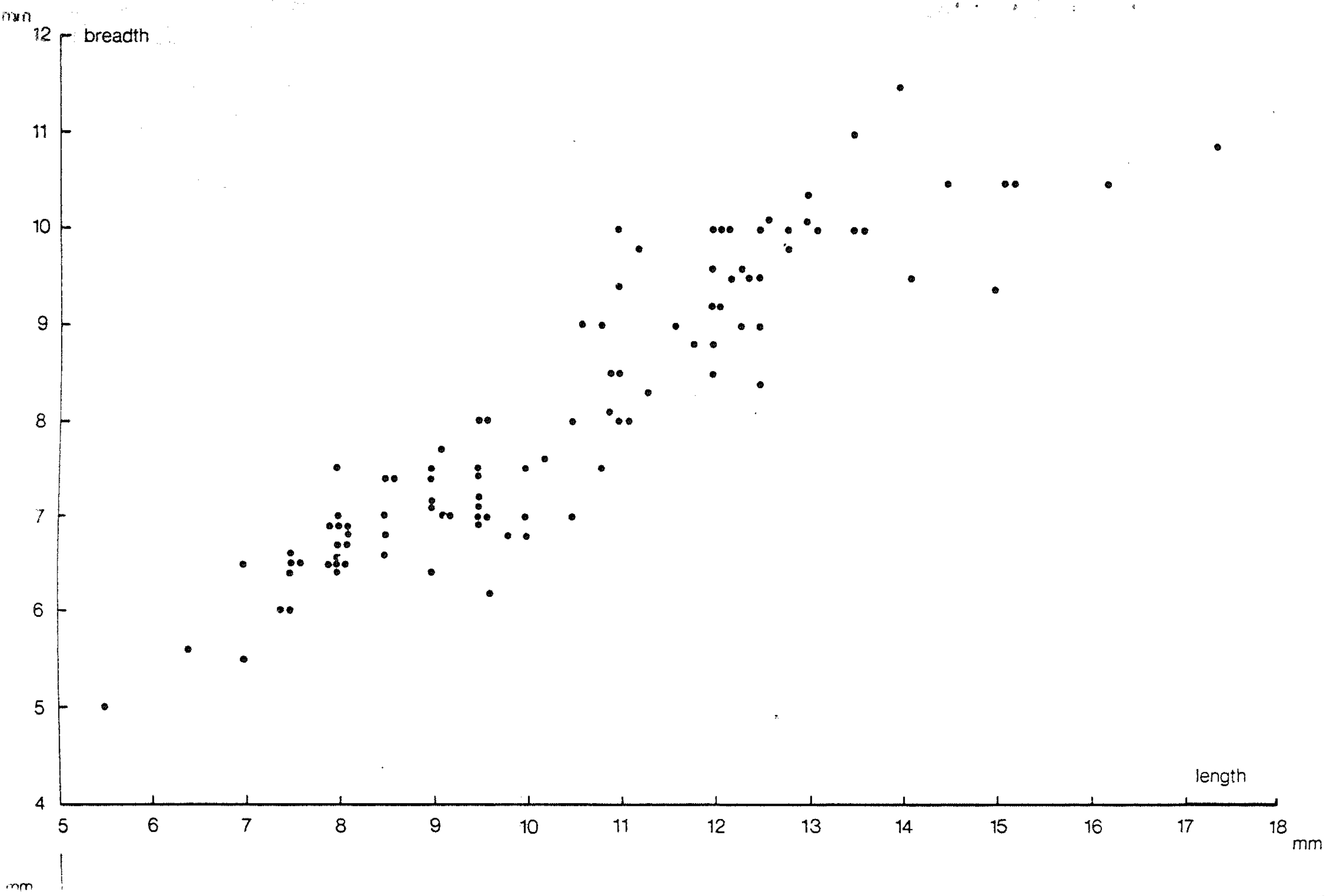
Plate 1 : Plant remains from Whitefriars.

a. *Juglans regia* (walnut). Endocarp fragment. 82
b, c. *Prunus* cf. *avium* (cherry). Fruitstones. 92
d. *Vicia faba* var. *minor* (horsebean) Charred seed (hilum at base) 75
e, f. *Prunus domestica* (plums) Fruitstones. 92
g. *Prunus spinosa* (sloe) Fruitstones 92

Plate 2 : Plant remains from Whitefriars

a. *Vitis vinifera* (grape). Seed. 74
b. *Linum usitatissimum* (flax). Seed. 98
c. *Calendula officinalis* (pot-marigold) fruit 86
d. *Cannabis sativa* (hemp) fruits 92
e. *Humulus lupulus* (hop) fruits 102


length
5 6 7 8 9 10 11 12 13 14 15 16 17 18
mm
thickness
mm
10
9
8
7
6
5
4
3
length
5 6 7 8 9 10 11 12 13 14 15 16 17 18
mm



mm
breadth
12
11
10
9
8
7
6
5
4
length
5
6
7
8
9
10
11
12
13
14
15
16
17
18
mm

Plants of economic importance

The charred cereals and pulses from the site comprise hulled and possibly naked barley, oats, bread/club wheat, rye and horse-bean. The rarity of charred rachis fragments is thought to indicate that the grains represent domestic food debris rather than crop processing waste. Uncharred oat caryopses were present in 92, a layer of litter, discussed further below.

