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Technical report: invertebrate remains from two samples from excavations at Broadgate, London (sitecode: BGA90)

by

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Summary

Two washovers of 10 litre sediment samples which had been processed by the excavator were submitted together with small vouchers of unprocessed sediment. Both samples were fills of a pit from Open Area 16 and attributed to period 9 (16th and 17th century) of the site.

Both washovers were very rich in insect remains, but the great majority were of a single species, and both vouchers of raw sediment yielded appreciable numbers of trichurid eggs.

The deposits were clearly faeces, with almost no evidence of other material from the remains examined here. Statistical analysis of measurements of the Trichuris *eggs strongly suggested that they were all of* T. trichiura *(the whipworm of humans) and hence that the faecal content of the deposits was primarily (if not exclusively) of human origin.*

KEYWORDS: BROADGATE; LONDON; INVERTEBRATE REMAINS; BEETLES; *THORACOCHAETA*; FLY PUPARIA; INTESTINAL PARASITIC NEMATODE EGGS; *TRICHURIS*; *ASCARIS*

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Introduction

An archaeological excavation was carried out by MoLAS at Broadgate, London. Two washovers of 10 litre sediment samples which had been processed by the excavator were submitted together with small vouchers of unprocessed sediment. Both samples were fills of a pit from Open Area 16 and attributed to period 9 (16th and 17th century) of the site.

Methods

The bulk of the samples had been processed (using a 250 micron flot sieve and a 1 mm internal sieving mesh) by MoLAS prior to submission to the EAU as washovers and small vouchers of unprocessed sediment.

The samples of raw sediment were inspected in the laboratory and their lithologies recorded using a standard *pro forma*.

Invertebrate remains were 'rapid scan' recorded (*sensu* Kenward 1992) in view of the overwhelming predominance of one taxon and the large size of the washovers (as compared with the small flots normally used for work on insect and other small invertebrate remains). Preservational condition of the invertebrate remains was recorded using the scheme of Kenward and Large (1998). In summary, preservation is recorded as chemical erosion (E) and fragmentation (F), in each case on a scale from 0.5 (superb) to 5.5 (extremely decayed or fragmented).

The samples were examined for the eggs of intestinal parasitic nematodes and other microfossils using the 'squash' technique of Dainton (1992). Measurements of maximum length (including and excluding polar plugs) and maximum width were taken using a calibrated eyepiece graticule at 400x magnification and subsequently converted to microns.

Although primarily for the detection of intestinal parasitic nematode eggs the 'squash' technique routinely reveals other microfossil remains, and where present (or markedly absent) these have also been noted.

Results

Both washovers were very rich in insect remains, but the great majority were of a single species. Preservation was characteristic (see below).

Context 850, Sample 31

Excavator's description and questions: Open area 16, Period 9 (16th and 17th century). Fill, soft dark reddish brown silt with some small artefacts. What biological remains are present? What was the function of this feature, was it a cess pit? Original volume of processed sediment: 10 litres.

Laboratory description of raw sediment: Dry, mid to dark brown, brittle, amorphous organic sediment, with pale flecks; working soft and slightly sticky when moistened.

A substantial proportion of the washover consisted of insect remains, almost all of which were puparia of the fly *Thoracochaeta zosterae*, believed to indicate extremely foul conditions, typically faeces, when found in archaeological deposits (see below). A faecal origin of this layer is supported by the presence of a range of foodplant remains and large numbers of eggs of intestinal parasitic nematodes. Other than the flies, insects (and other invertebrates) were unusually rare. There were a few beetles (Table 1), all being species likely to find their way into a latrine.

All of the parasitic nematode eggs seen in the initial microfossil 'squash' were of *Trichuris* (whipworm). Preservation of the eggs was variable (in particular the colour of the eggs ranged from very dark through to almost clear) but, overall, was recorded as 'good' (more than 40% of the eggs seen had retained both polar plugs). Further ‘squashes’ (a total of 3 slides) prepared in order to take measurements of the eggs were mostly of organic detritus with a little inorganic material. More than fifty *Trichuris* eggs per slide (a high concentration) were seen; almost all were measurable (excluding those partially obscured by detritus). A few fungal hyphae and two live soil nematodes were also noted, as was the absence of diatoms and phytoliths.

Context 851, Sample 32

Excavators description and questions: Soft, almost spongy, mid orangeish brown clayey silt with lenses of light brownish yellow and dark brown. Occasional chalk and charcoal fragments. What was the function of this feature, was it a cess pit? Original volume of processed sediment: 10 litres.

