FAUNAL EVIDENCE FROM A LATE MEDIEVAL GARDEN WELL OF THE GREYFRIARS, LONDON

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SUMMARY

The Excavation in 1979 of a well shaft within the area of the former eastern garden of the London Greyfriars produced exceptionally large assemblages of faunal remains whose deposition can be dated to the period c. *1480 to* c. *1500, corresponding with the friary's final decades before its dissolution in 1538. These assemblages are of especial general interest in two quite separate respects. They comprise on the one hand discarded food debris in the form of large mammal, bird and fish bones: evidence of a diet which contrast significantly with the more luxurious fare of the regular, monastic orders as attested by similar assemblages found elsewhere in Britain. The presence, on the other hand, of garden fauna represented by small mammal and amphibian bones points to wild, wet overgrown conditions very different from the traditional conception of the formal, orderly monastic garden, but perhaps more consistent both with the friars' characteristic preference for orchards and timber trees and also with the declining numbers and resources of the last decades of their existence.*

1. INTRODUCTION
by P. L. ARMITAGE

In 1979, excavation carried out by the Department of Urban Archaeology, Museum of London, in the west central area of the General Post Office site (Post Office Middle = POM 79) TQ 32068136[1] uncovered a deep chalk-lined well (Context 2033) which had once been associated with the Greyfriars' convent garden. Of cylindrical shape approximately 1m in diameter, the well was excavated to a depth of 9.135m OD (7.55m excavated depth), and the faunal material was recovered from the grey-black silt of context 2014 (level: 11.185 to 9.335m OD; excavated depth: 4.6m). Although the well was not bottomed due to dangerous working conditions, the consistency of the deposit (as well as the one below: 2101) suggested that it was at or very close to the original bottom.

According to the pottery evidence from the fill, this well had apparently fallen out of use sometime between *c.* 1480 and 1500 (Vince 1985)[2], and thereafter was used as a convenient refuse dump. The faunal remains of discarded food debris from the Greyfriars' kitchens provided important evidence of the friars' diet in early Tudor times. The disused well also acted as a natural pit-fall trap which collected unwary small wild animals and amphibians from the surrounding garden area, and this material provided a unique insight into the ecology of the garden in the period immediately prior to the dissolution of the friary.

Apart from the faunal remains from the 11th to the 16th century levels excavated in the collegiate grounds at Beverley, Yorkshire (Scott and O'Connor, forthcoming), the authors know of no other British monastic site

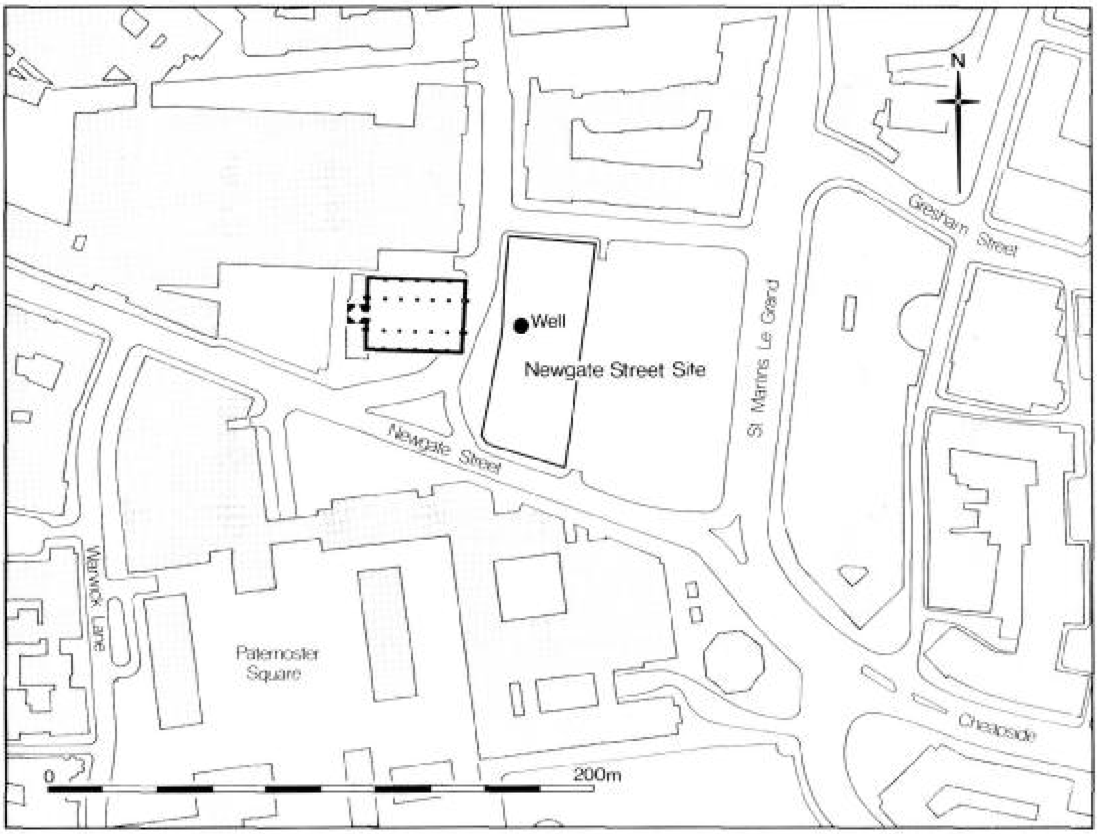


Fig. 1 Greyfriars Well: Location of the POM 79 site.

that has yielded both small and large mammal bones in such quantities[3], as well as an unusually large group of skeletal elements from a wide variety of wild bird species. For this reason, the faunal material from POM 79 has been the subject of a detailed study[4], the results of which are presented here in two parts under the following categories:

A. FOOD DEBRIS: large mammal, bird and fish bones

B. GARDEN FAUNA: small mammal and amphibian bones

HISTORICAL BACKGROUND TO THE GREYFRIARS GARDEN

Until its dissolution by Henry VIII in 1538[5], the order of the friars minor known as the Greyfriars occupied much of the triangle of land within the City wall between Newgate and Aldersgate, extending to the east just beyond the line of the former Pentecost Lane (Figs 1 and 2) (Honeybourne 1932). The Friars Minor first moved to this part of London from a temporary site in Cornhill in 1225, following a gift of land in Stynking Lane (now King Edward Street) made to their community by John Iwyn, a wealthy London merchant. Through further generous benefactions they acquired adjacent areas of land including ground lying to the west of King Edward Street, a gift from Queen Margaret, second wife of Edward I, on which the friars erected their great church

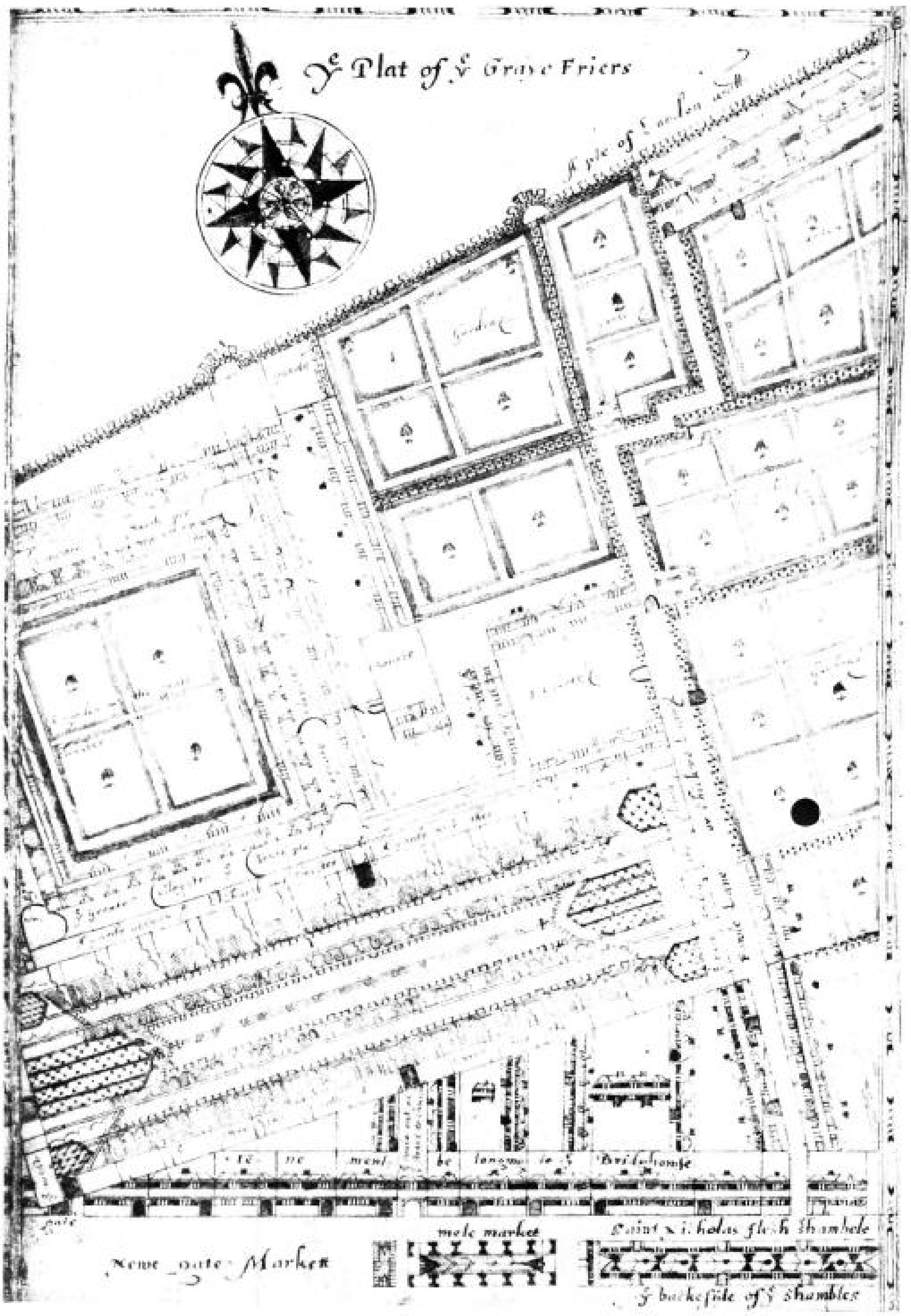


Fig. 2 Greyfriars Well: Modern street plan with outline of the Greyfriars' church, and the well.

(completed by about 1350) (Shepherd 1902, 238–245).

Traces of the southern aisle of the conventual church (later of the parish church of Christchurch) were discovered by P. Herbert of the Museum of London's Dept. of Urban Archaeology in 1976 (Herbert 1979). This excavation complemented an earlier one carried out by T. Johnson in 1973, which investigated the east end of the church (Dyson and Schofield 1981, 78).

From documentary sources it is known that in addition to smaller gardens within the Great Cloister and along the south side of the conventual church, the friars also had a much larger garden, on the site of which the present excavations took place, to the east of the church and which was referred to in the deeds of adjoining properties as 'the garden of the friars minor'. Kingsford (1915, rept 1965, 28) believed that as the convent garden was situated to the east of Stynking Lane (which linked Newgate Street and the lane along the City wall to the north) it was therefore separated from the main precinct of the Greyfriars. However, in a later documentary survey carried out by Honeybourne (1932, 27), evidence was found showing that Stynking Lane had been blocked up by the friars in 1274–75 and thereafter had ceased to exist, until 1600 when a footpath once more allowed passage northwards through the garden area.

There is very little more known about this garden, despite the existence of the well-known *Plat of ye Graye Friers*, which although dated 1617 incorporates material collected 70 years earlier, and therefore provides valuable information on the layout of the precinct at the time of the dissolution (Kingsford 1915, reptd 1965, 52; Honeybourne 1932, 11). Unfortunately much of the eastern part of the friars' precinct, which includes the convent garden, is not shown on the plan. In the small portion lying to the east of the conventual church which has been included in the 1617 plan, the cartographer has clearly made no attempt to depict flower beds, orchards, paths, etc. Instead, as with other gardens shown elsewhere in the plan, the garden is portrayed stylistically, taking the form of square and rectangular blocks of hedges enclosing a single, centrally placed tree of indeterminate species (see Honeybourne 1932, Plate 1).

