Settling the Ebbsfleet Valley

High Speed 1 Excavations at Springhead and Northfleet, Kent
The Late Iron Age, Roman, Saxon, and Medieval Landscape

Volume 3: Late Iron Age to Roman Human Remains and Environmental Reports

By Catherine Barnett, Jacqueline I McKinley, Elizabeth Stafford,
Jessica M Grimm, and Chris J Stevens

Settling the Ebbsfleet Valley

High Speed 1 Excavations at Springhead and Northfleet, Kent
The Late Iron Age, Roman, Saxon, and Medieval Landscape

Volume 3: Late Iron Age to Roman Human Remains and Environmental Reports

by Catherine Barnett, Jacqueline I McKinley, Elizabeth Stafford,
Jessica M Grimm, and Chris J Stevens

Settling the Ebbsfleet Valley

High Speed 1 Excavations at Springhead and Northfleet, Kent
The Late Iron Age, Roman, Saxon, and Medieval Landscape

Volume 3: Late Iron Age to Roman Human Remains and Environmental Reports

by Catherine Barnett, Jacqueline I McKinley, Elizabeth Stafford,

Jessica M Grimm, and Chris J Stevens

with contributions from

Martin Bates, Nigel Cameron, Sheila Hamilton Dyer, David Norcott, Rob Scaife, David Smith, Wendy Smith, Ian Tyers, Fay Worley, and Sarah F Wyles

Illustrations by
Rob Goller

Oxford Wessex Archaeology

2011

This book is the third of a series of monographs by Oxford Wessex Archaeology (OWA)

ISBN 978–0–9545970–4–7

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Published by Oxford Wessex Archaeology,
a joint venture between Oxford Archaeology and Wessex Archaeology

Oxford Archaeology, Janus House, Osney Mead, Oxford OX2 0ES, Registered Charity No. 285627
Wessex Archaeology, Portway House, Old Sarum Park, Salisbury SP4 6EB, Registered Charity No. 287786

Designed and typeset by Kenneth Lymer, Wessex Archaeology
Cover illustration by Peter Lorimer
Printed and bound by Cambrian Printers, Aberystwyth

Contents

List of Figures

List of Plates

List of Tables

(Tables on website are shown in *italics*)

Preface

by Paul Booth and Phil Andrews

This volume presents specialist reports, and illustrations and tables, on the late Iron Age and Roman human bone, and faunal and environmental remains recovered during archaeological investigations in the Ebbsfleet valley, near Gravesend, Kent. It is the third part of a four volume publication on investigations at Springhead and Northfleet, undertaken in connection with engineering works for Section 2 of the Channel Tunnel Rail Link (CTRL), now High Speed 1 (HS1). The archaeological discoveries made during HS1 Section 2, which range in date from the late Iron Age to the medieval period, are reported in Volume 1. Specialist reports on the Iron Age and Roman artefacts are reported in Volume 2, while those on the Saxon and medieval artefacts, human bone, and faunal and environmental remains are reported in Volume 4; additional data is available via the website (http://owarch.co.uk/hs1/springhead-northfleet/). These reports have been prepared by the Oxford Wessex Archaeology Joint Venture in conjunction with Rail Link Engineering for Union Railways (North) Limited (URN).

High Speed 1 is the new high-speed railway linking London mainline stations to the Channel Tunnel. Section 1 of HS1, running from the tunnel portal at Folkestone, passes through Kent to Pepper Hill near Gravesend, whilst Section 2 continues the line under the Thames at Swanscombe, and then runs through Essex and East London to London St Pancras.