Laboratory description of raw sediment: Dry, mid to dark orangeish brown, slightly compressible, crumbly amorphous organic sediment of low density, remaining unconsolidated when moist. Traces of fish bone and textile fragments.

The washover was composed mainly of fly puparia, the vast majority of which were of *Thoracochaeta zosterae*. This deposit too appears to have been faecal, with plant remains likely to have passed the human gut. Quite large numbers of hairs were observed, the broader possibly human and the narrower perhaps wool. Insects other than the flies were rather rare, and consistent with a latrine. The spider beetle *Tipnus unicolor* is often found in cess pit groups, probably having lived in latrine buildings and being attracted to faeces: in nature it probably feeds on small amounts of decaying matter, which it finds by smell, the artificial conditions of the wet cess pit operating as a trap for the unwary beasts. Of the other beetles represented by more than one individual, *Hister merdarius* is strongly associated with very foul material (especially faeces and corpses), and *Quedius mesomelinus* (provisionally identified in the absence of associated genitalia) is regarded as part of the post-depositional fauna typical of wasting organic deposits. Among the other beetles, *Coprophilus striatulus* and *Aglenus brunneus* may also be post-depositional invaders, while *Ptinus fur* is a characteristic domestic species and *Cercyon terminatus* is usually found in foul matter.

Most of the parasitic nematode eggs seen were of *Trichuris* but four eggs of *Ascaris* (maw worm) were also noted. Preservation of the eggs was, again, rather variable (the colour of the eggs ranged from dark through to transparent) but overall not as good as that observed from Sample 31. Further ‘squashes’ (a total of 5 slides) prepared in order to take measurements of the eggs were mostly of organic detritus with a little inorganic material and, as with the previous sample, revealed some fungal hyphae, live soil nematodes (six), and an absence of both diatoms and phytoliths. More than thirty *Trichuris* eggs per slide were seen; almost all were measurable (excluding those partially obscured by detritus) but few (less than 10%) retained both polar plugs.

Discussion

These deposits were clearly faeces, with almost no evidence of other material from the remains examined here. Plant remains were predominantly of edible species, including cereal bran, and apple and grape pips, and bone was mostly small enough to have been eaten. The fly *Thoracochaeta zosterae* has been subject to long-standing nomenclatural confusion (with the ‘latrine fly’ *Teichomyza fusca* Macquart), discussed by Belshaw (1989). On the basis of its modern biology it is not a fly which would be predicted to be found in abundance in archaeological deposits; it is now typically found in seaweed. However, it is very characteristic of ancient cesspits (Webb *et al*. 1998), so presumably conditions in these foul deposits were somehow especially favourable for it (e.g. Kenward and Hall 1995, 593, 747).

Many cess pit fills include ‘house fauna’ and other remains suggesting the possibility that floor sweepings were dumped into them, perhaps as a convenient way of covering the faeces (e.g. at The Brooks, Winchester, Carrott *et al*. 1996). There is no evidence for this practise in the present case, however. Even more surprising is the lack of fleas and lice, and of aquatic insects and Crustacea (aquatic microfossils such as diatoms were absent, too). This is not likely to be a result either of examining bulk-sieved material or of the rather odd preservational condition of the remains, and it seems that this pit was exclusively for excrement (and presumably urine), not even receiving washing water or combings. While water may have been from a clean source, accounting for the lack of aquatics, it is most unlikely that the user community was devoid of ectoparasites at this period in view of their ubiquity in the archaeological record and the numerous literary references to them as inevitable companions of even high-class citizens (e.g. Busvine 1976).

A further group of remains which is conspicuous by its absence is pests of stored food: no grain pests or bean weevils were found. Beans and peas may not have been eaten, and cereals may have been very finely milled and sieved, but another explanation might be that these faeces were of people with a food supply of high quality.

The preservational condition of these remains is a little unusual, and it seems very likely that they were undergoing recently-initiated in-ground decay. The rather uniform decolouration of the puparia and of many of the beetles is reminiscent of remains from superficial deposits in York suspected of recent, probably ongoing, decay (Kenward and Hall 2000). On the basis of observations of many stored samples from various sites, decay in storage seems unlikely to account for the condition of the fossils, even though the sediment appear to have dried out somewhat in storage.