Fruitstones and seeds of succulent fruits are common. Seeds of grape (*Vitis vinifera*) were recovered from 55 (Period III) and 74 (Period II). The latter gives the earliest post-Roman record of the grape in Norfolk, but need not necessarily be related to the beginnings of medieval viticulture in the Norwich area. Local cultivation would have been possible during the 'Little Climatic Optimum' of this period when mean summer temperatures were about 1°C higher than those of today (Evans 1975, 175) but the importation of dried fruits is equally likely. The *Prunus* fruitstones are mainly of sloe (*Prunus spinosa*), but large flat endocarps of cultivated plums (*Prunus domestica*) and intermediate forms comparable to stones of bullace and to small cultivated damsons are also present (see Fig). Cherry stones (probably *P.avium*) occur in small numbers. Fruitstones and seeds of wild species, notably strawberry and bramble, but also apple, hawthorn, raspberry and elderberry, were recovered from several deposits. The presence of these species in refuse layers suggests that some, or all, of them were consumed. Although negative evidence is necessarily suspect, the complete absence of fig achenes, (which are abundant and ubiquitous in later medieval deposits at Norwich), is of some interest. The earliest record of figs from the city comes from a 12th century well at 172N (31 Colegate), and it now appears that this may provide a date for the beginning of the importation of dried figs to the area.

Fragments of walnut (*Juglans regia*) came from three contexts (74, 82, 86: Period II), giving another earliest post-Roman record for the area. Hazel nut shell fragments (*Corylus avellana*) are, however, much more abundant and apparently formed a more significant part of the diet.

Seeds and fruits of the two main fibre crops, flax (*Linum usitatissimum*) and hemp (*Cannabis sativa*) were present in several samples. Pollen of *Cannabis* and *Linum* (*L. bienne*-type) occurred at relatively high frequencies in lake sediments thought to date from the Anglo-Saxon period at Old Buckenham Mere

Norfolk, implying that the cultivation of these crops was of some importance in early medieval East Anglia (Godwin 1968). Macroscopic remains of these plants from archaeological sites in the area are, however, relatively rare. Hemp fruits have not been identified before and flax is represented usually by small numbers of seeds, often individual specimens, for example from late Saxon deposits at Ipswich, 22 Wensum Street, Norwich, Anglia T.V. Extension, Norwich (all Murphy, forthcoming) and Great Yarmouth (Jones 1976). The only other site in East Anglia at which flax seeds have been recovered in quantity is the Middle Saxon settlement at Brandon (BRD 018), another riverside site (Murphy, forthcoming). According to Percival (1918, 397), flax grown for its bast fibres is often, but not invariably, harvested before the seed is fully ripe. After drying, the capsules and roots are removed and the stems subjected to controlled decomposition - 'retting' - before 'breaking' and 'scutching' to release the fibres. The retting has often been done by submerging bundles of stems in rivers. Bast fibres from stems of hemp are separated by a similar method. The initial processes clearly provide opportunities for the incorporation of flax and hemp seeds, ripe or unripe, in riverside deposits. Although no capsules or stem fragments were observed at Whitefriars, the unusual frequencies of flax and hemp seeds at this riverside site provide some grounds for suggesting that fibre crops were being processed in the vicinity. This would, incidentally, provide a possible explanation for the function of some of the stakes and posts at the site: to tether the submerged bundles of stems (p.).

Fruits of hop (Humulus lupulus) occurred in 11 samples. The hop is often common in alder carr in East Norfolk (Tansley 1953, 660), and pollen records [illegible]. Cultivation of the crop in this country is not thought to have been widespread before the early 16th century, but there are documentary records of imports for brewing before this date. The early medieval boat from Graveney contained large numbers of hop fruits, which [illegible] the remains of an imported cargo ([illegible]). The hops from Whitefriars may likewise be related to imports of the crop, but it is also possible that female inflorescences containing ripe fruits could have been gathered in nearby carr or carried to the site by the river.

Although many of the wild plants identified have traditionally been used as potherbs, more reliable evidence for the consumption of vegetables and herbs is provided by ~~seeds~~ fruits of only four species: Apium graveolens (celery), Pastinaca sativa (parsnip), c.f. Anethum graveolens (dill?) and Calendula officinalis (pot marigold). Apium is common in marshes near the sea and along brackish ditches (Petch and Swann 1968, 161), but the large numbers of fruits from refuse deposits at this site suggest that cultivated celery is represented. The few fruits of Pastinaca may likewise be from a cultivated parsnip since the wild species is most common on chalk soils and in the Breckland (Petch and Swann 1968, 163). The possible dill fruits are poorly preserved and have not been definitely identified. The achene of Calendula is of particular interest, providing an early record of a species not indigenous to Britain. It has been reported from Sewer Lane, Hull in late medieval contexts, and its history is fully discussed by Williams (1977, 19), who notes that 'goldeworte' or 'Calendula' is mentioned in Anglo-Saxon Leech books. The specimen from Whitefriars provides definite evidence for its presence in pre-Conquest Norwich, though the achene is poorly developed and may perhaps represent an accidental escape rather than intentional cultivation.

The seeds of opium poppy from 102 and 113 may, again, represent accidental importation; the species is nowadays an established alien. However, opium preparations made from the unripe capsules have been used in East Anglia to alleviate ague (malaria); in the 19th century Fenland for example, opium-chewing was common (Godwin 1978, 156). The seeds are commonly used for flavouring.