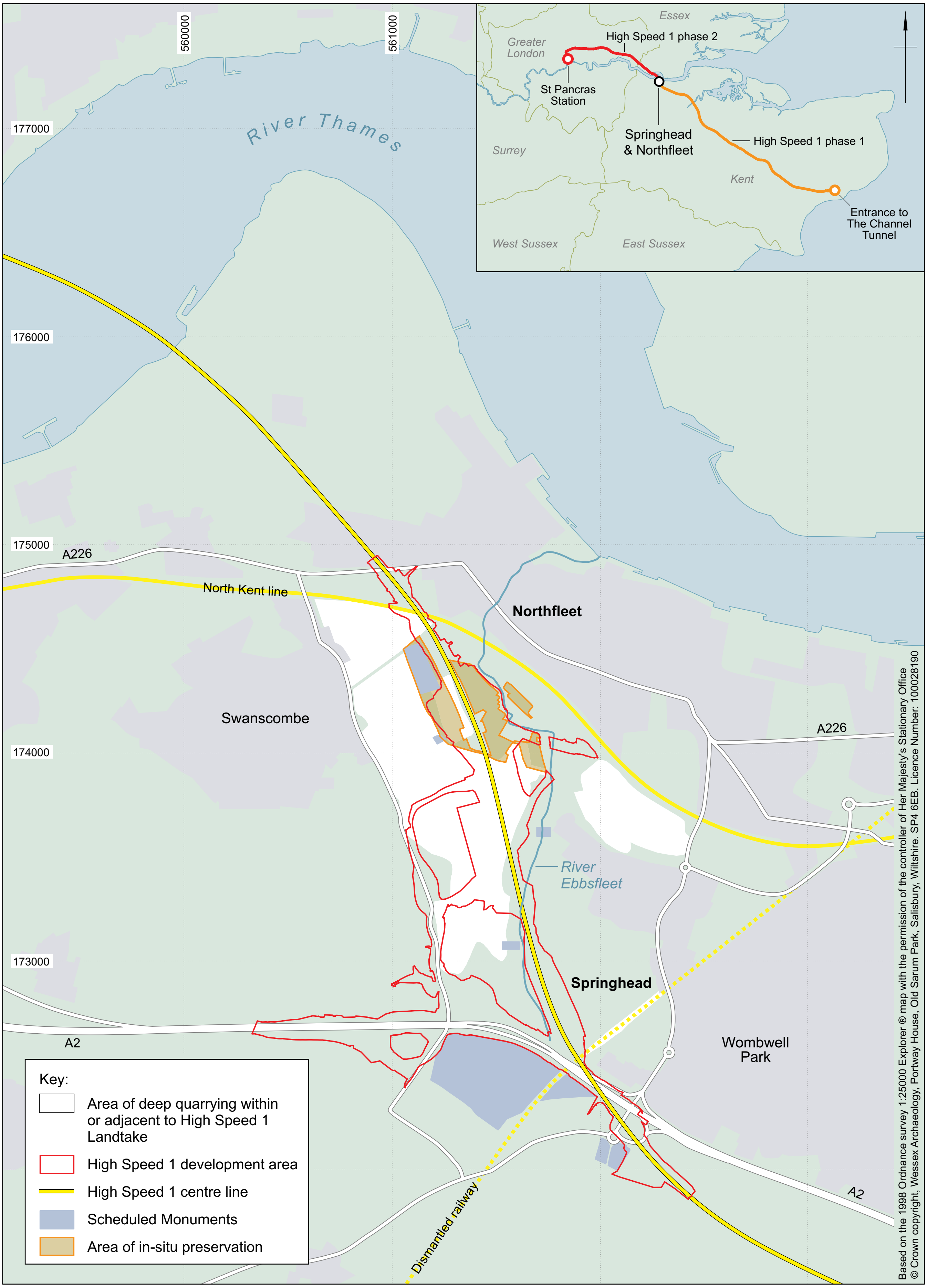
The massive engineering and construction project necessitated one of the largest programmes of archaeological works ever undertaken in Britain. Desk-based assessment was followed by extensive evaluation, comprising field walking, trial trenching, test pitting and borehole investigation. This allowed HS1's impact on the finite archaeological resources along the route to be assessed and mitigated. Where archaeological sites could not be bypassed, or preserved *in situ*, excavations were undertaken in advance of construction. The principal archaeological work for Section 1 took place in 1998–2001, while that for Section 2, commissioned by URN, took place between September 2000 and March 2003.