Identification of trichurids to species from their eggs is problematic in that the size ranges for different species often overlap significantly (Fig. 1). In the case of the remains from this site the problem is to distinguish between *Trichuris trichiura* (Linnaeus), the whipworm of humans, and *T. suis* (Schrank), of pigs; a particularly difficult task given that the size range for *T. trichiura* is a wholly contained subset of that for *T. suis*. Table 2 shows the egg measurements for each sample and Fig 1 shows the measurements with commonly quoted size ranges for *T. trichiura* and other trichurids of some common domesticated animals given as boxed overlays. Fig. 2 shows the measurement data on shorter scale axes and includes error bars.

Three of the data points fall wholly outside the ranges (allowing for error) for either *T. trichiura* or *T. suis* these may represent aberrant eggs, or could reflect 'in-ground' changes in egg morphology (all of the overlayed boxes for egg size ranges are based on limited sets of published 'modern' data). No real study of changes in egg morphology caused by varying ground conditions and states of preservation has been undertaken and comparison with modern data, though valid, must, of necessity, be cautious. However, forty-seven of the measurements fall within the range for modern *T. trichiura* and the remaining ten within the range for *T. suis*.

Mean values for polar plug to polar plug maximum length and maximum width for each sample were calculated. Sample 31 gave a mean length of 53.06 microns (standard deviation 2.62 microns) and mean width of 24.02 microns (standard deviation 0.85 microns). Sample 32 gave very similar values with mean length of 53.38 microns (standard deviation 2.47 microns) and mean width of 23.75 microns (standard deviation 1.09 microns). Table 3 gives summary descriptive statistics for each sample.

Frequency plots for the data for each sample and for the combined data from both samples (Fig. 3) show approximately normal distributions in each case (with varying skewness) but there is no indication of a bimodal distribution which would be expected if two species were present. Overall, the eggs appear to be from only one population (t-statistic values for the polar plug to polar plug maximum lengths and maximum widths are –0.48 and 0.98 respectively, supporting the hypothesis of the same underlying population and equal means) with a mean maximum length (including polar plugs) of 53.22 microns (standard deviation 2.53 microns) and mean maximum width of 23.89 microns (standard deviation 0.98 microns), strongly suggesting that the eggs are of *Trichuris trichiura*. That individual data points for the measurements fall outside the size range given for modern *T. trichiura* is perhaps most likely to be due to taphonomic processes but objective investigation of the effects of, for example, different soil chemistries on egg morphology has yet to be undertaken.

Some supporting (negative) evidence that the deposits contained only human faecal material is provided by the very low ratio of *Ascaris* (absent from Sample 31) to *Trichuris* eggs—Taylor (1955) has remarked that the opposite case may be indicative of pig, rather than human, faeces.

Retention and disposal

All of the current material should be retained for the present.

Archive

All material is currently stored in the Environmental Archaeology Unit, University of York, along with paper and electronic records pertaining to the work described here.

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Table 1. *Broadgate, London: insect remains from two samples.* ***Key****: m – 'many' and s – 'several'*, sensu *Kenward 1992*.

Taxon	**Context 850, Sample 31**	**Context 851, Sample 32**
Erosion:	E 2.0-3.5, mode 2.5 weak	E 1.0-3.5, mode 2.0 weak
Fragmentation:	F 1.5-3.5, mode 2.0 weak	F 1.0-2.5, mode 2.0 weak
Oligochaeta sp. (egg capsules)	>100	-
Thoracochaeta zosterae (Haliday) (puparia)	>500	several thousand
Sphaeroceridae sp?p. indet. (puparia)	m	s
Diptera sp. (puparium)	s	s
Diptera sp. (adult)	1	1
Laemostenus ?*terricola* (Herbst)	-	1
Cercyon terminatus (Marsham)	-	1
Hister merdarius Hoffmann	2	2
Coprophilus striatulus (Fabricius)	-	1
Philonthus sp.	1	-
Quedius ?*mesomelinus* (Marsham)	2	6
Staphylininae sp. indet.	-	1
Aleocharinae sp.	1	1
Tipnus unicolor (Piller and Mitterpacher)	1	7
Ptinus ?*fur* (Linnaeus)	-	1
Mycetaea hirta (Marsham)	-	1
Aglenus brunneus (Gyllenhal)	-	1
Coleoptera sp. (larva)	-	1
Parasitica sp.	-	1

Table 2. *Broadgate, London: Measurements for trichurid eggs in microns. All measurements for Sample 31 are taken directly from the eggs. For Sample 32 polar plug to polar plug measurements are calculated from the length excluding polar plugs measurements except where asterisked.* ***Key****: p-p = polar plug to polar plug maximum length; xpp = maximum length excluding polar plugs; w = maximum width.*