Wild Plants

The deposits at the site contained seeds representing several distinct plant communities. Not all of these would have been present locally; seeds have clearly been imported to the site both by human activity and also by the river from further upstream.

Seeds of ~~halophytes~~ coastal plants including Suaeda maritima (herbaceous seablite), Armeria [illegible] and Triglochin maritima (sea arrow grass) occur sporadically. Salt-marsh was certainly not present this far upstream; nor, since halophytic diatoms are absent (see ~~below~~ above), is it probable that these seeds were brought to the site on tidal surges. It thus appears that the seeds were imported by some human activity. A possibility is that they arrived on the hooves or in the guts of stock fattened on salt-marsh or sea-meadow before transportation by river to Norwich for slaughter. Darby (1934, 5, 43) has inferred that conditions on former intertidal mud flats and marsh in the lower part of the Yare valley were dry enough to provide grazing for sheep at the time of the Domesday survey.

The group of freshwater aquatics includes Chara sp. (stonewort), Ranunculus subgenus Batrachium (crowfoot), c.f. Myriophyllum sp. (milfoil?), Alismataceae (water plaintain family), Potamogeton c.f. perfoliatus (perfoliate pondweed) and Zannichellia palustris (horned pondweed). Nowadays dense beds of water crowfoot are characteristic of the upper reaches of the Wensum around Fakenham, whilst pondweeds (P.crispus and P.perfoliatus) predominate in the middle and lower reaches (Wortley 1976). The aquatic flora would certainly have been better developed before ~~human~~ recent modification of water flow and quality.

Many of the seeds of wetland plants must have been transported to the site by the river or by artificial means. This, together with the fact that some species occur in several types of wetland community, makes the detailed reconstruction of vegetation-types difficult. However, seeds of species common in reedswamp and carr are not abundant and the majority of the wetland plants represented could occur in wet meadows and other open riparian habitats. The commonest wetland taxa in the Whitefriars deposits are Eleocharis sp. (probably E. palustris), species of Carex, Polygonum hydropiper (in 100) and Urtica dioica. These plants probably grew in the immediate area as part of a relatively shade-free, disturbed type of wetland vegetation.

Reedswamp was present further upstream, however; peat deposits underlying the late Saxon causeway at 171N (22 Wensum Street) contained abundant *Phragmites* culm nodes, with fruits and seeds of sedges, rushes and *Typha*, as well as seeds of segetals and flax. (Murphy, forthcoming).

Dry soils developed on fluvial and glacial gravels above the river would have provided suitable conditions for a small group of species including *Dianthus* c.f.*armeria*, *Stellaria* c.f.*graminea*, *Aphanes* spp, *Rumex acetosella*, *Calluna vulgaris* and *Achillea millefolium*. *D.armeria* is nowadays a rare plant most frequently found in hedgerows and dry pastures on light sandy soils (Clapham, Tutin and Warburg 1968, 100; Petch and Swann 1976, 116).

The majority of the fruits and seeds of scrub and woodland plants are of edible types: bramble, raspberry, sloe, bullace, hawthorn, apple, elderberry and hazel. These may represent seasonal gathering, perhaps from some distance. Both leaves and fruitstones (as well as twigs, see below) of holly (*Ilex aquifolium*) were recovered from 100. The single *Betula* (birch) fruit could have been wind-transported.

The ruderals and segetals are mainly species common at medieval urban sites, and do not require detailed consideration. It is interesting, however, to note that two of the three deposits producing *Thlaspi arvense* also contained flax seeds; *T.arvense* is a common weed of flax (Hjelmqvist 1950).

Composition of the assemblages

The assemblages exhibit variations in species composition which can in some cases be related to processes of formation.

The lowermost deposits examined (88, 98, 114: period I) were generally very dark greyish-brown (10YR 3/2) sands and gravels including some wood and other organic debris; essentially they are natural river sediments. 114 included a significant proportion (20.2% numerically) of seeds of aquatics (mainly Ranunculus subgenus Batrachium, P.perfoliatus, and Zannichellia), confirming the fluvial origin of the deposit. 88 and 98 contained assemblages in which Urtica dioica was the most abundant species, probably derived from riparian vegetation. Human activity in the area during the formation of these deposits is indicated by seeds of segetals (eg. A.githago, S.arvensis, P.convolvulus, A.cotula etc.), and by the presence of flax seeds in all three deposits. 114 included the three halophytes discussed above.

92 was a dark brown (7.5YR 3/2) very compacted organic deposit consisting largely of laminated crushed and fragmentary grass culm. It included seeds of several species found in reed-beds (eg. Filipendula ulmaria, Iris pseudacorus), as well as oat (Avena) caryopses and cereal weeds (eg. Anthemis cotula, Centaurea cyanus) and a small fragment of heather (Calluna vulgaris). The deposit probably represents discarded flooring material or litter including reeds, oat straw and heather.

The remaining deposits are very mixed in character and can only be interpreted in general terms. Most appear to consist of domestic refuse, including the remains of food plants, upon which transient ruderal and disturbed wetland vegetation developed. Seeds of aquatic plants are present in small numbers and may have been deposited during flooding episodes or after transportation on fishing nets, footwear etc. The uppermost deposits examined (46 and 55 from Period III), contain no aquatics and only a few Carex and Eleocharis nutlets. Carbonised cereals and other food plants are common in these deposits as are seeds of Sambucus nigra and Urtica dioica. These are typical urban refuse assemblages, apparently formed in moist or wet conditions. The absence of aquatics suggests that there was little or no flooding at this stage.