Construction work relating to Section 2 in the Ebbsfleet valley included HS1 itself, Ebbsfleet International Station and associated access roads, and a connecting line to the existing North Kent Line. Oxford Archaeology undertook detailed excavation and a watching brief on land south of Northfleet, centred on NGR 516413 174196, towards the north end of the valley, while Wessex Archaeology undertook detailed excavation, strip, map and sample excavation, evaluation and a watching brief on various sites around the south end of the valley, at Springhead, centred on NGR 618000 727500.

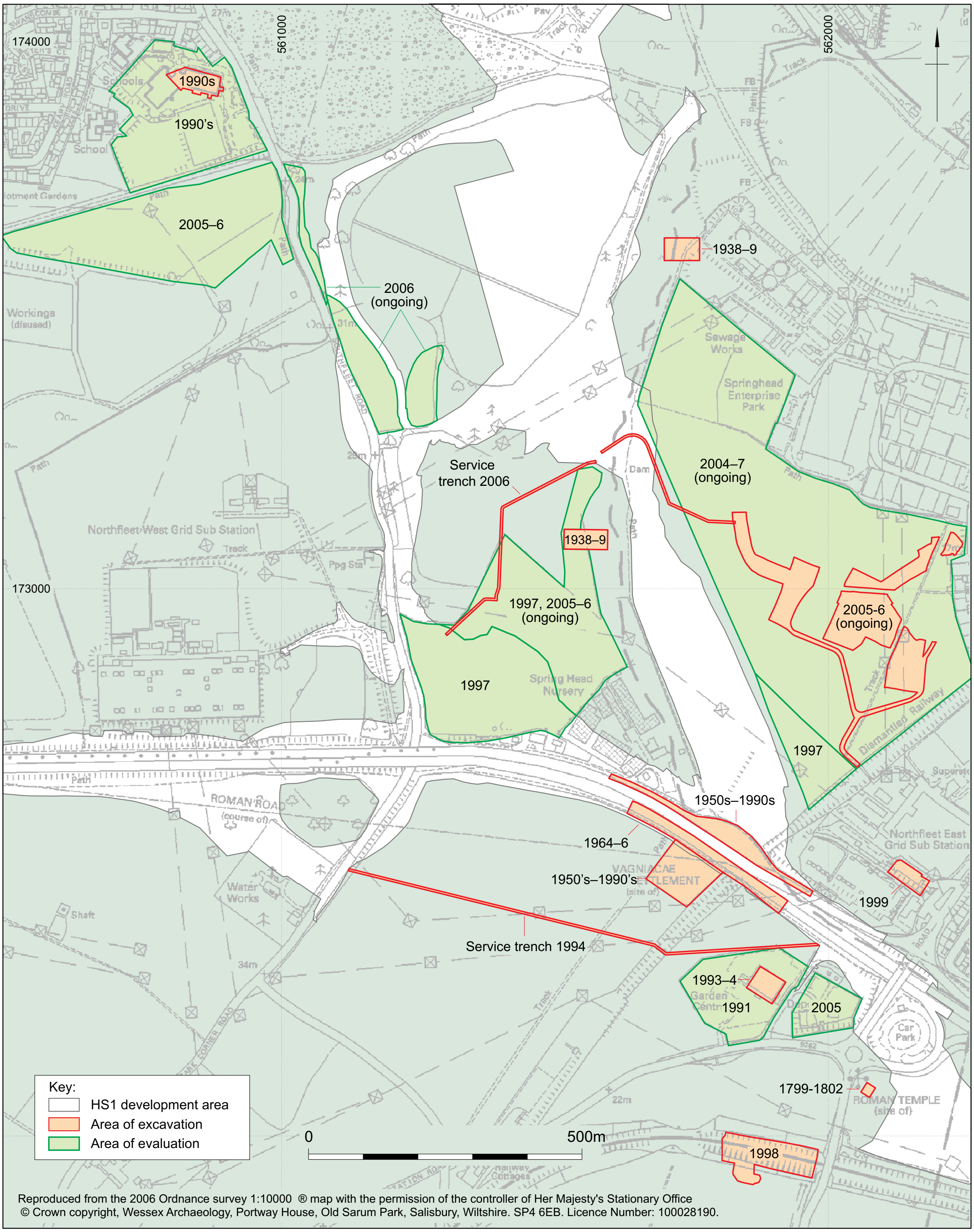
Following completion of the HS1 programme of work in 2003, there have been further, sometimes extensive investigations within and adjacent to the Ebbsfleet valley, in advance of infrastructure works and housing and commercial developments. Although these have revealed Palaeolithic and other early prehistoric remains, as well as further discoveries of late Iron Age, Roman, and Saxon date, it is not anticipated that any major revisions will be required to what is presented in this publication.