Context 850, Sample 31			**Context 851, Sample 32**		
p-p	xpp	w	p-p	xpp	w
55.00	50.00	26.25	53.75	50.00	22.50
52.50	47.50	23.75	55.00*	51.25	24.38
56.25	51.25	25.00	53.13	49.38	24.38
58.75	53.75	25.00	51.25*	47.50	25.00
52.50	47.50	25.00	56.25	52.50	24.38
53.75	48.75	22.50	54.38	50.63	22.50
52.50	47.50	23.75	48.13	44.38	22.50
51.25	46.25	23.75	58.75	55.00	25.63
52.50	47.50	25.00	59.38	55.63	24.38
57.50	52.50	22.50	58.13	54.38	26.25
47.50	42.50	23.75	53.13	49.38	25.00
53.75	48.75	23.75	52.50*	48.75	23.13
57.50	52.50	23.75	53.75	50.00	23.13
55.00	50.00	24.38	50.63	46.88	22.50
52.50	47.50	22.50	51.25*	47.50	25.00
52.50	47.50	23.75	51.25*	47.50	23.75
51.25	46.25	23.75	51.88	48.13	23.13
55.00	50.00	23.75	53.13	49.38	22.50
52.50	47.50	25.00	53.75	50.00	23.13
53.13	48.13	23.75	50.00*	46.25	23.75
54.38	49.38	23.13	50.63	46.88	22.50
52.50	47.50	24.38	53.75	50.00	23.75
51.25	46.25	24.38	53.75	50.00	23.13
53.13	48.13	25.00	53.75	50.00	22.50
55.63	50.63	23.13	54.38	50.63	25.00
50.00	45.00	24.38	53.13	49.38	23.75
51.88	46.88	23.75	52.50*	48.75	23.13
51.25	46.25	24.38	53.75	50.00	24.38
46.88	41.88	23.75	51.88	48.13	22.50
51.88	46.88	23.75	54.38	50.63	25.00

Table 3. *Broadgate, London: Descriptive statistics for polar plug to polar plug maximum length (l) and maximum width (w) measurements by sample.*

Sample 31 (l)		*Sample 32 (l)*		*Sample 31 (w)*		*Sample 32 (w)*	
Mean	53.06	Mean	53.38	Mean	24.02	Mean	23.75
Standard Error	0.48	Standard Error	0.45	Standard Error	0.15	Standard Error	0.20
Median	52.50	Median	53.44	Median	23.75	Median	23.75
Mode	52.50	Mode	53.75	Mode	23.75	Mode	22.50
Standard Deviation	2.62	Standard Deviation	2.47	Standard Deviation	0.85	Standard Deviation	1.09
Sample Variance	6.88	Sample Variance	6.08	Sample Variance	0.72	Sample Variance	1.19
Kurtosis	0.76	Kurtosis	1.02	Kurtosis	0.58	Kurtosis	-0.78
Skewness	-0.07	Skewness	0.61	Skewness	0.28	Skewness	0.46
Range	11.88	Range	11.25	Range	3.75	Range	3.75
Minimum	46.88	Minimum	48.13	Minimum	22.50	Minimum	22.50
Maximum	58.75	Maximum	59.38	Maximum	26.25	Maximum	26.25
Sum	1591.88	Sum	1601.25	Sum	720.63	Sum	712.50
Count	30	Count	30	Count	30	Count	30

Fig. 1. *Plotted trichurid egg measurements with overlay of size ranges for eggs of trichurids of several common domesticated animals and Trichuris trichiura. Larger circles represent multiple coincident measurements. Maximum length includes polar plugs.*