Prospects for future work

The botanical remains identified at this site have produced a provisional list of cultivated plants, and provide information about wild plant communities and the origins of certain deposits. Further work on similar types of deposit at future sites is unlikely to produce significantly more information, through it is possible that at other sites within the Late Saxon commercial centre a different set of activities involving different crop plants was taking place. There is, however, a greater chance of detecting such variations between sites if a wider range of contexts can be examined. Those sampled at Whitefriars - primarily river deposits and tipped layers of refuse - are 'open contexts', steadily accumulating, into which seeds from many sources may be incorporated. Consequently the seed assemblages are very mixed and generally are not easily interpretable in terms of the processing and utilisation of plant material. Hence it will be important to examine 'closed contexts' such as refuse pits, cess pits, hearths/ovens, floor deposits etc. which may be expected to contain plant remains produced by one activity, or at least by a restricted range of activities. If the 1981 excavations the 'Magistrates Courts' produce an adequately wide range of context-types for sampling it should be possible to produce a much more detailed picture of the plant economy of the settlement.

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Wood

by Jennifer Hillam and Peter Murphy

Large timbers were sent to the Sheffield Dendrochronology Laboratory for tree-ring analysis. The remaining wood collected at the site was examined and identified in Norwich.

All the timbers sent for tree-ring analysis were oak (Quercus sp.). Some were radially-split sections of wood, eg 99 A, and others were halved trunks, eg 34 B. Occasionally, whole trunks had been used, eg 34 C, whilst 30/3 was a tangentially-split plank.

The four timbers from 34, plus 30/3 came from young trees which must have been 40-50 years old or less when felled. These had wide annual rings (3-5mm), suggesting that the trees had grown under favourable conditions in a fairly open environment. The timbers from the lower layers, on the other hand, were narrow-ringed (widths less than 1mm). The outer rings of 78 B, for example, were so narrow that they could not be measured with any accuracy: the last c 88 rings had an average width of only 0.2-0.3mm. The trees producing these lower timbers therefore must have grown under less favourable conditions, probably with much shading from other trees. They were longer-lived than the upper timbers: 99 A and 78 B were 100-150 years old when felled, whilst 49 was probably as old as 300 years. (53 was also very old, but knots in the cross-section made it impossible to determine the exact age.)

Tree-ring analysis produced no positive results, most of the samples being unsuitable for measurement. The ring widths of [99] A, [78] B and [49] were measured and compared with dated reference chronologies covering the 10th-12th centuries. No acceptable cross-matching was found, even for [49] which had a ring sequence of 244 years and appeared ideally suited for tree-ring work. A similar situation occurred when medieval oak timbers from Cecelia Street in Ipswich were examined: no crossmatching was possible. East Anglia seems to be a problem as far as the tree-ring dating of medieval timbers is concerned. However, Saxon timbers from Mersea Strood near Colchester have recently been absolutely-dated so that the use of dendrochronology for East Anglian timbers cannot yet be ruled out.

(continued). – new paragraph.

The remaining wood from the site consisted of twigs, branches and timbers of several species. In general, the larger pieces were well-preserved, though some were strongly compressed. The twigs collected from the layers of brushwood were not identified, since many were badly crushed or partly decayed and the remaining specimens showed only a few growth rings in which characteristic features used in identification were not always well-developed. Some of the wood samples contained vivianite and orange-brown iron oxides in vessels and cracks.

The wood identified is listed in Table . The material falls into three main groups:

1. Mature oak timber. This occurs mainly in the form of stakes, produced by radial splitting, but pieces of ill-defined shape are also present.
2. Poles and stakes made from straight, untrimmed young growth of oak, ash, hazel, holly, willow, willow/poplar and *Prunus* sp.
3. Branch fragments of willow/poplar.

The second group is perhaps the most interesting. Young straight growth of fairly uniform size (here generally 2.5-3.5 cm) has traditionally been produced by systems of woodland management from coppice, pollards or suckers. It seems probable that by the 10th/11th centuries management of local woodland would have been necessary to meet the demands of the settlement for wood and timber. There are references to pollarding at this period in Anglo-Saxon charters (Rackham 1976, 53).

Which of these trees were growing in the immediate vicinity and which were imported from further afield cannot be determined directly, though it should be noted that holly is represented at the site not only by wood but also by leaves and fruitstones. Nuts and fruitstones of hazel and *Prunus* spp. have also been identified.

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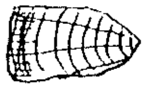
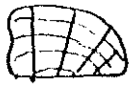
NORWICH: WHITEFRIARS CAR PARK SITE

Description of timbers - all oak (*Quercus* sp.)

No.	No. of rings	Sapwood	Average width(mm)	Sketch (not to scale)	Dimensions (cm)
*99A	79+	19+	1.48		13 x 3-
*78B	49+	bark	0.76		12 x 9 radius 8-9
53	-	-	-		33 x 25
*49	244	-	0.92		33 x 30
34A	15	-	-		11 x 8
34B	12	-	-		13 x 6-
34C	29	13	-		radius 8-1
34D	9	-	-		12 x 4-
30△3	37	12	-		23-26 x 7-8

* - samples of which the ring widths were measured. The complete ring sequence of 49 was measured. 99A had c 20 very narrow rings which could not be measured accurately and 78B had another c 88 (average width 0.2-0.3mm). Bark was present on both 99 and 78. 53 was very knotty, which obscured the ring sequence.