The four volumes of this publication comprise one of two separate archaeological studies reporting on the HS1 Section 2 excavations in the Ebbsfleet valley. The other publication, on 'Prehistoric Ebbsfleet', focuses on Palaeolithic, Mesolithic, Neolithic, Bronze Age and earlier Iron Age activity. The present publication, 'Springhead and Northfleet', concentrates on Roman and later activity, but also takes into account the late prehistoric origins of the Roman occupation of the area. The overlap with Prehistoric Ebbsfleet study, however, is slight as the most important later prehistoric remains – the late Iron Age ritual or ceremonial activity near the Ebbsfleet spring at Springhead – are outside the period covered by the Prehistoric Ebbsfleet study.

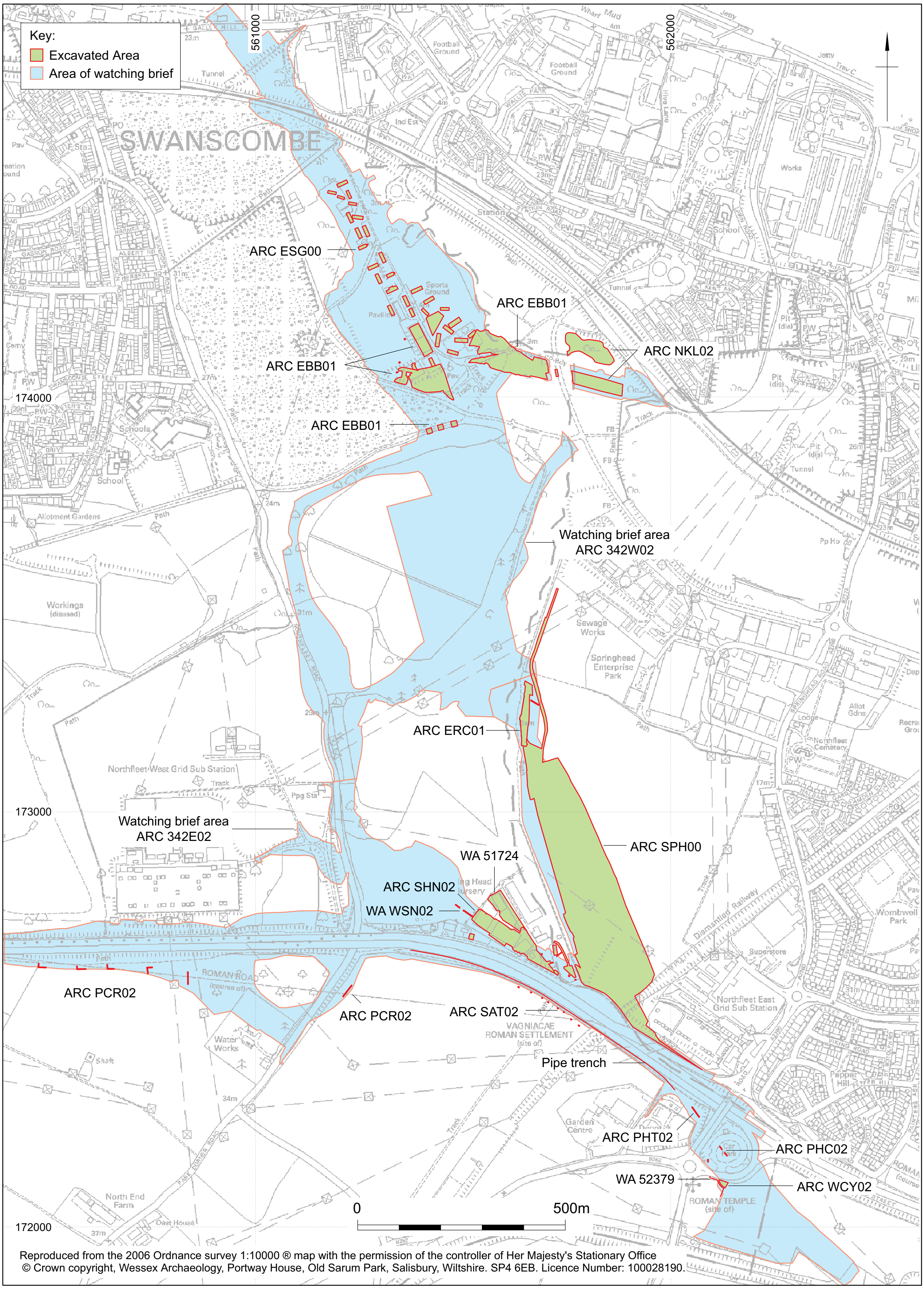
The Springhead and Northfleet publication reports on three major excavations, as well as on minor excavations, evaluations and other investigations, both HS1 and non-HS1. The principal discoveries comprise late prehistoric, Roman, and Saxon features at Springhead, including a sanctuary complex within the Roman town of *Vagniacis*, and two mid-Saxon cemeteries to its east (site code: ARC SPH00); the Roman roadside settlement at Springhead Nursery (site codes: ARC SHN02 and WA 51724); and late prehistoric, Roman, and Saxon features at Northfleet, where a middle Saxon watermill was discovered immediately adjacent to the Northfleet Roman villa (site code: ARC EBB01). Investigations were also undertaken on the site of a Roman high status walled cemetery south-east of Springhead, first investigated between 1799 and 1802 (site codes ARC WCY02 and WA 52379). This publication also consider the results of excavations at two HS1 Section 1 sites, the Pepper Hill Roman cemetery which is associated with *Vagniacis*, and the rural settlement at West of Northumberland Bottom, to the east of Springhead. Finally, the results of earlier (as well as on-going) non-HS1 investigations and excavations undertaken by a variety of groups at both