The only other extant documentary evidence relating to the convent garden during the time of the Greyfriars is to be found in the records of the Assize of Nuisance, in which two private lawsuits mention the garden. In the first, dated 15 February 1370, the guardian of the Friars Minor, Brother Robert de Madyngton, complained that a local butcher, Richard Bayser, living in nearby Pentecost Lane, had allowed water mixed with the blood, hair and 'other filth' from his slaughterhouse to enter the Greyfriars' garden, 'causing a stench in many places there'. Seven years later, on 2 October 1377, it was the friars who caused a nuisance when they blocked up the 'kennel' (drain) that ran northwards across their garden, forming an extension of the drainage gutter that collected rain water from Pentecost Lane to the south. John Norhampton, draper, and other local inhabitants of Pentecost Lane complained that the friars' action had prevented rainwater from emptying through this drain into Houndsditch as it should, and, they claimed, in bad weather the street gutter overflowed, causing their possessions to rot as well as drowning children in the nearby tenements (Chew and Kellaway 1973, 142 & 161). Apart from bare references to the garden in the deeds relating to property in Pentecost Lane, the extant documents are silent until 1562, when a grant shows that by this date the garden was being leased by Sir Martin Bowes to John Launde, butcher, for a term of forty years at the annual rent of 53s. 4d. (Colin Taylor *pers. comm.*).

The precise location of the convent kitchens is unknown, but they probably lay, like the beerhouse, in the service area beyond the far end of the friars' church. It is true that this would have been almost at the opposite end of the precinct from the excavated well of the eastern garden, but the latter's relative remoteness and seclusion from the central area of the buildings presumably meant that the well provided a more suitable repository for kitchen waste than either the cloister garden or that immediately to the south of the church.

2. THE FAUNAL REMAINS
A. FOOD DEBRIS
LARGE MAMMAL BONES
by BARBARA WEST

A total of 4939 large mammal bones (weighing 49,440g) was recovered, 65.5% of which were unidentified fragments; thus, the sample of identified bones was reduced to 1638. The species, bone elements, fragments, weight and sieving percentages are included in Fig. 13. According to Boessneck's (1970) method, most of the sheep/goat bones were probably sheep. The percentages recovered by sieving increased as the identified animal size decreased, but reached 96–97% in the three fragment categories (cattle-size, sheep-size and unidentified).

As can be seen from Fig. 3, the relative proportions of species represented

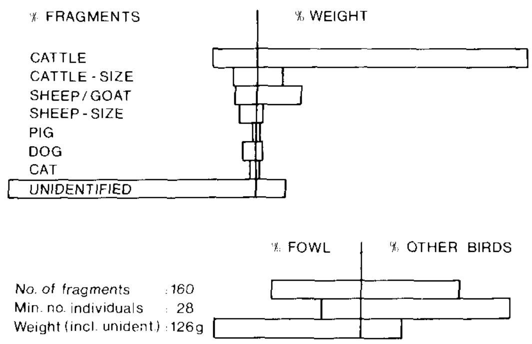


Fig. 3 Greyfriars Well: Double histogram comparing species by percentages of weight and fragments.

depended on the method of quantification; however, the only drastic discrepancies occurred in cattle and unidentified fragments. For reasons discussed in detail elsewhere (Uerpmann 1973), the weight method was preferred as more accurate; thus, while cattle predominated, sheep played a minor role and pigs were so scarce as to be outnumbered by the few dogs. Cats, fallow deer, and rabbits were present in small numbers.

Using initial categories of carcass components outlined by Uerpmann (1973) and Maltby (1979) according to the relative quality of meat yield, the data were combined for the two main food animals in Fig. 4. As can be seen, the lesser quality meat provided by the skull predominated in the weight and fragment percentages for both species, while proportions of high quality meat were consistently small.

Butchery marks were recorded on 16% of the cattle bones and 23% of sheep, with only 1–2 instances among pigs, cattle-size, fallow deer and rabbits. The single rabbit skull bore skinning marks across the nasal bones. Although the general butchery patterns for cattle and sheep were similar to those from other medieval sites (for example, vertebrae cleaved along the sagittal plane), the sample was too small for useful comparisons.

16% of the identified bones bore a black stain that could be mistaken for burning, 5 bones were stained green, and only 7 bones had been gnawed by dogs.

	Cattle		Sheep	
	% weight	% fragments	% weight	% fragments
High quality meat: (scapula, humerus, pelvis, femur, vertebrae)	23	16	10	16
Lesser quality meat:				
A (tibia, radius, ulna)	3	2	4	5
B (skull, maxilla, mandible, loose teeth)	59	74	83	66
Lowest quality meat: (metapodials, phalanges, etc.)	15	8	3	13

Fig. 4 Greyfriars well: Relative quality of meat yield.

Age ranges were estimated using epiphyseal fusion, dental eruption (Silver 1969) and dental attrition (Grant 1975 and Payne 1973). Dental attrition patterns were assessed using methods devised by O'Connor (1983a) and West (1984a). Estimates for cattle indicated that most were killed at 3–4 years. The few pig bones were from individuals under one year. Although the fusion data for sheep indicated that the majority were less than 3½–4 years, with a peak slaughter age at 2½–3 years, the dental attrition data suggested that half the sheep were killed at 3–4 years, and half at 4–5 years. These contradictions illustrate the problems associated with small samples. Among the dogs were a few bones of puppies, although most were from adults over 1½ years. The cat bones represented individuals under 2 years, with a few 6–12 months olf, as well as one foetal and two newborn kittens[6].

The only bones recovered for which sex could be determined were the horn cores and innominates of sheep (using the descriptions of Armitage 1977), which indicated 14 males and 1 castrate, representing surplus stock not required for breeding or wool production.

PATHOLOGY

Evidence for pathology was found in 6 cattle bones: 1 metatarsal with a small swollen area near the distal posterior foramen indicating an injury to the back of the hind foot; and 4 proximal metacarpals and 1 distal first phalanx, each with a small circular pit of irregular resorption in the articular surface. Not only are these pits similar to those found occasionally in bovine mandibular hinges, but also to the 'osteochrondritis dissecans' in human tibiae (Wells 1974), and it is possible that they all represent similar necrotic reactions of bone to stress upon the joint (in the cattle, this stress was probably caused by traction).

One sheep radius bore an exostosis near the proximal articulation, indicating a ligament which probably ossified in reaction to elbow injury, similar to those found in York (O'Connor 1984). Two sheep mandibles exhibited severe periodontal disease, which both Maltby (1979) and O'Connor (1982) attribute to poor nutrition: an assumption for which there is no evidence. Periodontal disease in both humans and animals is caused by deposits of food debris (calculus) on the teeth; however, one interesting phenomenon is that cattle teeth from archaeological deposits often exhibit large quantities of adhering calculus yet suffer less periodontal disease than sheep, which bear little calculus yet far more frequent periodontal disease. This can be explained by the unpublished work of Hardwick (Manchester Dental School, Armitage, *pers. comm.*), who studied calculus on modern sheep teeth and found that a major component was silica grains, not from the opal phytoliths of plants (Armitage 1975), but from the *soil*. Because sheep crop plants much closer to the ground than cattle, they ingest large quantities of soil, from which the silica grains irritate and inflame the gum tissue.

Pathologies among the dog bones included one humerus with arthritic deposition and eburnation around the distal articulation (indicating an arthritic 'elbow' joint), one maxilla with irregularly-healed alveoli (indicating infection after the loss of the first incisor), and one lumbar vertebra in which the left transverse process never developed, while the right one grossly overdeveloped in the wrong direction, forming a long projecting spine curving backwards (towards the tail)[7].

MEASUREMENTS

Measurements (Fig. 14) were taken using the method of von den Driesch (1976). Using conversion factors listed by von den Driesch and Boessneck (1974: Fock, for cattle; Teichert, for sheep), the mean withers height for the 19 cattle metapodials was 132.9cm (standard deviation: 15.7; coefficient of variation: 3.6), ranging from 114.3 to 156.3cm. These cattle were generally larger than those from all periods at Exeter (Maltby 1979), 9th–13th century Lincoln (O'Connor 1982), 9th–10th century York (O'Connor 1984), 13th–15th century London (Trig Lane: West, unpublished), and the medieval periods at Portchester and Northolt (Grant 1977), but similar in size to those from medieval hospital of Maison Dieu, Ospringe, Kent (Wall 1980) and to the largest specimens from 16th century Baynard's Castle, London (Armitage 1977).

The few sheep bones yielded a mean withers height estimate of 60.5cm, which is similar to those at Exeter, Lincoln and Maison Dieu. The mean shoulder height for dogs (Harcourt 1974) was 45.1cm, indicating medium-sized animals.

BIRD BONES
by BARBARA WEST

A total of 416 bird bones (weighing 125.5g) were recovered by sieving, 61.5% of which were fragments of indeterminate species (see Fig. 15).

The relative proportions of species represented was unusual in that domestic fowl did not invariably dominate the collection. As can be seen in Fig. 5, fowl accounted for only 48% of the identified fragments, and a mere 21% of the minimum number of individuals. However, a more accurate estimate was probably given by the weight of bone (see section 2.1), in which fowl outweighed all other fragments including the unidentified.

No evidence of butchery or burning was found on any of the bones, and only 2 fowl bones had been gnawed by dogs. All the bird bones represented adults except for 1 juvenile rock dove, 1 sub-adult jackdaw, and 1 newborn, 2 juvenile and 1 sub-adult fowl. Sex in domestic fowl bones can be determined by three methods: measurement comparisons within large samples (inapplicable here), the presence of medullary bone (a deposit within the limb bones of laying hens; Driver 1982) and the presence of tarsometatarsal spurs (West 1982, 1985). Although no medullary bone was found, 4 of the tarsometatarsi were female and 1 male/capon.

Domesticated birds were represented by fowl, goose, and probably rock dove (pigeon). Measurements of the few complete fowl limb bones (Fig. 16) indicate that these birds were generally larger than the Roman, Saxon and medieval material from Exeter (Maltby 1979), Lincoln (O'Connor 1982), and London: General Post Office and Watling Court (West, 1983), St. Magnus (Carey and Armitage, 1979). Similar in size to those from the London sites of Aldgate (17th–18th century, West 1984b), Crosswall (18th century, West 1981) and the palace deposits at Baynard's Castle (*c.* 1520–40, Carey 1982), they were also within the wide range of mid-15th century fowl bones from Trig Lane (West, unpublished). Thus the measurements provide additional confirmation of the general size increase of domestic fowl in the late medieval to post-medieval periods.

The habitats of the wild birds were represented by a fairly even distribution of coastal, marsh, field and woodland species. Resident birds which could be caught year-round (using nets, snares, birdlime, etc[8].) were the robin, skylark, song and mistle thrushes, ringed plover, snipe and jackdaw. The grey plover and green sandpiper were only available in Winter, while the garden warbler (a visitor from Africa) could only have been caught in summer (Peterson, Mountfort and Hollom 1979). Rather surprising was the absence of duck and woodcock, which were relatively common at Exeter, Lincoln, Beverley (Scott 1984), Kirkstall Abbey (Ryder 1965), Maison Dieu and three of the other London sites mentioned above.

FISH BONES
by ALISON LOCKER

Most of the fish bones were recovered by sieving. Over 50% of the sample were vertebrae. A complete list of the elements identified is given in tabular form in Fig. 17.

The following species were identified: roker (*Raja clavata*), eel (*Anguilla anguilla*), conger eel (*Conger conger*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*), smelt (*Osmerus eperlanus*), dace (*Leuciscus leuciscus*), roach (*Rutilus rutilus*), cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangius*), hake (*Merluccius merluccius*), tub gurnard (*Trigla lucerna*) and plaice (*Pleuronectes platessa*).