Table : Wood

* indicates specimens apparently mis-labelled on site.

Context	Taxon	Timber/Young wood	Diameter (young wood only
30	Indet. diffuse porous	Y	3.3cm
51	*Quercus* sp.	T	-
54	*Quercus* sp.	T	-
62	*Quercus* sp.	T	-
63/4*	*Quercus* sp.	T	-
66WA	Indet. d.p.	Y	frag.
66WC	Indet. d.p.	Y	frag.
66WD	*Salix/Populus* sp.	Y	11cm
66 24	*Prunus* sp.	Y (branched)	2-3cm
69	*Quercus* sp.	T	-
78A	*Quercus* sp.	T	-
85a	*Corylus* sp.	Y	2.5cm
85A	*Corylus* sp.	Y	2.5cm
85C*	*Fraxinus* sp.	Y	3cm
85C*	Indet. d.p.	Y	2.5cm
85D	*Salix/Populus* sp.		frag.
85E	*Salix* sp.	Y	2.5cm
85F	Indet. d.p.	Y	3.5cm
85G	Indet. d.p.	Y	6cm
85H	*Salix* sp.	Y	5cm
90	*Quercus* sp.	T	-
94	*Quercus* sp.	T	-
97	*Quercus* sp.	T	-
99BCDE	*Quercus* sp.	T	-
101A	*Salix/Populus* sp.	Y (branched)	5x1.7cm (flattened)
101B	*Corylus* sp.	Y	2.5x1cm (flattened)
101D	*Salix* sp. (?)	Y	4x1.5cm (flattened)
103	*Quercus* sp.	T	-
105a	*Ilex* sp.	Y	3cm
105b	*Corylus* sp.	Y	3cm
107	*Quercus* sp.	Y	3.5cm
113	*Quercus* sp.	T	-

Soil Report on Whitefriars, Norwich (421N)

25.11.80

R.I. Macphail

During 1979, Saxon to Medieval deposits were excavated by the Norfolk Archaeological Unit (Field Officer, B.S. Ayers) south of the River Wensum, Whitefriars, Norwich, to ascertain the nature of settlement in the Saxon and early Mediveal periods along this waterfront site.

A box-monolith was received containing a sample from Periods III and IV relating to the late 11th - early 12th century onward. As this was an anthropogenic deposit was treated in the same way as "Dark Earth" samples had been investigated previously. (See Ancient Monument Lab. Reports Nos. 3055, 3057, 3059, 3060 and 3061). It was tested for alkali soluble humus, loss on ignition and pH. Additionally , thin sections were manufactured from level 30 to study in detail features of this wet anthropogenic deposit, as the dark colour of the material tends to obscure most pedogenic characteristics.

Results

The layers examined, namely, 51, 46, 30 and 27 have a uniform, neutral pH. (See Analytical Data). Alkali soluble humus decreased from levels 51 and 46 to levels 30 and 27, perhaps through the oxidation of material in the upper part. Loss on ignition, strangely increases in level 27, although washing for inclusions revealed far more charcoal in the underlying level 30. Mixed with the silt and sands, inclusions included pot fragments, mortar, plant remains, carbonised wheat grains, charcoal, a variety of bone and fish bone, slag, shell, one struck prehistoric flint, and Bryzoa.

Three thin sections of level 30 were scrutinised. They revealed the relatively organic character of this deposit. The fabric is generally agglomeroplasmic in character (See Micromorphology) in that soil material is clustered as fine peds between large skeletal grains. The latter comprise quartz grains, shell fragments charcoal, and a variety of plant material.

Most of soil matrix contains high proportions of organic matter, probably including fine charcoal, which together with the organic matter leads to the deposit having a dark colour. Skeletal grains reflect the variation in dumped material, as noted in the inclusions earlier, and this includes plant material. The preservation of recognisable plant material, but more pertinently of amorphous organic matter clearly suggests the effects of anaerobism. This accounts for the lack of faunal mixing or droppings, but nevertheless poor pollen preservation (R.G. Scaife, pers. com.) and well structured peds, channels and metavughs suggests wetting and drying, and the movement of soil water. A high pH and any oxygenation would accelerate pollen destruction by microfauna, and obviously the upper deposits seem to have been oxidised to some extent.

The amorphous organic matter, the probable presence of vivianite, and the occurrence of parasite eggs in this level (R.G. Scaife, pers. com.) suggest that some of the input into this deposit may be cess, as described from similar urban environments, as at York.

In comparison to probable Late Roman "Dark Earth" from London, which has already been studied in thin sections (Macphail, 1980), the anthropogenic deposits at Whitefriars differ by being far more organic, with a uniform soil fabric. This relates to the absence of earthworms reworking the soil, as in London, where there is the loss of much organic matter due to oxidation. Nevertheless the variety of inclusions in both the "Dark Earth" of London and the deposit at Whitefriars is illustrative of soil formation in dumped material; although at Norwich inwash may also have supplied additional matter. The deposits at Whitefriars are thus acting as a wet base-rich Bg horizon, while in contrast "Dark Earth" can be described as a dried-out base rich B horizon. In summary, the deposit at Whitefriars seems to be very heterogenous, and is mainly comprised of dumped material although inwashed material may well be included. Its wet character has preserved much organic matter, which may be in part derived from cess.