HS1 Sections 1 and 2, and map of the Ebbsfleet Valley and surrounding area showing HS1 development area at Springhead and Northfleet



Map of Springhead and surrounding area showing non-HS1 Section 2 archaeological investigations



Map of the Ebbsfleet Valley showing HS1 and non-HS1 archaeological investigations (with site codes)

Springhead and Northfleet: concordance of principal sites, by site code / name and periods

Period	Pre-LIA	LIA	ERB	MRB	LRB	E / MS	LS	Med	P-med / Mod
Springhead									
ARC SPH00 (sanctuary site)	✓	✓	✓	✓	✓	✓	✓	✓	✓
ARC ERC01 (Ebbsfleet River crossing)	✓		✓						
ARC SHN02 (roadside settlement)			✓	✓	✓			✓	
ARC WCY02 (walled cemetery)				✓					
ARC 342E02 (watching brief)			✓	✓	✓	✓		✓	✓
WA 51724 (part of roadside settlement)			✓	✓	✓			✓	
Northfleet									
ARC ESG00 (sports ground)	✓	✓	✓	✓	✓	✓			
ARC EBB01 (villa/mill site; western complex wetlands)	✓	✓	✓	✓	✓	✓		✓	✓
ARC NKL02 (North Kent Line)	(✓)								
ARC 342W02 (watching brief)	(✓)								

(✓) – Sedimentary sequences only

Springhead and Northfleet Roman villa, including work on the South Thameside Development Route 4, are considered.

The detailed specialist reports in this volume of the Springhead and Northfleet publication cover the late Iron Age and Roman human bone and animal bone assemblages recovered during the reported excavations, as well as environmental remains and dating evidence relating to contemporary landscape, and subsistence and economy.