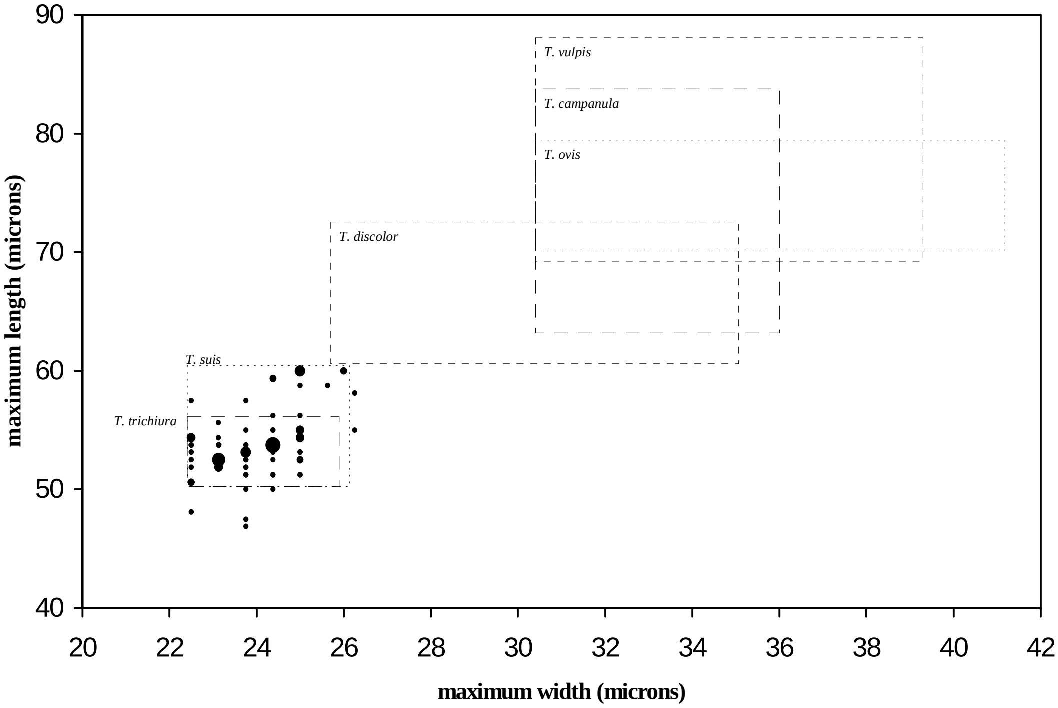

Fig. 2. *Plotted trichurid egg measurements with overlay of size ranges for eggs of* Trichuris trichiura *and* T. suis. *Error bars are +/- 0.25 of a graticule division or 0.625 of a micron representing the resolution of the measurements. Larger circles represent multiple coincident measurements. Maximum length includes polar plugs.*

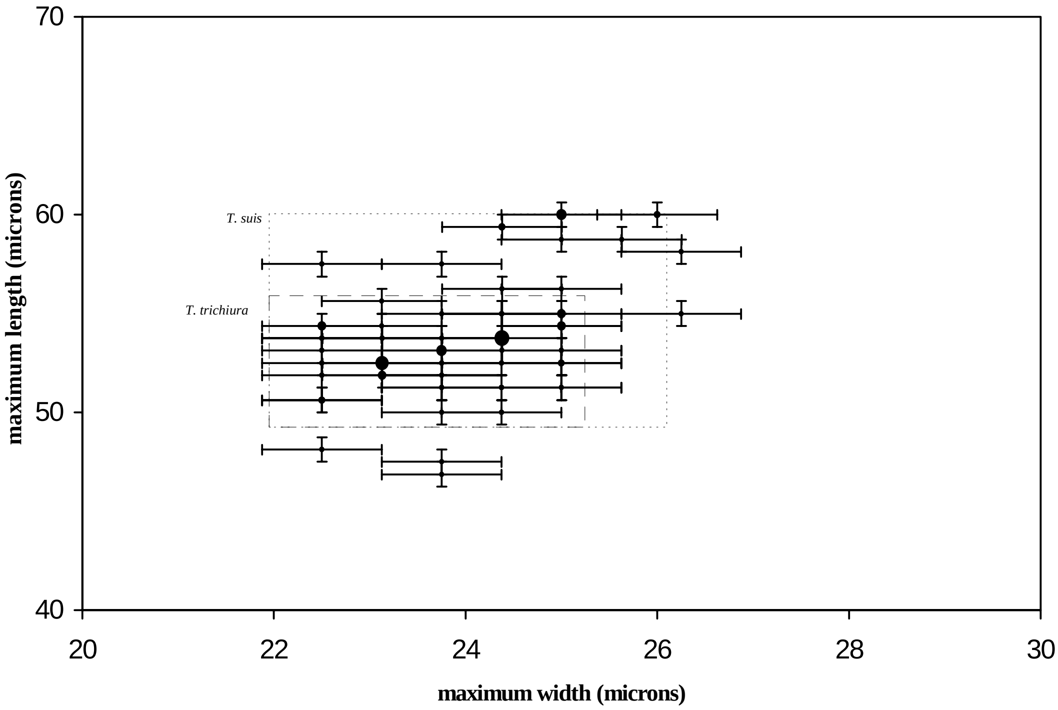

Fig. 3. *Histograms of the distributions of polar plug to polar plug maximum length and maximum width measurements by sample and for the combined data from both samples.*