These species represent a wide variety of habitats and suggest a number of fishing methods (as discussed by Wheeler, 1978). With regard to the marine fish, mature cod would be the deepest water fish present, being found in depths of up to 600m in a variety of habitats. Immature individuals may be found closer inshore. Hake, a

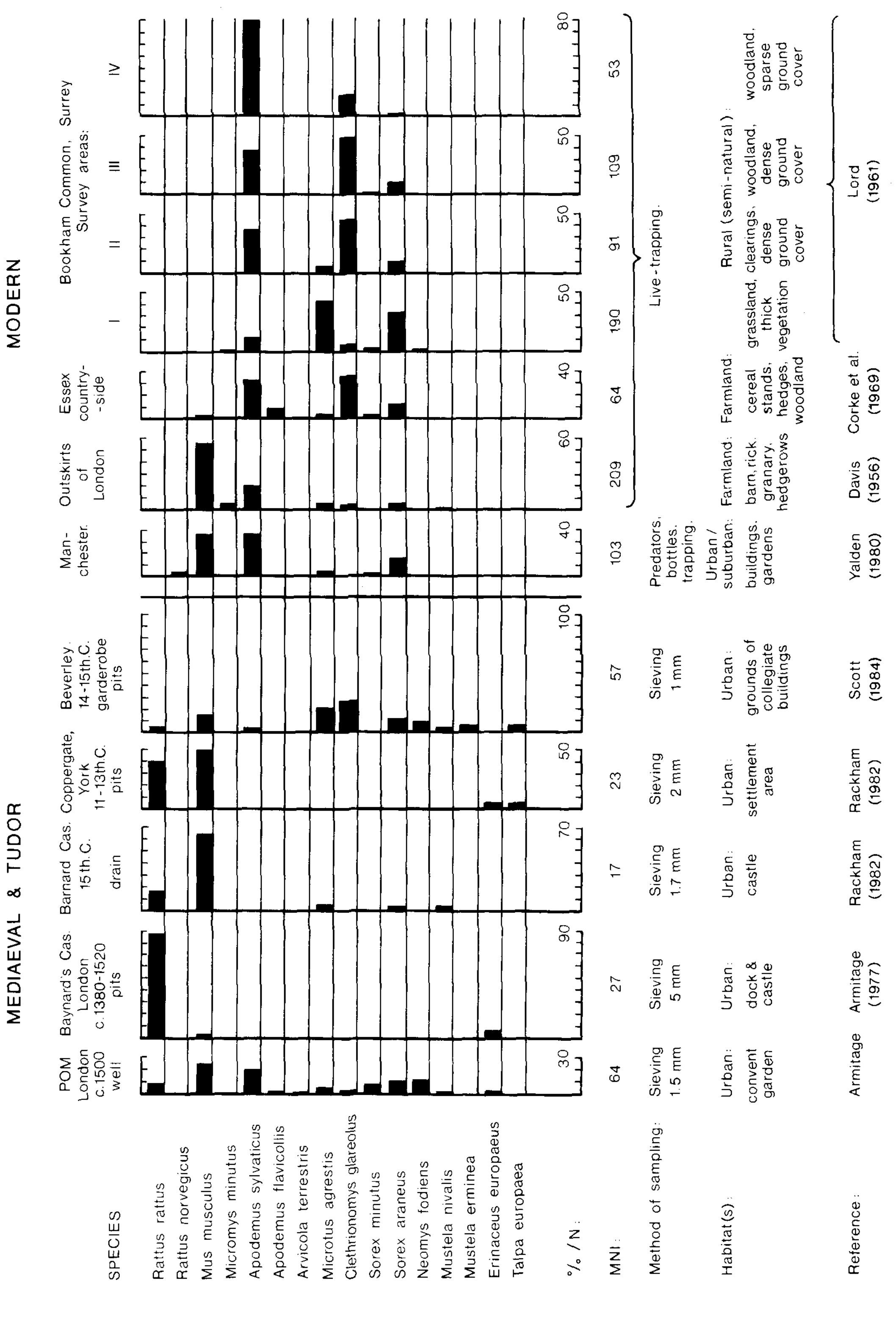


Fig. 5 Greyfriars Well: Double histogram comparing the relative percentages of domestic fowl with other birds using three methods.

moderate-to-deep water fish, is found near the bottom, and haddock live close to the seabed in depths of up to 300m. These three species would have been mainly taken on lines. Whiting is a shallow water, inshore fish and may have been caught by a combination of lines and nets.

Surface shoaling fish found in coastal waters and which are seasonally netted include herrings and sprats. The use of draft nets gave rise to the herring fleets and their associated industries (which developed on a large scale in the 14th century) from which herrings were marketed smoked or pickled (packed in barrels). Sprats were salted, and are especially common in inshore coastal waters, the young being found in estuaries and at certain times of the year are particularly abundant. The sprat fishery of the Thames is very ancient and was usually carried out using stow nets (Wheeler 1979, 77) in which large numbers of fish can be caught. Sprats were pickled in brine, and salmon were also pickled and salted[9]. Fish were often put into cold pies, which preserved the fish as they were filled with clarified butter which set and excluded the air[10]. Saltfish and herrings were put into pies with fruit[11].

Similarly the smelt, being very good to eat, has also been an important tidal fishery of the Thames. The largest catches were made in winter and early spring when the adults are migrating[12].

Rays and skates would also be caught on lines as bottom dwelling fish, but the shallow-water dwelling species were also caught in kiddles (shoreline traps) which prevented the fish returning to deeper water after feeding on the shoreline at high tide[13]. The tub gurnard although quite edible is likely to have been an incidental catch with other bottom living fish.

The conger eel prefers rocky coastlines with niches it can inhabit, and would be caught on lines. Eels are often caught in rivers and streams in eel-bucks, which trap them as they are going downstream. These traps were often used in the Thames strung across a weir or millstream. Eels were also kept in fishponds[14].

The salmonid vertebrae may belong to either salmon or trout, but both species could have been caught in the Thames, salmon-bucks trapping the fish on their migration upstream[15].

All the marine fish could have been caught in the North Sea off the southeast coast except the hake whose range extends to the northern North Sea and the Western Channel, and which was probably brought to London from a northern fishing port probably salted or dried.

Although the preserving of fish made it available cheaply throughout the year the position of the site with access close to the largest port in Britain makes it very likely that at least some of the fish was consumed fresh, especially fish in season such as herrings, sprats and smelts. Comparisons were made against modern reference specimens of known size and weight. None of the archaeological material proved to be remarkable in size and no knifecuts or other cut marks were observed.

B. GARDEN FAUNA BONES OF SMALL WILD MAMMALS

by PHILIP L. ARMITAGE

A total of 2,911 skeletal elements from twelve species of small wild mammal[16] was recovered. Identification of this material was made by comparison with modern specimens in the mammalian osteological collections in the British Museum (Natural History). Reference was also made to Lawrence and Brown (1973). A complete inventory of the skeletal elements identified is given in Fig. 18. The minimum number of individuals (MNI) represented by the sample collected was estimated at 64[17].

The small mammal remains are described below in systematic order under species. Only a basic summary of each species is presented. More specific information, including details of epiphysial fusion in the limb bones, is available in the level II archival record at the Museum of London.

The species represented:

Mus Musculus house mouse

MNI = 17. Sex could be determined in 7 innominate bones after the method of Brown & Twigg (1969); these were identified as 6 males and 1 female. Using dental eruption and attrition, the ages of 4 maxillae were estimated as follows (using the method of Lidicker, 1966, 38): 1–2 months (2 individuals); 2–4 months (1 individual); and 4–6 months (1 individual). 15 out of the 20 mandibles (lower jawbones) collected were sufficiently intact to allow measurement by Dr. Michael Festing, who subjected the data to multivariate analysis. From this study, it was discovered that the jawbones from the Greyfriars' well are significantly smaller than the sample of modern house mice from London in the collections of the BM(NH) (see Appendix I). As all the modern mice had been caught by means of live-trapping, while those from POM represent a pit-fall sample, this disparity in size probably simply reflects sampling bias[18], and there is no reason to believe that the overall range in size in the Tudor mice was any different from that of modern London mice.

Apodemus sylvaticus wood mouse
MNI = 13. All immature (either juveniles or sub-adults). Sex could be determined in 9 innominate bones (after the method of Brown & Twigg 1969); these were identified as 4 males and 3 females.

cf. *Apodemus flavicollis* yellow-necked mouse
MNI = 1. Young subadult represented by 1 complete tibia and 1 incomplete (anciently broken) femur. The length of the tibia compares favourably with the specimen of *Apodemus flavicollis* in the collections of the BM(NH) (reg. no. 1958.6.18.2). The Greyfriars animal is an interesting historic record as this species today is no longer found in London and is only known from localities further away, in Kent, Surrey and Essex (Corke 1977a, 127; 1977b, 219).

Microtus agrestis field (short-tailed) vole
MNI = 3. All immature. 2 males and 1 female were identified from the innominate bones using the method of Brown & Twigg (1969).

Clethrionomys glareolus bank vole
MNI = 2. Both immature. 1 right mandible is from an animal less than 3 months old (age estimated after the method of Alibhai, 1980).

Arvicola terrestris water vole
MNI = 1. Immature.

Rattus rattus black rat
MNI = 6. All immature: 4 subadults and 2 very young juveniles.

Sorex minutus pygmy shrew
MNI = 5. All immature (juveniles and subadults).

Sorex araneus common shrew
MNI = 7. By inspection of the degree of wear in the molar teeth, the ages of 6 animals could be determined (after the method of Crowfoot 1957) as follows: 4 juveniles and 2 sexually mature animals. Using the description of Brown & Twigg (1970), the innominate bone of 1 sexually mature male was identified.

Neomys fodiens water shrew
MNI = 7. Using the method of Crowfoot (1957, 110–113), the ages of 6 individuals could be determined from their teeth wear: 5 juveniles and 1 sexually mature animal. 2 sexually mature males were recognised among the innominate bones (using the method of Brown & Twigg 1970).

Erinaceus europaeus hedgehog
MNI = 1. Immature.

Mustela nivalis weasel
MNI = 1. Fully grown adult (dentally and skeletally mature).

AMPHIBIAN BONES
by BARRY CLARKE

Careful examination of the assorted small bones obtained by sieving yielded a total of 59 frog bones (genus *Rana*) (see Fig. 19). These bones were identified by comparison with specimens in the amphibian osteology collection in the British Museum of National History (B.M.(N.H.)).

At the time the well fell into disuse, the British frog fauna was even more restricted than it is today, with probably only common frog (*Rana temporaria*) and possibly also pool frog (*Rana lessonae*) and edible frog (*Rana esculenta*) being found[19]. The edible frog is probably not a native of this country, but the history of its introduction is rather sketchy (Smith 1973, 141). Boulenger (1898, 286–7) also suggested that edible frogs were an introduced rather than a native species, and cited records of introductions of edible frogs from France and Belgium in 1837, 1841 and 1842; pool frogs possibly 'of Italian origin' and, interestingly in the present context' 'perhaps introduced by monks'; and also marsh frogs (*Rana ridibunda*)[20] from Berlin, probably in the 1880s. The evidence suggests that the marsh frog was not a part of the fauna of this country in 1500, but one cannot so easily discount the possibility of casual, localized introductions of edible and pool frogs.

The sample of 59 bones represents a fairly small proportion of the remains of a minimum of 6 frogs. Although for most, specific identification is not possible, some elements compare very closely with B.M.(N.H.) specimens of *R. temporaria* and in these cases there can be little doubt of the identification. There was no sign of newt bones (*Triturus* spp.) and no unequivocal evidence of toad bones in the sample.

Elements found (numbers of individual elements in brackets):

Right mandible (1). Right angular (angulo-splenial of some authors) only, dentary and Meckel's cartilage absent. Combination of size and degree of curvature suggests *Rana* rather than *Bufo*. Subadult to adult.