The report on the human remains analyses the assemblage from Springhead, which comprises a single cremation burial and a minimum of 48 inhumation burials, and a single inhumation burial of a neonate from within the Northfleet villa complex. At Springhead, four of the inhumations were in a small cemetery on the south-western margin of the roadside settlement, the rest comprising small groups and singletons scattered across both the roadside and the settlement sanctuary site; in two cases dual burials were made within one grave. In addition, two contexts contained whole or partial skulls which appear to have been deliberately placed, while other bones had been redeposited in a variety of features, including a 'ritual shaft', or within spreads and layers across the areas of occupation.

Over 68,000 fragments of animal bone were recovered, from Springhead (*c* 82%) and Northfleet (*c* 18%), including many complete animal skeletons. At Springhead, from the late Iron Age at the sanctuary site, and in the Roman roadside settlement, the assemblages are dominated by sheep/goat, followed by pig and cattle, while that assemblage from the Northfleet Roman villa at is dominated by cattle, followed by sheep/goat and pig. In addition, 286 fish bones were recovered, from both marine and freshwater species. The environmental evidence for Roman subsistence and economy is presented in reports on charred plant remains, wood charcoal and marine shell.

Environmental sequences and remains relating the development of the Roman landscape were recovered, from both the upper Ebbsfleet valley at Springhead and the lower valley at Northfleet, from a range of locations, including waterlogged alluvial and peat sequences associated with the river edge, as well as calcareous colluvial deposits and soils upslope. This range of evidence is presented in reports on sediments and soils, pollen, diatoms, molluscs, waterlogged plant remains and insects, with dating evidence presented in reports on radiocarbon dating and dendrochronology.

Radiocarbon determinations were calibrated using OxCal ver 3.10 (Bronk Ramsey 1995; 2001) utilising the atmospheric data presented by Stuiver *et al* (1998) and expressed at the 94.5% confidence level (2 sigma level with the end points rounded outwards to 10 years) following the form recommended by Mook (1986).

Chapter 1
Human Bone

by Jacqueline I McKinley

Human remains were recovered from 133 contexts, 100 from the Sanctuary site (ARC SPH00) and 33 from the Roadside Settlement (ARC SHN02) (Table 1; Figs 1–2; human remains from Northfleet are described separately below). The majority of the deposits (104) were of Roman date and the rest (29) Anglo-Saxon (see Vol 4). The bone from all except one context is unburnt, that from 6355 representing the remains of a Roman cremation burial. The Roman assemblage includes the remains from a minimum of 48 inhumation burials, four from a small cemetery on the south-western margin of the Roadside Settlement with the rest comprising small groups and singletons scattered across the Sanctuary site and the Roadside Settlement. In two cases dual burials were made within one grave: 12214 and 12224 in pottery vessel 12222 and 5164 and 5165 within grave 5162. Four other deposits may represent the remains of *in situ* burials but the material could have been redeposited (see below). Two contexts contained whole or partial skulls which appear to have been deliberately placed (2997 and 10186). Bone from the remaining contexts (37) had been redeposited in a variety of features, including 'ritual shaft' 2856, or within spreads and layers across the areas of occupation.

Methods

Recording and analysis of the cremated bone followed the writer's standard procedure (McKinley 1994, 5–21; 2000). The minimum number of individuals amongst the redeposited material was assessed from counts of the most commonly occurring skeletal elements in association with contextual information and distribution (McKinley 2004a). Age (cremated and unburnt bone) was assessed from the stage of skeletal and tooth development (Beek 1983; Scheuer and Black 2000), and the patterns and degree of age-related changes to the bone (Moorees *et al* 1963; Buikstra and Ubelaker 1994). Sex was ascertained from the sexually dimorphic traits of the skeleton (Bass 1987; Buikstra and Ubelaker 1994). The variable integrity of the attributed sex is denoted in Table 1 as: '??'most likely, '?' probable and un-questioned.

A standard series of measurements was taken where possible (Brothwell and Zakrzewski 2004) to enable the calculation of various skeletal indices including stature and cranial index (Trotter and Gleser 1952; 1958: Brothwell 1972, 88; Bass 1987). Non-metric traits were recorded in accordance with Berry and Berry (1967) and Finnegan (1978). The degree of erosion to the bone was recorded using the writer's system of grading (McKinley 2004a, fig. 6.1–7).