Analytical Data

Layer	pH	Alk. Sol, Humus	% Loss on Ignition
27	6.8	88.0	8.5
30	6.8	105.0	6.9
46	6.8	202.0	7.6
51	6.8	152.0	6.9

N.B. Alk. Sol. Humus. mgms. per 100 gms. air dry soil

Refs. Macphail, R.I. 1980 Soil and botanical studies of the "Dark Earth". BAR (Forthcoming)

Micromorphology, level 30, Whitefriars, Norwich (421N)

The fabric is mainly agglomeroplasmic, porphyroshelic in part, unorientated, with rather diffuse boundaries, and contains well devloped fine channels and metavughs, without cutans. Skeletal material is very diverse, and comprises mainly sub-rounded silts and fine and medium quartz sand, with feldspar and oolites also common. Coarse sand to fine gravel-sized aragonite (shell) fragments are present. Nonmineral skeletal material includes charcoal fragments and more commonly recogniseable plant remains (See Percentage Fabric Analysis below). Plant material is generally black under Plane Polarised Light (PPL), but may be dark reddish brown. It is non-birefringent, and black under Reflected Light (R. L.). In many cases cell material is visible. One coarse dendriform rod phytolith is present.

Amorphous organic matter is also present, and may be included within peds or act as a loose void-fill. This material is pale brown (PPL) with a finely granular texture under high power. In one slide amorphous organic matter is associated with crystal filaments, which are thin, pleochroic (pale blue to colourless - PPL), with strong birefringence and parallel extinction. This is likely to be the phosphate mineral, vivianite, as noted by the excavators in the underlying level 46.

The fine fabric of the peds is generally dark brown to black (PPL), non-birefringent (ie. opaque under Crossed Polarised light), and dark grey to black (R. L.). This suggests fines, clay and fine silt are complexed with high amounts of organic material, as described above. Also the high proportions of charcoal present in washed samples is also indicative of this material also being important in the peds. These large quantities of organic matter, including fine charcoal, are likely to give these deposits their dark colour - a suggestion already proposed for the "Dark Earth" of dry urban sites (Macphail 1980).

The deposit contains very few glaebules; ferri-manganic bodies, and as soil ignition indicated very low iron content, this may well relate to a waterlogged history. A high organic content would also sustain anaerobic conditions, again preserving the organic matter itself. In this sense evidence of soil fauna is not surprisingly missing.

Percentage Fabric Analysis (Semi-Quantitative)

Pore Space	31%
Mineral Grain	35%
Amorphous Organic Matter /Soil Complex	32%
Charcoal	0. 5%
Amorphous Organic Matter	2%
Plant Material	13%

The Environmental Evidence : A general discussion

by Peter Murphy

The purpose of this concluding discussion is to provide the general archaeological reader with an outline account of the environment of the site and of the types of human activity represented. These activities may broadly be divided into three groups: the importation and use of agricultural produce, the exploitation of marine resources, and the modification and exploitation of local habitats.

The samples of large mammal bone and crop plant remains recovered at Whitefriars are the products of a set of activities and processes specific to this site. Only further excavation and research can establish whether this material is truly representative of the complete range of agricultural procedure entering the Late Saxon town. Nor is it known how extensive an area was supplying the city with foodstuffs and other raw materials. It follows that the interpretation of this material must at present be in terms of this particular site rather than the complete economy of the city and still less the agriculture of the region.

Some problems in the interpretation of the bone data have been discussed above, but the available evidence is thought to indicate that the bulk of the bone is food refuse, with cattle providing the most meat overall followed by caprovines whilst pigs contributed a relatively small amount. Bones of horse are rare, and horseflesh may not have been consumed. There are, however, changes in the composition of the bone assemblages between successive site periods. In particular cattle bone fragments predominate in periods 1, 3 and 4, whilst in deposits attributed to period 2 (when activity on the waterfront was at its most intensive), caprovine bone fragments are most abundant. Furthermore, there is a change in emphasis of bone types, so that whilst in period 1 a large proportion of the cattle and caprovine bone consists of waste material (skull bones and metapodials) by period 4 this proportion had been much reduced. It is thought that this reflects a change from the deposition of butchery waste to that of domestic waste related to the shift of the commercial centre of the town from the Whitefriars (Tombland area in later periods. Avian bones make up a minor, but significant, component of the samples, but have not, as yet, been assigned to species.

The plant macrofossils recovered give a minimum range of cultivated plant foodstuffs available, including cereals (barley, oats, bread/club wheat, rye) pulses (horsebean), succulent fruits (grape, plums, cherries) nuts (walnut, hazel-nut) flavourings (hop, dill (?), opium poppy) vegetables and pot-herbs (celery, parsnip, pot marigold). It cannot be determined on the present evidence whether the more exotic species were cultivated locally or were imported. However, it is remarkable that almost all the crops known from later medieval contexts at Norwich (with the principle exception of figs) occur in the deposits of period I and II, an indication of the innovative character of late Saxon agriculture and trade. The composition of the seed assemblages recovered suggests that these deposits include spillage from fully processed crops and domestic food refuse, rather than crop processing waste. However, the types of 'open' context available for investigation at this site rarely produce useful information about the utilisation and processing of crop plants but rather a bare species list. A priority in the 1981 excavations must, therefore, be to study a wider range of contexts related to specific types of activity.