Humeri (6). Size and condition suggests 3 individuals represented: 1 adult and two juveniles, but in the case of the 2 largest humeri the size, elongate nature of the crista medialis (medial crest or ridge) and its situation relative to the eminentia capitata (ball joint articulation with forearm or radioulna) suggests these elements are both right humeri from adult male *Rana*; therefore probably between 4 and 6 frogs are represented. The nature of the crista ventralis (ventral crest or ridge) suggests *R. temporaria* rather than *R. esculenta* or *R. lessonae*.

Radioulnae (8). It is possible to differentiate between isolated left and right radioulnae as follows: Hold the bone so that the proximal end (i.e. the end which articulates with the humerus) is uppermost, turn it so that the olecranon (terminology of Ecker 1887, 51, Fig. 39 and see Fig. 6 in this paper) or humeral facet is pointing away from you. If the olecranon is directed to the right, it is a right radioulna, and vice versa. In addition, the groove separating the distal radial and ulnar heads of the radioulna is deeper on the right in a right radioulna and on the left in a left radioulna, when the bone is held as described above. Thus there are 6 right and 2 left radioulnae present in the sample, giving the minimum determination of 6 frogs in the total sample mentioned above, including at least 1 adult. These elements have the general appearance, size and proportions of *Rana* rather than *Bufo* radioulnae, but it is not possible to distinguish between *Rana* spp. on radioulnae alone.

Metacarpal/metatarsal/phalangeal bones (21): It was not possible to distinguish between these as isolated bones; probably *Rana* rather than *Bufo*.

Urostyle (or *coccyx*) (4). Clearly *Rana* rather than *Bufo* (see Fig. 6): the sacrococcygeal cotyles are round rather than oval as in *Bufo* and the dorsal crest is more fully developed than in *Bufo* (virtually absent). In one, the dorsal crest is more obvious than in the other three. This may be variation or a *possibility* that the sample consists of 3 *R. temporaria* and 1 *R. esculenta* or *R. lessonae*. 4 urostyles indicate 4 frogs present in the sample, size indicates 1 adult and 3 juveniles.

Ilium (1). Left ilium only present; ischium and pubis absent. The size and nature of the dorsal crest, dorsal and ventral acetabular expansions, relative position of the acetabular fossa and positions of the dorsal prominence and dorsal

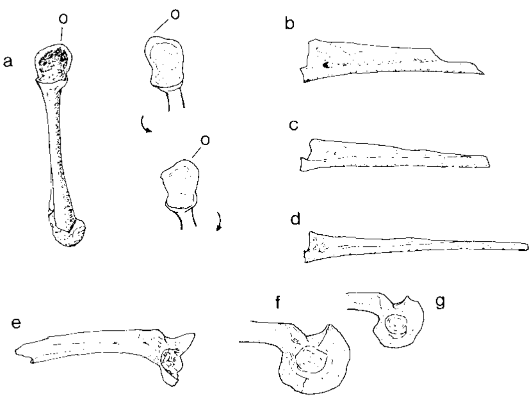


Fig. 6 Greyfriars Well: a. (left): Right radioulna of *R. temporaria*; (top right): close-up of left radioulna; (bottom right): right radioulna showing proximal head of humeral facet. b-d. Urostyles of (top to bottom) POM site specimen, *R. lessonae* and *R. temporaria*. Note that some specimens of *R. esculenta* (not illustrated) show at least as high a crest as the POM specimen. e–g. Ilia of POM site specimen, *R. temporaria* and *R. lessonae*. o = olecranon, arrow indicates side of bone with deeper groove. (Drawings by Barry T. Clarke)

protuberance relative to each other and to the dorsal crest indicate that this is a left ilium from a young-to-halfgrown *R. temporaria* (see Fig. 6).

Femora (5). Slender, degree of curvature suggests *R. temporaria*. While 5 femora in the sample indicate the presence of a minimum of 3 individuals, the appearance of these elements suggests it is more likely that they came from 4 or 5 common frogs.

Tibiae (9). Slender, not *Bufo* but not possible to distinguish between *R. temporaria* and *R. esculenta*/*R. lessonae* on the tibia alone.

Assorted bones (6). From their general appearance, particularly the curvature of the inner and outer margins and slight dorsoventral flatness that are probably 3 calcanea and 3 astragali of *Rana* sp. representing a minimum of 2 (possibly 3) individuals.

In conclusion, it seems likely that all these bones are the remains of at least 6 common frogs, including adult, halfgrown and juvenile frogs, with the remote possibility (based on the slender evidence of the state of the dorsal crest of a single ilium) that a young edible or pool frog may have been present.

According to Smith (1973, 122–3), the name of *Rana temporaria* has pre-Linnean origins and means 'temporary frog' which was an allusion to their apparent disappearance outside the breeding season. Common frogs are strongly terrestrial at other times of year, being less dependent upon ponds, etc., than is commonly supposed. While some may spend much of the summer in the water, most 'spend the greater part of their active life on land, in fields, gardens, meadows and woods' (Boulenger 1898, 309). The situation of the friary garden and surrounding countryside suggests a suitable habitat for common frogs, more suitable than for edible or pool frogs which show a greater preference for water, particularly in the case of adults. The well may have acted as a pitfall trap or as a temporary habitat.

3. INTERPRETATION

A. FOOD DEBRIS

THE DIET OF THE GREYFRIARS
by BARBARA WEST

The evidence (sections 2.1–2.3) suggests that the meat in the diet of the London Greyfriars (calculated by weight) consisted primarily of beef. Mutton played a minor role and pork was relatively rare, followed by chicken and small amounts of fallow deer, wild birds and rabbit[21]. If fragment numbers are used for the calculations, however, a rather interesting list results, in order of importance in the diet:

1 cattle	15 rock dove
2 sheep	garden warbler
3 chicken	16 roach
4 rabbit	17 salmonid
5 *herring*	18 haddock
6 *robin*	hake
7 *eel*	elasmobranch
8 whiting	19 song thrush
9 sprat	20 green sandpiper
10 plaice	21 ray
11 *pig*	conger eel
12 snipe	dace
cod	skylark
13 smelt	mistle thrush
14 *goose*	ringed plover
jackdaw	grey plover
gadoid	*fallow deer*

Fig. 7: Relative importance using fragment counts.

When one considers that the robins high on the list in Fig. 7 represent approximately seven individuals, and that the fallow deer at the very bottom represents a large hind leg joint, the fallacy of mere fragment-counting becomes clear. Unfortunately, fragment numbers must be used in order to compare the Greyfriars data with that of five other medieval monastic sites: Kirkstall Abbey (16th century: Ryder 1956, 1957), Maison Dieu (1470–1550: Wall 1980), Beverley (11th–16th century: Scott 1984), Westminster Abbey (12th–

13th century: Jones 1976; Locker 1976) and Coventry (mid-16th century Whitefriars' school: Holmes 1981, in which bone weight was also used).

Rather surprising is the scarcity of pork in the Greyfriars' diet, since it is well-represented at Westminster, Beverley, Maison Dieu and particularly suckling pigs at the Coventry Whitefriars; however, Ryder (1956) explains the small numbers of pig bones at Kirkstall Abbey by suggesting that pork was considered a luxury in 16th century Yorkshire. Wall (1980) mentions historical records stating that in 1235, fifty hogs were sent to Maison Dieu by the king for the establishment of a herd. Scott (1984) has also found faunal and historical evidence for an elevated social status of the monks at Beverley, and the numbers of deer, rabbit, swan, peacock and suckling pig found at Coventry suggest that the Whitefriars' students were eating rather well indeed (although Holmes 1981, did not recognise it).

Another surprising feature is the very high proportion of lesser quality meat represented by skulls, which remains consistent for cattle and sheep in both weight and fragment analysis (Fig. 4). By contrast, Maison Dieu produced 2–3 times as much high quality meat for these two species as the Greyfriars site, and less than one-third the proportion of skulls. Coventry also yielded large percentages of high quality meat (65%–84% for cattle, sheep and pigs). Scott, however, mentions unusually high proportions of sheep skulls and feet at Beverley, while Ryder reports very high percentages of sheep and pig skulls at Kirkstall Abbey.

All the species of animals, fish and birds in the Greyfriars' diet would have been readily available in London. The heads of cattle and sheep would have been particularly cheap and easy to obtain from the adjacent Shambles. The variety of fish consumed was undoubtedly due to the large number of religious fasting days when eating of meat was forbidden, amounting to almost half the days of the year (Wilson 1973). Wilson also notes that herrings and eels (high on the list in Fig. 7) were the poor man's fare. Although these species were also important at Westminster Abbey, several other species of rare and highly-valued fish found there indicated the extreme wealth of the Benedictine order (Jones 1976).

Many of the bird species consumed (thrush, plover, lark, robin and warbler) were not found on any of the other monastic sites. Larks were recommended by physicians for their digestibility, and were the second most expensive of the small birds in the price lists of the City Poulterers described by Wilson[22]. Other small birds, however, could be bought cheaply[23]. Jackdaw, 'that most urban and ecclesiastical of birds'[24], appears on all but one of these six monastic sites, and though usually dismissed as a scavenger, it could also have been eaten like its cousins, the rook and magpie. Rook pies were popular with poorer folk[25], and magpies were on the bill of fare drawn up for the monks of Waltham Abbey, Essex in 1059 (Fitter 1945).

In summary, the paucity of pig bones, the very high proportion of lesser quality meat provided by skulls, and the numbers of cheap fish and small birds on this site suggest that the London Greyfriars were restricted to a rather economical diet, compared to the more luxurious fare of some of their contemporaries, particularly at Maison Dieu and Coventry. Even Maison Dieu, however, suffered poor fortune during this period (1483–1516), and most of the evidence for a wealthier status for Beverley is of an earlier date (13th century). The diet of the London Greyfriars most clearly resembles that of the monks of Kirkstall Abbey: rather frugal fare, enlivened by occasional gifts such as venison or goose, as well as the odd skylark 'for medicinal purposes'.

This marked contrast in quality of diet with that of the more self-indulgent regular monastic orders elsewhere (with the exception of Coventry) is also consistent with what little is known of general conditions of life at the London Greyfriars in the late 15th and early 16th centuries, as studied by Kingsford. Despite evidence of a certain relaxation of their original ideals (especially in respect of personal possessions) and also of a decline in the number of inmates (at the Dissolution there were only 25 friars compared with at least four times that number two centuries earlier), their standards remained essentially intact. The house maintained its reputation as a leading school, and relations with both City and Crown remained cordial. In the present context it is interesting that in 1522 the friars for the first time entertained the City's rulers to dinner. On that occasion, no doubt, the fare was lavish, but all the indications are that general standards were more austere. As a counterpart to the dietary evidence presented here, and as testimony to an abiding ideal of poverty, the Greyfriars in 1502 resolved to exchange the brown russet of their dress for a kennet russet which cost half the price (Kingsford 1915, 19–23).

B. GARDEN FAUNA THE GREYFRIARS' CONVENT GARDEN

by PHILIP L. ARMITAGE

SOURCE OF THE SMALL MAMMAL BONES

Given that one is dealing with a garden well the discovery of frog bones in the fill came as no great surprise and clearly these are the remains of animals that had lived in or near the shaft. Interpretation of the small mammal bones on the other hand was not so straightforward and it required a considerable amount of research and consultation with fellow zoologists before the assemblage was finally identified as a natural pit-fall deposit.

Concentrations of small mammal bones found at archaeological sites derive from one (or combination) of the following sources:

(i) SCATS OF MAMMALIAN PREDATORS

Bones of small prey (mice, voles and rats) caught and eaten by foxes, dogs, cats and weasels will pass through the digestive tract and are expelled with the other undigested waste food products in the faeces. It may therefore be postulated that one or more of these carnivorous predators when visiting or living in the garden deposited scats in the vicinity of the well. Later, presumably during clearance of the garden, earth containing the scats was collected and together with other garden refuse dumped into the disused well. If part of the assemblage did indeed originate in this way from scats, a proportion of the bones in the fill could be from prey caught and eaten *outside* the City walls rather than within the garden and the usefulness of the small vertebrates for ecological interpretation would consequently be reduced. Careful microscopic examination of the skeletal elements, however, failed to reveal any similarities with the bones documented by Andrews (1983) and Andrews & Nesbit Evans (1983) that were obtained from scats of various mammalian predators. Nowhere in this sample was there the degree of fragmentation and corrosion (caused by digestive juices) that is generally associated with such material.