Results

A summary of the results from analysis is presented in Table 1. Full details are in the archive.

Bone Condition and Survival

The surviving depths of the Roman graves varied from 0.04 m to 0.77 m with an average of 0.18 m. The majority of the *in situ* remains recovered comprise those of neonates, the surviving depth of the graves having a range of 0.04–0.2 m, average 0.08 m; the non-neonate graves had a range of 0.1–0.77 m with an average depth of 0.36 m. Intercutting between graves occurred in only one instance, part of the right leg being removed from burial 3485 by the insertion of grave 3142 in the Sanctuary enclosing ditch. Disturbance of burials by later features was also rare, disturbance in antiquity to the dual burial made in pottery vessel 12222 in the south-west corner of the probable temenos associated with the temple in property 2 and pit 3167 cutting grave 3170 representing the only examples. A small amount of bone may have been lost from the shallowest adult (3142; 0.1 m) and neonatal (5162; 0.04 m) graves. The grave cuts for at least 14 of the *in situ* neonates were not, however, observed in excavation (denoted * in Table 1) and the presence of neonatal human bone was not always noted on site. The unexpected location, small size and shallow depth of neonatal graves, often cut through and immediately backfilled with dark soils forming layers or the upper fills of pits or ditches, can render their recognition difficult in excavation. Lack of familiarity with neonatal human bones by the excavator – a common occurrence – often means that such young human remains are not recognised at the time of excavation (particularly when large quantities of animal bone are present) and consequently not subject to the same recording methods as those of older individuals or those within clearly defined grave groups. In some cases at Springhead, limited recovery of the skeletal remains of these neonatal individuals undoubtedly occurred as a