After foodstuffs, one of the most important of agricultural products was fibre for use in textile and rope production. Remains of both flax and hemp have been identified and the relative abundance of seeds of these two species has been interpreted as indicating local processing of fibre crops, in period 1. At present the importance of wool production is unclear. However, more detailed studies of the age structure of the sheep populations represented by bones at the site may be expected to indicate more clearly whether the emphasis in sheep-rearing was on meat or wool; at present the evidence seems to indicate that meat production was a priority.

Marine resources clearly provided a significant proportion of the animal protein consumed at the site. The interpretation of the fishbone is subject to problems similar to those restricting interpretation of the mammal bone and food plant remains, in that the samples are of unknown and probably diverse origin, and may well not be representative of fish consumption in the town as a whole. In these particular deposits cod, whiting and herring are most abundant with lesser amounts of cartilagenous fish, eel and flatfish (plaice and flounder) and some mackerel, horse mackerel and bass. All these taxa are known from contemporary deposits at Great Yarmouth.

Large quantities of marine mollusc shell were present at Whitefriars, some layers (eg 82) consisting almost entirely of crushed shell. The species composition of the mollusc sample is thought to indicate specialised shellfish exploitation of estuarine mussel and oyster beds in the Breydon Water area, in contrast to diversified shellfish exploitation at Yarmouth.

Quantitative assessment of the contribution to diet by shellfish was not possible due to shell fragmentation, but, given suitable deposits of material, will be attempted in 1981. Studies of the epifauna of the shells has not produced useful habitat information due to the wide ecological tolerances of the taxa present, but will also be pursued further in 1981.

A further 'marine' resource thought to have been of importance by the time of the Domesday Survey, if not before, was grazing marsh on the former intertidal mudflats and salt marsh in the lower part of the Yare Valley. Indisputable evidence for the use of such pasture is unlikely to be obtained at an urban site of this type; but the few seeds of coastal plants recovered are plausibly, though tentatively, interpreted as having been imported to the site on the hooves or in the guts of stock pastured in such areas.

The development of Norwich inevtiably resulted in the modification of local habitats, some changes simply being accidental side-effects of human activity, whilst others resulted from deliberate attempts to increase the production of necessary commodities or to alter conditions to human advantage in other ways. At Whitefriars, attention naturally centres on the river. In the Late Saxon period two main forms of modification may be expected to have occurred: pollution by organic matter, and the alteration of river flow.

From the nature of the riverside deposits and the biological remains which they contain it is clear that organic refuse was being dumped along the river bank; and there is no doubt that the amounts of phosphates and nitrates reaching the river in solution as run-off and from stock-yards, slaughterhouses and sewage would have increased with the development of the city. However, palaeolimnological studies at Strumpshaw Broad, on the Yare downstream from Norwich have shown that nutrient inputs to the river and adjacent bodies of water were relatively low before 1800 (Moss 1980, 287) and it therefore seems improbable that effluents from the early medieval town would have had significant effects on water quality. Indeed, the remains of a diverse aquatic flora and fauna from the river sediments at Whitefriars show that at this early period the influx of pure water was sufficient to prevent any general de-oxygenation resulting from this localised pollution.

As has been noted above (p) there is reason to believe that a pre-Conquest bridge existed at Whitefriars. The known late Saxon causeway upstream at Fye Bridge was built of piles with a central gap of less than 2m (Hudson 1898) and any contemporary bridge at Whitefriars may well have been built in a similar way. Besides the potentially disastrous effects after heavy rain of such constructions, there would obviously have been effects on mean current speeds and hence on aquatic plant and animal communities. By analogy with modern dams, weirs and bridges in the area one would expect tranquil slow-flowing water upstream of such a barrier, containing a well-developed vegetation of aquatic macrophytes, in turn providing substrates for many invertebrates and epiphytes; whilst current speeds of more than 60cm per second producing a non-silted bed with sparser vegetation and more restricted faunas would occur downstream (Wortley 1976).

In interpreting the remains of aquatic organisms from the river sediments the possibility of such artificial modification must be borne in mind. Interpretation is further complicated by the fact that the assemblages of biological remains will contain an allochthonous component, although the high proportion of intact diatom frustules and the presence of paired Pisidium valves seems to suggest that transportation may not be a major problem. In summary, the biological remains do suggest deposition in a tranquil environment. The river sediments contained an indigenous mud flora of diatoms together with some frustules derived from nearby solid submerged substrates and a very small planktonic component. The fruits and seeds of aquatic macrophytes include a relatively wide range of taxa indicating a diverse flora of the type characteristic of the slow-flowing middle and lower reaches of East Anglian rivers. These higher plants provided substrates for freshwater snails, predominantly 'ditch' and 'moving-water species'; but shells of species such as Ancylus fluviatilis indicating swifter current-flow were not observed. This range of organisms would be consistent with the type of community to be expected just upstream from a bridge, but equally could occur in other circumstances. It will be interesting to see whether the organic remains from comparable contemporary riverside sediments at the 1981 excavations downstream from the bridge will be similar or whether any indications of increased flow-rates can be detected.

Although some of the bones of freshwater fish may be derived from moribund animals stranded at high tide or after floods the majority of the material is thought to be food refuse, and thus provides [illegible] the exploitation of freshwater fisheries. Pike, eel, Cyprinids (carp family) and Salmonids (possibly trout) have been identified, but in the samples from this site bones of marine fish was much more abundant.