(ii) PELLETS OF AVIAN PREDATORS

A number of birds regurgitate the bones and other undigested parts of their prey in the form of a pellet (see Glue 1970; Bang & Dahlstrom 1974). It may be suggested therefore that an avian predator when visiting or nesting in the Greyfriars' garden perched on the edge of the protective wall around the well (if indeed such structure was present) or sat in the rafters inside the well house or canopy protecting the winding gear (again if this was present)—or, perhaps even in the branches of an overhanging tree. In any of these locations a bird would have been in a good position to deposit its pellets directly into the well shaft.

Listed below are the species of avian predators who roost or nest in towns and would therefore be most likely suspects for depositing small mammal bones in this well, in the form of regurgitated pellets:

CROWS: Family *Corvidae*, *Corvus* spp.
FALCONS (birds of prey): Family *Falconidae*, kestrel *Falco tinnunculus*
OWLS: Family *Tytonidae*, Barn owl *Tyto alba*
Family *Strigidae*, tawny owl *Strix aluco*[26]

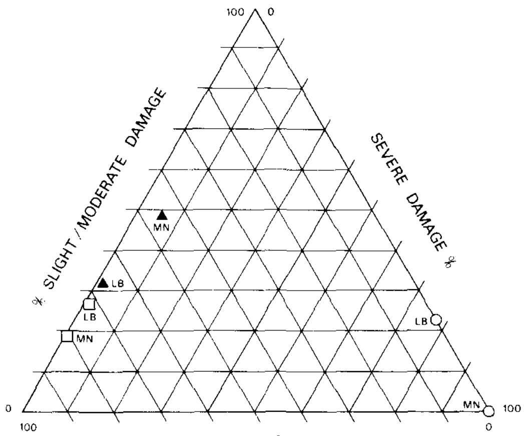


Fig. 8 Greyfriars Well: Degree of damage in small mammal bones from kestrel and owl pellets compared with specimens from the Greyfriars' well (POM 79).

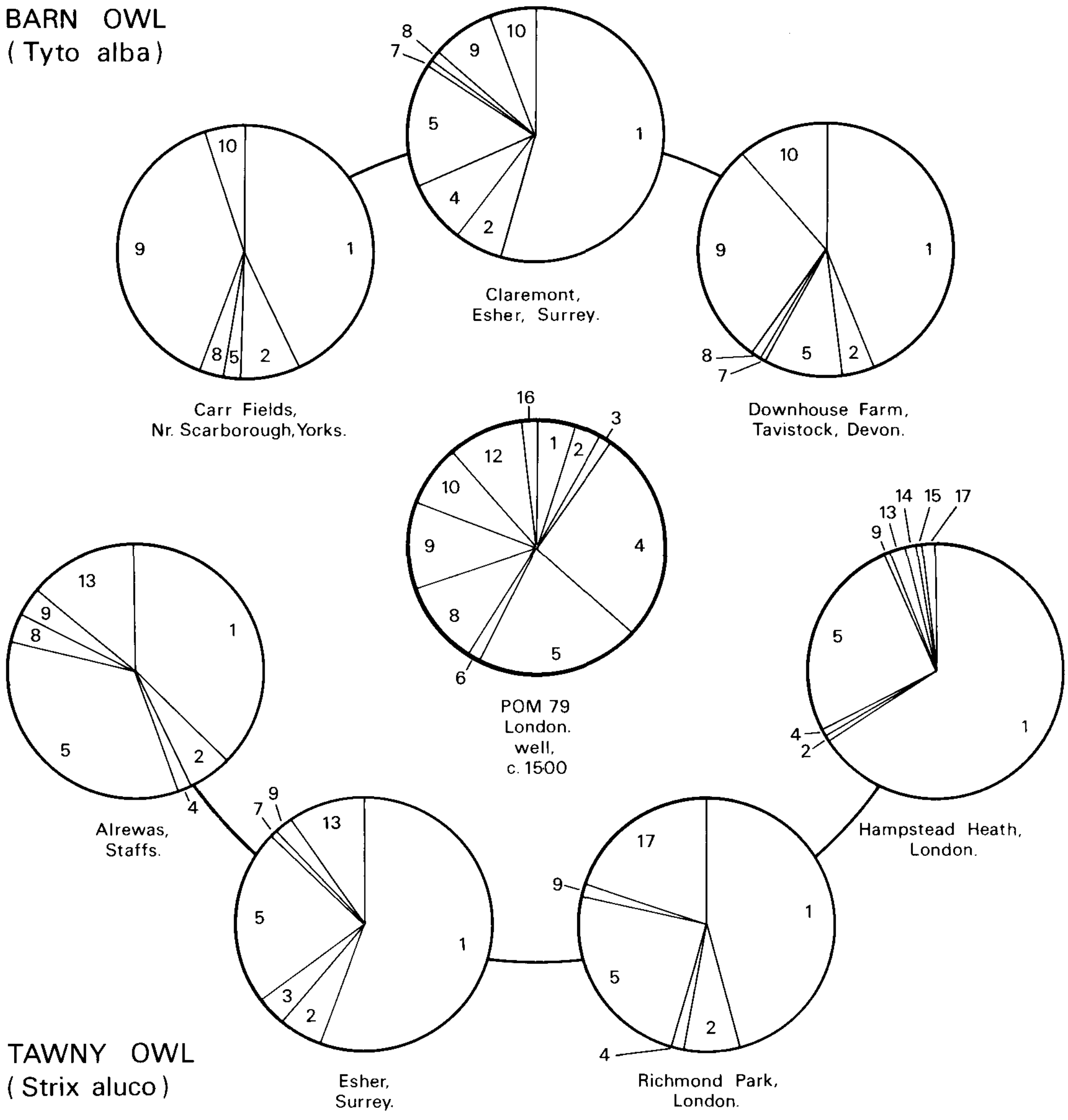
Taking each of these birds in turn, it can be demonstrated that this small mammal assemblage could not have come from their pellets and the scenario of pellet deposition described above must therefore be rejected.

CROWS—Dr Derek Yalden, who was invited to comment on the assemblage, is firmly of the opinion that the presence of large skulls from hedgehog, rat, water vole and weasel rule out the possibility of crow pellets (Yalden 1985 *pers. comm.*).

KESTREL—Dr Yalden also says that diurnal raptors like the kestrel are generally unlikely to capture many nocturnal animals such as mice, whose skeletal elements dominate the assemblage (Fig. 9). The possibility of kestrel pellets is also discounted by the pattern of breakage in the assemblage (Fig. 8). From Fig. 8 it is seen that the majority of the specimens are intact and in a good state of preservation, in marked contrast to the bones from modern kestrel pellets examined by the author[27], many of which were so comminuted that only unidentifiable slivers of bone remained and whose surfaces were badly pitted and corroded by the action of digestive juices. Final evidence supporting the rejection of the possibility of kestrel pellets is provided by the species composition of the assemblage which bears no identifiable relationship with the diet of this bird. In the kestrel diet the most frequent mammalian prey item is *Microtus agrestis* (Shrubb 1980, 112–113) but this small mammal species forms only a relatively small proportion (4.8%) of the total number of animals collected (Fig. 9) in this sample.

BARN OWLS AND TAWNY OWLS—While the pattern of breakage and general condition of the small mammal bones from the present site appear similar to that found in the barn owl pellets from Tring, Hertfordshire, examined by the author (Fig. 8) and to the descriptions of owl pellets given in Bang & Dahlstrom (1974: 195–196) and Dodson & Wexlar (1979), microscopic inspection of the bones failed to detect any sign of erosion on the articular heads (proximal epiphysis) of vole femora or corrosion in isolated vole teeth which have been recorded by Dr Peter Andrews in bones extracted from modern owl pellets (Andrews 1984 *pers. comm.*).

It is also important to note that the relative proportions of the different species present in the sample do not match the known diet of either the barn own or tawny owl documented by various workers (Fig. 9). In both of these birds the



KEY TO SPECIES:

1	Microtus agrestis	7	Micromys minutus	13	Rattus norvegicus
2	Clethrionomys glareolus	8	Neomys fodiens	14	Talpa europaea
3	Arvicola terrestris	9	Sorex araneus	15	Sciurus carolinensis
4	Mus musculus	10	Sorex minutus	16	Mustela nivalis
5	Apodemus sylvaticus	11	Sorex sp.	17	Oryctolagus cuniculus
6	Apodemus flavicollis	12	Rattus rattus		

Fig. 9 Greyfriars Well: Percentage composition of small mammalian species found in samples of barn owl and tawny owl pellets compared with the assemblage from the Greyfriars' well. Hedgehog has been omitted from the POM sample as this animal does not generally constitute a potential prey for owls, and rabbit has also been omitted, as this animal in Tudor times was mainly confined to warrens and was therefore presumably not readily available to owls (Southern 1954, Teagle 1962, Glue 1970, Lawrence and Brown 1973, Bevan 1982).

most frequent major prey item is the field vole *Microtus agrestis*, which in this assemblage only forms 4.8% of the total number of animals collected.[28]

(iii) PIT-FALL DEPOSIT

Having carefully considered and eliminated the possibility of mammalian and avian predators as the sources of the small mammal assemblage it must be supposed that the animals accidentally fell into the well shaft and, being unable to climb out owing to the depth of the shaft, perished. Supporting evidence for the conclusion that the well acted as a giant pit-fall trap is provided by the preponderance of immature animals in the collected sample. 59 out of the total of 64 individuals present (92.2%) were classified as either juveniles or subadults, and such animals are well documented as being prone to falling into wells and other sunken man-made features. Young hedgehogs in particular are frequently found drowned in ornamental ponds, lakes and sewage farm tanks (Morris 1966, 48). Although the discovery of this species in the well therefore came as no surprise, it is strange that given the abundance of this animal in gardens, only a single individual was present in the sample collected.

If the well acted as a natural pit-fall trap, how were the small mammals able to approach close enough to the well shaft to fall in? The answer to this depends very much on whether or not the well head was originally protected by a wall. Unfortunately, modern building activity had truncated the later medieval and early Tudor levels at the site removing the top part of the well structure and leaving only the buried stone-lined shaft intact. Faced with the problem of the lack of any direct archaeological evidence, the possibility that there was originally either a stone or a brick wall around the well head (opening) must be considered. Contemporary illustrations of medieval garden wells (Fig. 10) indicate that most were usually only protected by a low circular wall, probably about 2.5–3 feet (0.6–1m) in height. This would not have presented an insurmountable obstacle to most small mammals, which are generally agile climbers and jumpers (Lawrence and Brown 1973). After the garden well had fallen out of use, its protective wall may have been removed entirely (robbed), or the stone blocks or bricks may have become dislodged, creating gaps in the structure through which small animals could pass.

Alternatively, there might not even have been a wall. Instead, the well opening could have been marked only by a single or double course of stone-work forming a raised rim less than one foot in height (0.30m) with a hinged metal grill over the top of the shaft to prevent people from falling in. A surviving example of this type of well, dating from the 13th century, may be seen in the cloister yard of Michelham Priory, East Sussex; inspection of this particular well reveals just how easy it would have been in the absence of a protective wall for the small mammals in the Greyfriars' garden to approach and fall into the well shaft. It should not be imagined, however, that there was a 'mad scramble' to reach the well shaft and that all the small animals present in the fill had fallen in in the space of a few days. From the pottery evidence (Vince 1985) it is seen that the timespan for the accumulation of the small mammal deposit in the well may have extended over 50 years, which would mean that on average only one or two animals were falling into the well each year.

While it is not possible to ascertain the exact rate of collection, the time of year when the majority of the small mammals were 'captured' is suggested by their ages at the time of death and by the sex of the animals. The preponderance of immature animals together with the relatively high numbers of males indicate most were 'caught' during the summer months. This interpretation is based on modern studies of the behaviour and population dynamics of small mammals in the wild and is best illustrated with reference to the shrews, wood mice and black rats in this sample:

SHREWS: As described by Crowfoot (1957, 113–125) investigations into shrew populations have revealed evidence of an annual turnover. After August adult animals born in the previous year begin to become increasingly rare and between October and February they have disappeared completely, possibly due to their failure to compete with the new generation for scarce food resources during the winter months. It follows that only during the summer would one expect to find old and young together in the population as is the case in this sample which includes two adult *Sorex araneus* and one adult *Neomys fodiens* in addition to the juvenile animals. The relatively large numbers of immature animals also points to summer 'capture' for it is during this time of year that the young range over large areas actively searching for a territory, and being inexperienced, are more likely to fall

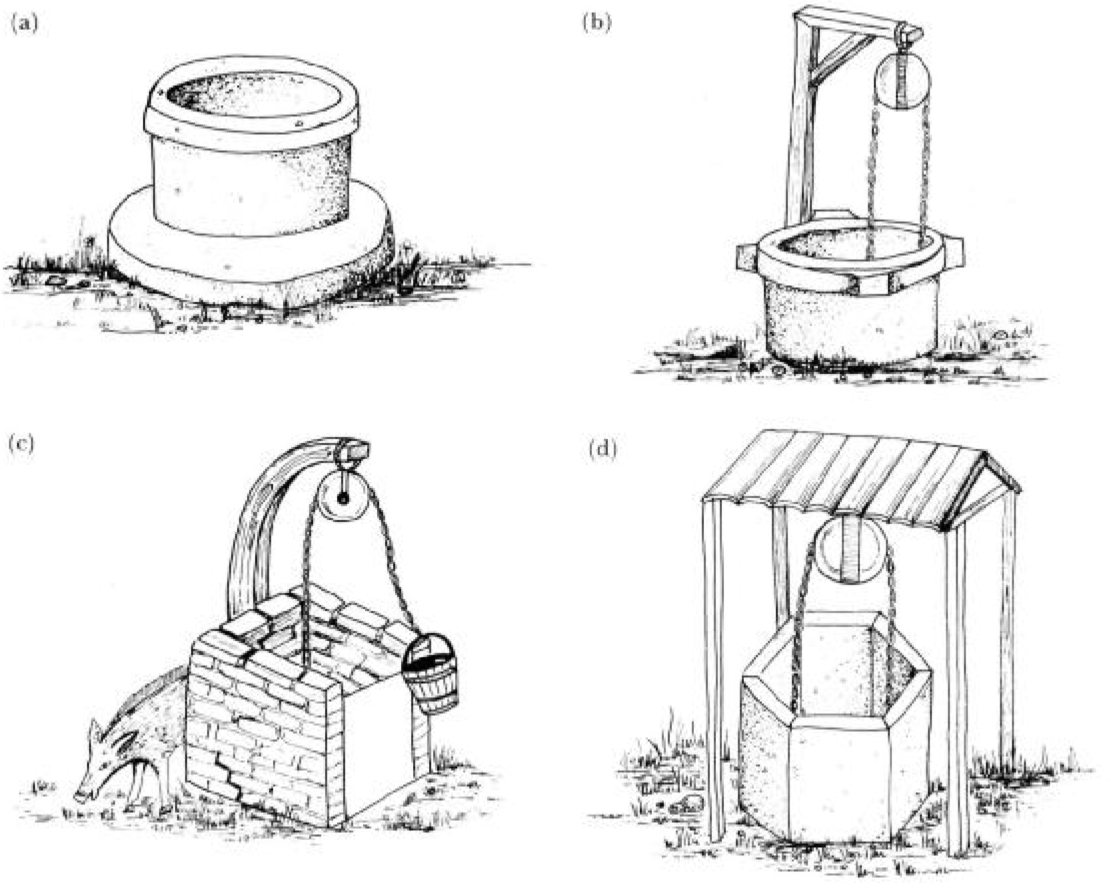


Fig. 10 Greyfriars Well: Details of four garden wells and one street well taken from later medieval and 16th century manuscripts and paintings: (a) *Grimani Breviary c.* 1510; (b) book of French romances given to Queen Margaret of Anjou by the Earl of Shrewsbury in 1445; (c) *Cocharelli manuscript*, late 14th century; (d) 'Battle between Carnival and Lent' by P. Bruegel. (Drawings by Kate Armitage)

into natural pit-fall traps than the more cautious adults (Ellenbroek 1983 *pers. comm.*).

The relative members of the shrew species present in the sample also merit special mention. Although it is well known that the three species *Sorex araneus*, *Sorex minutus* and *Neomys fodiens* are able to live sympatrically in the same area (Barrett-Hamilton & Hinton 1914–21; Ellenbroek 1980, 119; Churchfield 1984, 211), the water shrew is generally outnumbered by the common shrew in most habitats (Churchfield 1983 *pers. comm.*) but in this sample both of these species occur in equal numbers (MNI = 7). Two explanations may account for the unusually high number of water shrews found in the well. From his experience of shrew behaviour, Dr Ellenbroek has suggested that *Sorex araneus* and *Sorex minutus* may indeed have been more abundant than *Neomys fodiens* in the Greyfriars' garden (as would be predicted from modern ecological studies), but because both common and pygmy shrews are better at sensing and therefore avoiding pit-fall traps, proportionally less of them were 'caught' in the well (Ellenbroek 1983, *pers. comm.*). Dr. Sara Churchfield has suggested that the number of water shrews present may be biased by their more gregarious behaviour, which has led two or more animals to fall into the well at the same time (Churchfield 1983 *pers. comm.*).

Species	Typical habitat
1. COMMENSAL SPECIES:	
house mouse:	Found in close association with man; the presence of this animal reflects the proximity of the garden to human habitation.
black rat:	As for house mouse.
2. SPECIES REQUIRING GROUND COVER:	
field mouse:	Field mice are today abundant and widespread in gardens in the outer suburban areas of London where they often come into houses during the winter months (Burton 1974). This species has also been found in the flower-beds of Regent's Park, London (Barrett-Hamilton & Hinton 1914–21, 521). These mice would therefore have been quite at home in the Greyfriars' garden, provided there was some form of ground cover to conceal them from predators such as feral cats which were a common feature of later medieval and early Tudor London (Armitage 1977, 109).
yellow-necked mouse:	Basically a woodland animal which requires adequate ground cover.
field vole:	Prefers to live in rough, ungrazed grassland (Evans 1977, 189). Near London has been found on unmown commons and parks throughout the suburbs (Burton 1977).
bank vole:	Widespread in hedgerows and woods in the outer suburbs around London (Burton 1974). This timid creature tends to avoid those areas disturbed by man and its occurrence in the Greyfriars' garden must therefore mean that there was a low level of human activity and/or the environs of the well were sufficiently heavily overgrown to provide adequate cover (see Konig 1973, 110).
common shrew and pygmy shrew:	Both species prefer habitats with plenty of ground cover (Corbet 1977, 50–56) and their numbers tend to be depressed in areas disturbed by man's activities (Crowfoot 1957, 146). The relatively high numbers of these animals at the present site must therefore indicate thick grassland, scrub and/or hedges nearby, with very little disturbance by the friars.
weasel:	Today this animal is to be found in woodlands and hedgerows wherever there are voles and mice (King 1977, 340). Its presence therefore indicates that parts of the garden had sufficiently thick undergrowth to provide adequate cover.
hedgehog:	The ideal habitat is the quiet suburban garden rather than the open countryside, providing there is sufficient cover for nesting: fallen leaves; thick grassland; brambles or scrub (Morris 1966, 43–46).
3. SPECIES FAVOURING AQUATIC HABITATS:	
water shrew:	Mainly found by clear unpolluted streams and ponds wherever there is cover (Jenkins 1977, 59) and is rarely far from water (Konig 1973, 23). However, this animal has been observed in woods and pastures and even grubbing in the droppings of horses on a public road (Barrett-Hamilton and Hinton 1914–21; 139–140). Today, in the London area, increasing water pollution levels are driving water shrews away from rivers and streams (Burton 1966, 41) and it may be conjectured that similar circumstances forced water shrews living along the banks of the City ditch to seek new territory inside the walls, in the Greyfriars' garden.
water vole:	Although the water vole prefers to live on well vegetated banks of rivers and water-filled ditches, it is also found some distance from water, in gardens, and may be particularly abundant in orchards (Konig 1973, 111, Stoddart 1977, 199–200).

Fig. 11 Greyfriars Well: Summary of preferred habitats of the small mammals in the POM sample.

WOOD MICE: In early summer overwintered males become aggressive towards juveniles, as do adult females during pregnancy and care of their newborn offspring. This aggression promotes dispersal in juveniles whose chances of survival during this stressful period are drastically reduced (Montgomery & Gurnell 1984, Flowerdew 1984). It may be supposed that this social behaviour in mature males and females caused juvenile wood mice in the Greyfriars' garden to range more widely over previously unexplored and therefore unfamiliar territory, ultimately leading many of these inexperienced youngsters to their deaths through falling down the well.

BLACK RATS: Unlike its hardier cousin the brown rat *Rattus norvegicus*, which despite the temperate climate of Britain is able to live freely in the open countryside, the black rat is not really suited to living in northern latitudes, in a cooler and wetter environment than its sub-tropical homeland in southern Asia. Black rats living in Britain during the later medieval period would therefore have rarely ventured away from the warmth of human habitation (see Twigg 1984, 86–88) especially during the cold winter months. The presence of this species of rodent in the well must therefore indicate summer 'capture', the time when a few of the more intrepid younger rats were tempted to leave their nests in the friary buildings and/or the tenements along Newgate Street and Penticost Lane in order to scavenge in the nearby Greyfriars' garden. Unfortunately there are no surviving contemporary records to show that rats infested the Greyfriars' buildings, but their presence may be inferred from documentary evidence from other monastic houses in Britain. Two Account Rolls of Durham Abbey, for example, mention payments made to rat catchers for removing rats from the premises (rolls dated 1347 and 1356)[29].

RECONSTRUCTION OF THE GARDEN ENVIRONMENT CIRCA 1500

As discussed by Rackham (1982) small mammal bones from natural pitfall traps such as those from the well may be used in reconstructing the site environment. However, as pointed out by Levitan (1984, 124–125), it is only comparatively recently that the merits of using such material for this purpose have been recognised; hitherto, environmental archaeologists preferred to base their conclusions on pollen and molluscan evidence, where this was available, believing that since small mammals generally have a relatively small home range (up to 200 metres) they could only provide specific information relating to a limited area. As Levitan rightly says, it is the molluscs which should be regarded as reflecting the microenvironment; small mammals on the other hand are not so restricted in their activity (mobility) that they are unable to give a broader picture of the environment of a site. In this case, the small mammal fauna from the well can reveal important information not only about the condition of the ground in the immediate vicinity of the well opening but also much further away, thereby providing an overview of the whole of the convent garden. On the basis of modern ecological studies it has proved possible to identify some of the habitat preferences and niche requirements of the different species forming this small mammal assemblage and so construct a picture of the convent garden as it was *c.* 1500 (Fig. 11).

Site name/locality	Habitat(s)	References	N	S	$\bar{H}$	D
TUDOR:						
Post Office Middle, City of London	Greyfriars convent garden	Armitage	55	8	1.80	1.71
MODERN:						
South Manchester	urban/suburban: built-up areas, suburban gardens and railway embankments	Yalden (1980)	140	5	1.13	0.96
Outskirts of London	farmland: barn, ricks, granary and hedgerows	Davis (1956)	206	6	1.29	0.98
Essex countryside	farmland: arable fields, hedges	Corke *et al* (1969)	64	7	1.51	1.36
Bookham Common, Surrey	rural (semi-natural):	Lord (1961)				
	I grassland, thick vegetation		190	7	1.42	1.21
	II clearings, dense ground cover		91	4	1.13	1.02
	III woodland, dense ground cover		109	4	0.99	0.90
	IV woodland, sparse ground cover		53	3	0.58	0.42
Whipsnade Zoo, Bedfordshire	rural (semi-natural): strip of thick undergrowth, patches of willow herb and bramble	Reidy (1984)	50	4	1.12	1.07

Fig. 12 Greyfriars Well: Diversity in the small mammal fauna from the Greyfriars' well compared to modern suburban, agricultural and rural (semi-natural) habitats. N: total number of individuals; S: total number of species; $\bar{H}$: Shannon-Weiner information function (Shannon and Weaver 1949); D: Simpson's index of diversity (Pielou 1977, 309–11).