Remains of aquatic organisms were most abundant and best-preserved in the deposits of periods I and II, which clearly consisted of natural and semi-natural river deposits or layers of shell, brushwood or refuse incorporating some sediment of fluvial origin. The source of the uniformly dark deposits of periods III and IV was initially much less obvious: it was unclear during excavation whether these deposits were dumped material or whether they included a significant component of flood loam. This distinction is clearly of importance for an understanding of the utilisation of the site in its later phases. Studies of soil micromorphology have shown that a typical deposit (30) was very heterogenous, probably consisting largely of dumped material perhaps with some inwashed sediment. The presence of amorphous organic matter and probably of vivianite, together with the occurrence of parasite eggs (Trichuris), is thought to indicate that the deposit was partly formed of cess. The algae from these upper layers include some diatom genera tolerant of extreme environmental conditions, such as occur in wet soils as well as many cysts of Chrysophyta. The high proportion of fragmented diatom frustules is thought to indicate mechanical disturbance. Taking into account the results of the soil investigation, the most probable of the alternative interpretations of the samples of algae suggested above is that these artificial deposits remained wet primarily by capillary action with occasional river flooding. The absence or rarity of seeds of aquatic plants and molluscs in the later deposits provides further grounds for thinking that though these deposits formed in damp or wet conditions they were rarely flooded. Thus, this accumulation of deposits is seen to result almost entirely from the dumping of material after the main phase of commercial activity at the site had ceased.

This dumping obviously resulted in a major change in the types of habitat present along the waterfront, but it appears that the natural wetland vegetation of the valley floor had already been largely obliterated at the site in periods I and II. Although peats containing macroscopic remains of Phragmites, Carex, Juncus and Typha, representing riverside reedswamp, are present beneath the late Saxon causeway crossing the river along the line of Wensum Street (171N), remains of reedswamp plants were rare at Whitefriars. This may be partly attributable to the use of reeds for thatching and litter, but disturbance resulting from the occupation of the site was probably a more significant factor in the long term.

Most of the biological remains so far discussed are derived from local habitats. Samples from 90, 74 and 30 were analysed for pollen in an attempt to provide information about regional vegetation. However, it appears that localised pollen input from herbaceous plant communities is of greater importance than regional input in all these samples. The range of ruderal taxa determined from pollen shows good correspondence with the species list of ruderals from macrofossils: such vegetation was clearly well-developed on disturbed ground in and around the site. Similarly, the pollen evidence conforms with macrofossil evidence in that wetland taxa are relatively poorly represented. The significance of the cereal-type pollen and pollen of cereal weeds is not easily assessed: local cereal cultivation could be indicated but equally these pollen-types could be derived from human faecal material, from animal feed or from the unloading of grain crops. The abundance of Gramineae pollen may likewise be interpreted as a regional input or a local anthropogenic effect. Cannabaceae pollen was present in samples from 90 and 74: both Cannabis and Humulus were identified from macrofossils at the site. The arboreal pollen percentages are low and dominated by Quercus and Corylus, with some Betula, Pinus, Tilia, Alnus, Fagus and Salix. This is thought to indicate a regional input from oak-hazel woodland outside the town, with some pollen from valley-floor trees such as alder and willow.

The demands of the developing city for fuel and constructional timber would eventually have depleted local supplies unless techniques of woodland management were adopted. It is tempting to see the results obtained from tree-ring studies as evidence for such a development. The oak timbers from the lower layers at the site had very narrow rings, having grown probably in shaded conditions, and were from old trees, as much as 300 years in one case. Timbers from the upper layers had wide annual rings, suggesting that the trees had grown in open conditions, and were from young trees, 40-50 years old. This could be thought to indicate a change from an initial felling of primary woodland to the use of timber produced by the medieval woodland system of 'coppice-with-standards', but obviously more data will be required before such an interpretation can be accepted without reservation. However, the young straight poles and stakes of oak, ash, hazel, holly, willow, willow/poplar and Prunus sp. may be from managed woodland, produced by coppicing, pollarding or from suckers. Mosses derived from at least two distinct types of woodland were identified in soil samples: Thuidium tamariscinum, common in woodland on heavy clay soils and Thamnium alopecurum found in dry calcareous woodlands. How these mosses reached the site is unclear, but since both are forest-floor plants rather than epiphytes it is improbable that they arrived attached to timbers.

Pollen of Erica and Calluna is present but rare, never comprising more than 2 % of total pollen. These low levels of Ericaceae pollen may represent a regional and appear to confirm historical evidence indicating that Mousehold Heath, less km from the site, was forested in the early middle ages and that the open hea roduct of latermedieval overgrazing and deforestation (Rackham 1976, 136).

There is evidence for hunting and gathering in both woodland and open habitats. Bones of roe and red deer and hare were identified at low frequencies in the bone samples, but on the present evidence there is no reason to suppose that hunting provided a significant proportion of the meat consumed at the site. Wild plant foods, in particular fruits and nuts from woodland and scrub (sloe, strawberry, bramble, apple, hawthorn, raspberry, elderberry and hazelnuts) were evidently gathered seasonally and are numerically more important in these samples than cultivated fruits and nuts.

Studies of sediments and biological remains have, then, produced information relating to the exploitation of a wide variety of resources and to the effects of human activity on the local environment. It should be noted in conclusion however, that the area excavated was only some $30m^2$. It is highly improbable that such a small area would produce material reflecting the full range of economic activities involving plants and animals. A primary objective during the forthcoming excavations at the 'Magistrates Courts' site must, therefore, be to assess the degree of variability between sites at the commercial centre of the Late Saxon town.