	Cattle	Cattle-sized	Sheep/goat	Sheep-sized	Pig	Dog	Cat	Fallow deer	Rabbit	Unidentified
Horn Core	7		22							
Skull	253	263	89	159		1	6		1	
Maxilla	50		20			2	2		1	
Mandible	35		20		2	7	6		1	
Teeth	89		39			12	2			
Scapula	2	1	1			5	5		1	
Humerus	16		4	2	5	2	7		1	
Radius	4		8			4	6			
Ulna	4		2		3	4	4			
Innominate	14	8	13	2		3	3		1	
Femur	24		7			5	3	1	1	
Tibia	6		5			8	6			
Fibula							3			
Carpal	1		3							
Metacarpal	18		6							
Tarsal	2		8							
Calcaneus	1		1			3	2			
Astragalus	2		1			1	4			
Metatarsal	15		5			2				
Metapodial			6			22	6		30	
1st Phalanx	3		2			}			}	
2nd Phalanx	2		1			} 43			} 32	
3rd Phalanx			4			}			}	
Sacrum	3		3			1				
Vertebrae	31	11	16	9	2	8			1	
Rib		16		41		28	13			
Hyoid			1							
Unidentified										3241
Total	582	299	287	213	12	161	78	1	70	3241
% of 4944	11.8	6.0	5.8	4.3	0.2	3.3	1.6	0.02	1.4	65.6
Weight	35,262	3067	5614	545	394	597	102	37	20	3807
% of 49,440	71.3	6.2	11.4	1.1	0.8	1.2	0.2	0.07	0.04	7.7
% fragments recovered by sieving	33	96	65	97		76	92		96	97

Fig. 13 Greyfriars Well: Large mammals: summary of skeletal elements.

From Fig. 11 it can be seen that there was an extraordinarily rich variety of habitats to be found in the Greyfriars' garden: thick grassland, scrub, water-filled ditches and/or ponds, and possibly also hedges and orchards. Taken as a whole the reconstructed picture is one of an overgrown and bankrupt garden, a scene which conflicts with the more traditional view of the idealised monastic garden in which the overall effect was one of 'ordered regularity' (McLean 1981). On the other hand, the friars generally, who never aspired to the degree of self-sufficiency characteristic of many of the regular monastic orders, seem to have been chiefly concerned with the provision of fruit and timber: the Commissioners' Surveys of friaries generally made just before the Dissolution show that the terms 'orchard' and 'garden' were used interchangeably. In the friars' garden at Ilchester were eight

	No. of bones	GL range		Bone	GL	BP	SD	BD	44	45	46	Withers Height Estimates: Range (cm)	Mean	General mean	Standard deviation	Coefficient variation
	7	224.1	242.4	Metatarsal	236.1	53.0	30.2	61.2				144.5–156.3	152.3			
Cattle	4			Horn Core					203.7	72.6	55.2					
	12	186.4	209.0	Metacarpal	198.4	61.3	36.5	64.5				114.3–128.1	121.6	132.9	15.73	3.6
									40	41	42					
Sheep	2	148.5	152.9	Radius	150.7	32.7	17.6	27.5				59.4–61.2	60.3			
	1			Humerus	143.8	39.3	15.5	31.9					60.7	60.5		
	10 (male)			Horn Core					150.9	53.1	39.5					
	3	127.9	171.5	Tibia	148.5	27.5	10.4	18.0				38.3–51.0	44.3			
Dog	2	127.7	167.8	Femur	147.8	29.9	10.3	24.3				38.8–51.4	45.1			
	1			Humerus	130.8		9.7	27.9					42.2			
	1			Ulna	178.2								50.1	45.1		
	1			Ulna	100.3											
Cat	1			Tibia	98.3	16.5	6.2	12.6								
	1			Humerus	89.7	15.1	6.7	15.5								
	1			Radius	84.5	7.6	5.2	11.8								
Rabbit	1			Femur	84.3	15.9	6.7	13.1								

Fig. 14 Greyfriars Well: Large mammals: measurements.

	Unidentified bird	Domestic fowl (*Gallus gallus*)	Domestic goose (*Anser anser*)	Rock dove (*Columba livia*)	Jackdaw (*Corvus monedula*)	Song thrush (*Turdus philomelos*)	Mistle thrush (*Turdus viscivorus*)	Skylark (*Alauda arvensis*)	Robin (*Erithacus rubecula*)	Garden warbler (*Sylvia borin*)	Ringed plover (*Charadrius hiaticula*)	Grey plover (*Pluvialis squatarola*)	Snipe (*Gallinago gallinago*)	Green sandpiper (*Tringa ochropus*)
Skull								1						
Mandible	1													7
Scapula								2						
Clavicula														1
Coracoid	1		1	2				2		1	1			1
Sternum	4	4						1						2
Humerus	3							4	1			2		2
Radius	4							2						2
Ulna	4			2	1			4				1		
Metacarpal	3	1		1		1	1	4	1					
Innominate	2													
Lumbosacrale	2							7						2
Femur	5							4	3			1	1	4
Tibiotarsus	7			1				7				3		2
Fibula	2													
Metatarsal	7	1	4		1			5				3	1	2
Phalanges	21													83
Vertebra	6													2
Rib														22
Tracheal rings														42
Sesamoid	4													
Unidentified														82
Total	77	6	5	6	2	1	1	43	5	1	1	10	2	256
% of 416	18.5	1.4	1.2	1.4	0.5	0.2	0.2	10.3	1.2	0.2	0.2	2.4	0.5	61.5
Min. no. of individuals	6	1	3	1	1	1	1	7	2	1	1	2	1	

Fig. 15 Greyfriars Well: Birds: summary of skeletal elements.

No. of bones	GL range		Bone	GL	BP	SD	BD	Did	Dip
3	99.5	133.4	Tibia	114.1		6.2	11.8		21.2
3	78.6	94.8	Femur	86.2	15.9	7.2	15.3		
3	34.8	46.9	MC	41.2	12.7			7.7	
3	64.9	90.9	Ulna	77.5	9.4	4.7		10.9	
2	74.2	84.3	MT.U	79.3	13.5	6.6	14.0		

Fig. 16 Greyfriars Well: Birds: measurements.

orchards and a grove containing 220 ash trees and a great number of elms (*ibid.*, 53–5), and it is perhaps in this context of husbandry that the London Greyfriars eastern garden should best be seen. If indeed the Greyfriars ever had a 'formal' garden it is more likely to have been confined to the centrally placed Great Cloister which in descriptions of the friary premises was said to contain 'The Garden', a name which persisted long after the area was paved over for use by Christ's Hospital (Kingsford 1915, 47–48).

An additional consideration is that, as has been seen, the Greyfriars' numbers at the Dissolution had fallen to a quarter of their strength in their heyday, and it is also likely that the financial support of the citizens on which the friaries were always largely dependent had also declined during the final decades of their existence. The Commissioners of visitation in 1538 reported the widespread ruination of both friary buildings and gardens in the Midlands, and on the sale of jewellery and the felling of timber in a desperate attempt to raise money (Knowles 1959, 362, 366). Although these extreme conditions were probably symptomatic only of the last year or so before the Dissolution, when popular support was finally withdrawn, it is more than likely that declining numbers and resources over the final few decades had led to a gradual neglect of peripheral activities, and that the maintenance of gardens had suffered in consequence.

Whatever the historical reasons for the wild overgrown state of the Greyfriars' convent garden, there also remains to be explained the biological phenomenon of the incredibly high species diversity in the small mammal population of this one area. Unfortunately, com-

	Pharyngeal	Dentary	Premaxillar	Skull fragment	Vertebrae	Denticle	Unident	Total
Ray						1		1
Elasmobranch					3			3
Eel					36			36
Conger eel					1			1
Herring				8	57			65
Sprat					25			25
Salmonid					4			4
Smelt					8			8
Dace	1							1
Roach	1			1	2			4
Cod					10			10
Haddock				2	1			3
Whiting	2	2	3	7	14			28
Hake				3				3
Tub gurnard					3			3
Plaice				5	9			14
Gadoid				5	1			6
Unidentifiable				12	3	1	124	140
Total	4	2	3	43	177	2	124	355

Fig. 17 Greyfriars Well: Fish: summary of skeletal elements.

Bone element	Species M.m.	A.s.	A.f.	M.a.	C.g.	A.t.	R.r.	S.m.	S.a.	N.f.	E.e.	M.n.	Total
skulls	—	1	—	—	—	—	—	4	5	3	1	1	15
maxillae	13	19	—	—	1	1	4	—	—	—	—	—	38
premaxillae	14 (mice & voles)												14
mandibles	27	24	—	4	1	—	2	2	11	9	2	2	88
	4 (mice)												
teeth				14		4							158
	136 (mice, voles & rats)								4 (common or water shrew)*				
scapulae	1	4	—	1	—	1	2	1	3	4	2	2	54
	32 (mice & voles)								1 (shrew)				
humeri	28	13	—	3	—	1	6	3	10	11	1	2	90
	12 (mice)												
radii	45 (mice & voles)					1	1						47
ulnae	22	26	—	1	1	1	4	2	7	8	—	—	72
innominate bones	12	13	—	3	—	1	2	2	6	9	—	1	88
	39 (mice & voles)												
femora	13	16	1	1	1	1	3	7	8	13	1	—	80
	15 (mice)												
tibiae	15	16	1	—	2	1	5	5	9	3	1	—	89
	31 (mice)												
metapodial bones	142 (not sorted to species)												142
phalanges	493 (not sorted to species)												493
vertebrae	1118 (not sorted to species)												1118
ribs							8					18	325
	299 (mice, voles & shrews)												
													2911
MNI	17	13	1	3	2	1	6	5	7	7	1	1	64

Fig. 18 Greyfriars Well: Small mammals: summary of skeletal elements and estimated minimum numbers of individuals (MNI) for each of the species identified: M.m., house mouse *Mus musculus*; A.s., wood mouse *Apodemus sylvaticus*; A.f., yellow-necked mouse *Apodemus flavicollis*; M.a., field (short-tailed) vole *Microtus agrestis*; C.g., bank vole *Clethrionmys glareolus*; A.t., water vole *Arvicola terrestris*; R.r., black rat *Rattus rattus*; S.m., pygmy shrew *Sorex minutus*; S.a., common shrew *Sorex araneus*; N.f., water shrew *Neomys fodiens*; E.e., hedgehog *Erinaceus europaeus*; M.n., weasel *Mustela nivalis*.

Bone	*R. temporaria*	*R. esculenta / R. lessonae*	*Rana* sp.
Mandible	1 (right)	—	—
Humeri	6	—	—
Radioulnae	—	—	8
Metacarpal/metatarsal/phalanges	—	—	21
Urostyle (coccyx)	3 (or 4*)	1*	—
Ilium	1 (left)	—	—
Calcanea	—	—	3
Astragali	—	—	3
Femora	5	—	—
Tibiae	—	—	9

Fig. 19 Greyfriars Well: Amphibians: summary of skeletal elements.

parison of this urban small mammal assemblage with contemporary rural faunas is not possible at this time for lack of published material. However, it is fascinating to contrast the very high values for faunal diversity[30] obtained for this London garden with the lower values for modern suburban, agricultural and semi-natural habitats (Fig. 12)[31]; the extraordinary rich species diversity found at this early Tudor urban site is nowhere matched by any of the modern samples. Species enrichment in the friary garden was undoubtedly due to the very wide variety of different habitats found in close proximity, which together formed what ecologists would call a 'patchy' environment (or *ecotone*). The garden can thus be regarded as a transitional or overlapping zone between more than one community of small mammal. As discussed by Odum (1971, 157–159) it is in such 'tension zones' that both the number of species present and the population densities of some of the species are greater than in the flanking communities; a phenomenon often referred to as the *edge effect*. The diversity level in the small mammal fauna from this site has been the subject of a special study, the results of which have been published elsewhere (Armitage 1985).

APPENDIX I

Report on the statistical analysis of the house mouse jawbones from the Greyfriars garden well and the collections of the B.M.(N.H.) by M. F. W. FESTING

A total of sixteen Tudor mouse mandibles (from the Greyfriars well) were received which appeared to be reasonably complete. However, when we attempted to measure them, mandible number 4 had five missing measurements, and was eliminated from the study. The remaining mandibles, together with seven mandibles from modern London mice in the collections of the B.M.(N.H.) were measured, as described by Festing (1972). Six mandibles had measurements number 6 and/or 8 missing, and it was decided to carry out the analysis on the nine remaining measurements. Mandibles numbered 3, 6 and 7 (from the Greyfriars sample) each had a missing measurement (measurements 5, 10 and 7 respectively). These were estimated by linear regression on two nearest measurements, using an unrelated sample of laboratory mice to calculate the regression coefficients.

As there may be bias in measuring left mandibles, a sample of twenty pairs of left and right mandibles from laboratory mice were measured in order to estimate the degree of such bias. The measurements for left mandibles were then multiplied by an appropriate factor so that the means of the left and right would be identical. In fact, the coefficient ranged from only 1.01 to 1.07 for measurements 2–11, though the coefficient was slightly higher (1.19) for measurement number 1. These corrections are unlikely to have had much effect on the overall results.

Following these various corrections, the 9 measurements on a total of twenty-two mice

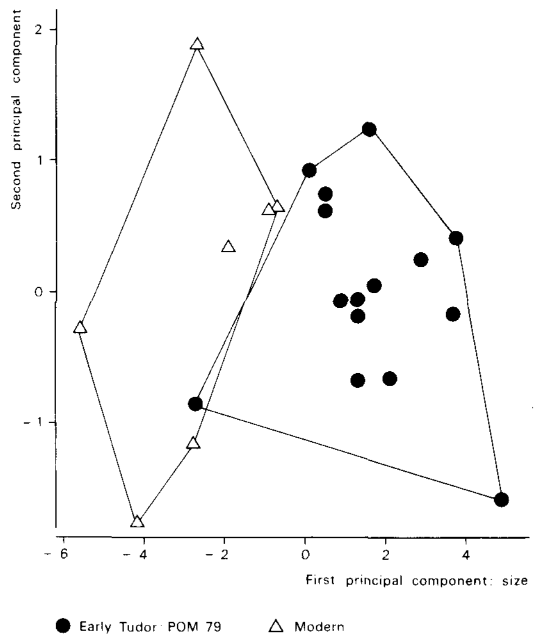


Fig. 20 Greyfriars Well: Statistical comparison of the jawbones of Tudor and modern house mice from London. Plot of the first and second principal components.

were subjected to a Principal Components Analysis.

There was only one principal component associated with a latent root greater than 1.0, and this was clearly a size factor as all the coefficients had the same sign, and were approximately equal. This component accounted for 84% of the total variation.

The second principal component is difficult to interpret, but it only accounted for 9% of the total variation, and did not distinguish between modern and Tudor mice, so can probably be neglected.

The graph of individual scores (Fig. 20) shows that fourteen out of the fifteen Tudor mice had a higher score on principal component one than any of the modern mice. In conclusion, the Tudor mice appear to be smaller than the modern mice; however as discussed by Armitage, this size disparity may reflect the sampling bias of pit fall trapping versus live-trapping (see note 18).

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NOTES

1. Site supervisor: John Burke-Easton.
2. Synopsis of the report on the pottery from the POM 79 well by Dr Alan Vince (Dept. of Urban Archaeology, Museum of London), 1985:

   The Greyfriars well was filled in at a time when Tudor pottery was in use and a broad date range of *c.* 1480 to *c.* 1550 would normally be given. The *terminus post quem* is provided by the sherds of Raeren stoneware vessels, which are first documented at the very end of the 15th century. A *terminus ante quem* is provided by the absence of Cologne stoneware vessels, which are common by *c.* 1550 but which were first produced in the second quarter of the 16th century.

   The absence of white-slipped Guy's ware bowls and Cistercian ware cups suggests a date at the earlier end of the date bracket, *c.* 1480–1500. If so, the pottery and the animal bones found with it are more than likely to be refuse from the occupation of the Greyfriars than from the dissolution period or later. Vessels are represented by several joining sherds and few show signs of abrasion or weathering. The implication is therefore that the pottery was thrown into the well on one or more occasions over a short period of time.

   The pottery would therefore support two hypotheses: either the well was filled in at one time or was filled over a limited period not discernable archaeologically, perhaps less than 50 years.
3. The successful recovery of large quantities of small mammal bones was entirely due to bulk sampling and wet sieving. On encountering an unusually high concentration of small animal bones, the site supervisor, John Burke-Easton (in consultation with P. Armitage), decided to carefully remove the last 0.5m depth of the deposit (between levels 9.835 and 9.335m OD). The infill (estimated volume: 0.39 cubic m) was then washed through a 1.5mm mesh sieve on site and the residue collected sent to the B.M.(N.H.) for sorting and analysis.
4. Work on the faunal material from POM 79 was carried out under contract to the Historic Buildings and Monuments Commission. Copies of the level III site archive and level II faunal record are housed at the Museum of London, where they may be consulted on request. All the animal bones are held in the collections of the British Museum (Natural History) where they may be inspected by prior appointment. Under the B.M.(N.H.) catalogue scheme, the collection from POM 79 has been assigned registration numbers DUA 1985.5000–5232.
5. The deed of surrender was signed on 12 November 1538 (Kingsford 1915, reptd 1965: 26).
6. Dogs and cats have also been found on all five other monastic sites (see section 3.1), and are assumed to represent stray scavengers or their use for security and pest control.
7. Suggestions explaining this last pathology would be welcomed by the author.
8. Wilson, 1973.
9. Ibid, p. 45.
10. Ibid, p. 42.
11. Ibid, p. 45.
12. Wheeler, 1979, 48.
13. Ibid., p. 80.
14. Ibid, p. 61.
15. Ibid, p. 61.
16. The term 'small mammal' is often taken to mean all animals up to

about 120g live-weight, following the definition of Delany (1976, 1). However, had this scheme been adopted for the Greyfriars material certain of the larger sized creatures found such as the hedgehog (*Erinaceus europaeus*), whose adult live weight may reach 1100g (Morris 1977, 31), would have been excluded from the analysis. Fortunately, zoologists sometimes extend the term to cover the intermediate sized wild mammals, with an upper live-weight limit of 5kg (see Stoddart 1979, *passim*). This latter approach was therefore adopted as the most appropriate one for dealing with the faunal material from the well.

17. MNI: This value derived from the totals of unpaired and paired elements, with the latter group matched on the basis of similar epiphysial fusion patterns and size (in limb bones) and on the evidence of comparable tooth eruption and wear stages (in upper and lower jawbones) after the method of Chaplin (1971, 70–75).
18. Sample bias: Experiments carried out in America to compare the efficiency of pit-fall trapping versus live-trapping in sampling a field population of voles (*Microtus townsendii*) revealed that pit-fall traps generally caught younger and therefore smaller animals, and if adults were present these were usually the smaller subordinate individuals (Boonstra & Krebs, 1978; Beacham & Krebs, 1980). Live trapping, on the other hand, resulted in the capture of larger adults who were generally the more dominant, aggressive individuals; the authors found that these animals frequently chased away juveniles and smaller subordinate adults during encounters around the baited traps. Although there seems to be no comparable study of the results of using different forms of trapping in sampling free-living house mice, observations made on laboratory animals has however revealed that the larger, socially superior individuals were more likely to enter live traps (Andrezejewski *et al* 1959). From these studies it may be suggested that younger inexperienced house mice together with socially inferior adults living in the Greyfriars garden had been much more prone to falling into the well, thereby resulting in a sample biased in favour of smaller individuals. The situation contrasts markedly with the animals in the modern sample in the collections of the B.M.(N.H.), which were all caught by means of live-trapping and therefore represent the other extreme where larger individuals predominate. The relatively higher incidence in the Greyfriars sample of male house mice compared to females, suggested by the innominate bones, may be explained by the behaviour of males, who traverse larger areas thereby increasing the probability or their encountering and falling into natural pit-fall traps such as the Greyfriars well (see Smith *et al* 1975, 38).
19. See Arnold and Burton (1978, 84) for a note on unusual hybrid relationship between edible, marsh and pool frogs.
20. Given as a subspecies of *R. esculenta* in Boulenger (1898); now accorded full species status by most authors.
21. No weight data is available for the fish, and many of the bird bones are so tiny that individual weighing is impractical.
22. Wilson 1973.
23. Ibid.
24. Fitter 1945, 106.
25. Wilson 1973.
26. Hunting ranges of owls: Field observation and tracking by radiotelemetry have shown that both tawny owl (*Strix aluco*) and the barn owl (*Tyto alba*) range widely in search of prey; in the space of a single night's hunting, the former species can cover an area up to 25ha (Southern 1954) and the latter between 25 and 30ha, during the non-breeding season (Lenton 1980a, 1980b, 1983 *pers. comm.*). These hunting ranges would certainly have taken any owl who might have been nesting or roosting in the Greyfriars garden out beyond the City walls and into the surrounding fields and woods. It is important to realise that in the early Tudor period there was still little systematic development of the outer suburbs of London and the open countryside extended up to the wall in many places (see Keene 1975; Platt 1976, 40). Inspection of contemporary maps of London reveals that the extra-mural settlement in the northwest was confined to a relatively small area centred on Smithfield, which was surrounded by arable fields, pastureland, orchards and small belts of woodland, forming ideal hunting areas for tawny and/or barn owls.
27. The fresh kestrel and barn owl pellets were supplied by Dr Philip Burton, subdept. of Ornithology, B.M.(N.H.), Tring, Herts.
28. Archaeological evidence of this bias towards *Microtus agrestis* in the owl's diet is provided by the deposit of small bones of late 12th–13th century date found overlying the *frigidarium* floor of the abandoned Roman bath house at Caerleon, South Wales, in which over 45% of the small mammal bones (interpreted as the accumulated remains of barn owl pellets) came from field voles (O'Connor 1983a, 110–113).
29. *Surtees Society* vol. 99 (1898) vol. I: 42; *Surtees Society* vol. 100 (1899) vol. II: 558. Rats are also known to have infested the monastic gardens at Norwich, where the monks found it necessary to hire a rat-catcher on more than one occasion (McLean 1981, 37).
30. The following indices of species diversity were chosen as the most reliable estimators of species richness:

(1) Shannon-Wienner information function (Shannon and Weaver 1949)

$$\bar{H} = -\sum \frac{(ni)}{N} \log \frac{(ni)}{N}$$

where ni = number of individuals for each species
N = total number of individuals (combined value for all species)

(2) Simpson's diversity index (Pielou 1977, 309–11)

$$C = \sum \frac{Nj(Nj-1)}{N(N-1)}$$

$$D = -\log C$$

where C = index of species concentration
D = index of diversity
Nj = numbers of individuals belonging to the jth species (J = 1. . . ., s; s = number of species)
Σ Nj = N = the total number of individuals (combined value for all species)

See also Odum (1971, 144); Pielou (1975, 5–18); Lambshead *et al* (1983).

31. In order to facilitate a direct comparison between the Greyfriars sample, representing a pit-fall deposit, and the modern material, sampled by means of live-trapping (mostly using Longworth traps), it was necessary when calculating values for species diversity to leave out animals larger than 60g live-weight as these are unable to enter Longworth traps due to the restricted size of the tunnel entrance (see Delany 1976, 2). Although immature weasels are under 40g live-weight and can therefore enter the Longworth trap, when fully grown they would be unable to do so since their weight increases to 85g and may even reach up to 202g in the adult male (King 1977, 339). It was therefore, decided to exclude this species from the calculations as the animal from the well was identified as a fully grown adult.

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