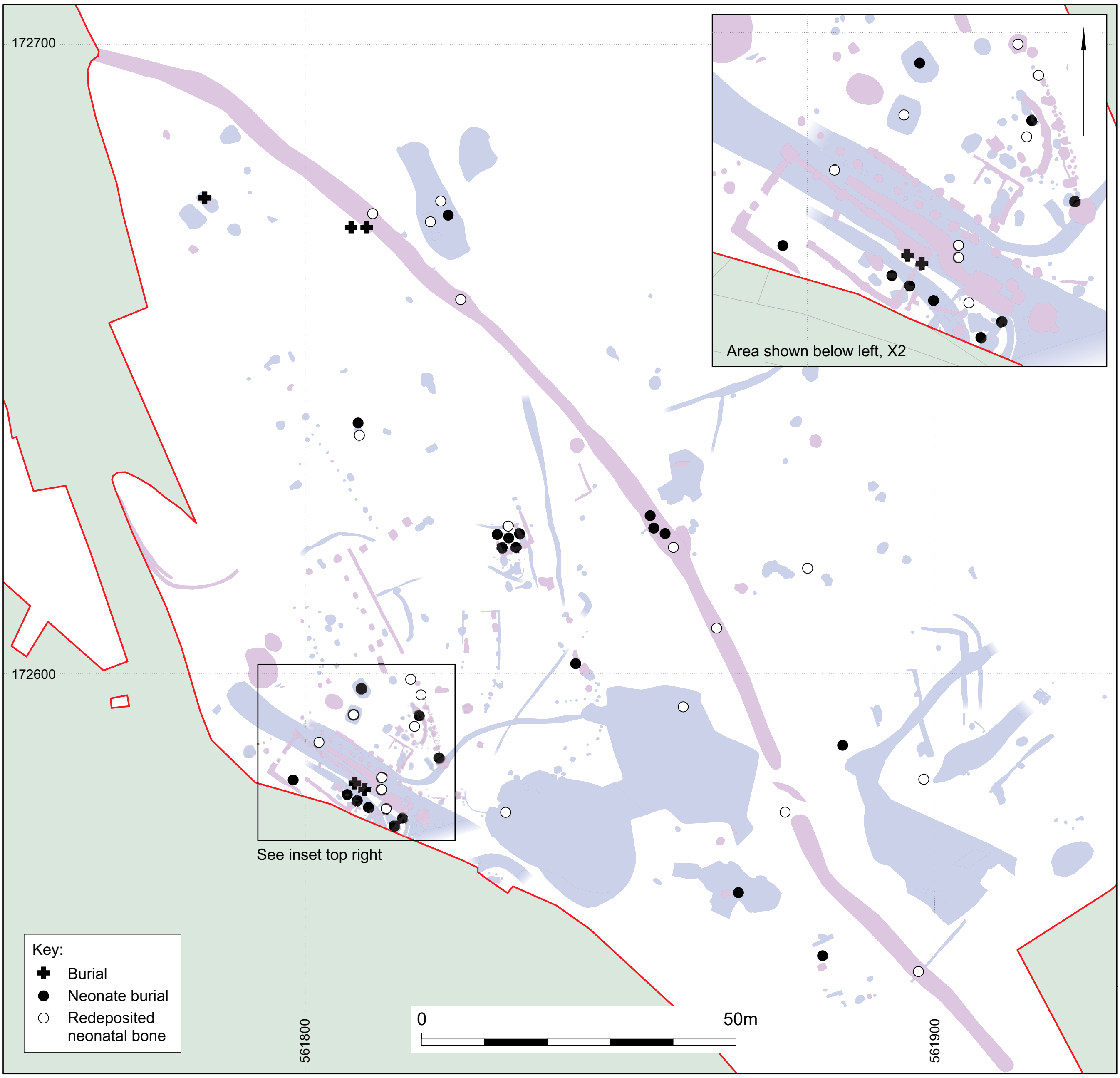


Figure 1 Distribution of burials in Springhead Sanctuary (ARC SPH00)

result of excavator error, and it is possible that the remains of some such young individuals could have accidentally been removed entirely from the archaeological record under the rigors of machine stripping or rapid/mass hand excavation.

The percentage of skeletal recovery from the Roman graves ranged from 11% (adult) to 97% (neonate) with an average of *c* 48%. Although the neonatal and non-neonatal groups have a closely similar range and average, the factors affecting skeletal recovery clearly differed for each group. With few exceptions the neonatal bone is well preserved (majority graded 0–1), the burials having been made in occupation layers or in the fills of features, and the often low percentage of skeletal recovery reflects disturbance and non-recovery on site. Most of the non-neonatal burials were made in graves which cut through and were backfilled with the acidic natural brickearth (or Thanet Sands) resulting in poor skeletal preservation (grades 4–5), with preferential loss of trabecular bone, and often leaving little recognisable trace other than the tooth crowns after lifting. Notable exceptions are burials 2309, 3485 and 10197, the graves for which were cut through pit and ditch fills, and 19080 which was buried in mixed dumped and alluvial deposits adjacent to the Ebbsfleet river (Table 1). The neonatal remains recovered from below the southern part of the Sanctuary complex (Fig 2) were covered by a skim of mineral precipitate, the formation of which may be related to the proximity of the contemporaneous road immediately to the north-east affecting the burial environment (post-depositional pedogenic effects).

Table 1 Summary of results from human bone analysis from Springhead

Context	*Cut*	*Deposit type*	*Quantification*	*Phase*	*Age & sex*	*Pathology*
ARC SHN 02						
10022	10021	burial	*c* 15% s.u.l.	M/LR	adult *c* 30–40 yr ??female	calculus; enthesophytes – femur shaft
10047	10046	burial	*c* 20%	M/LR	adult *c* 30–40 yr ?male	*ante mortem* tooth loss; mv – impacted max. C, absent man. M3
10130	10079	burial	*c* 35%	M/LR	adult >55 yr ?male	calculus; periosteal new bone – right fibula shaft, both calcaneal-talus surfaces; remodelling - both calcaneal-talus dorsal surfaces; enthesophytes – fibula shaft, right calcaneum
10186	10233	?placed	*c* 9% s.	ER	adult >30 yr female	
10197 (inc 10150)	10150	burial	*c* 70%	M/LR	adult >55 yr male	*ante mortem* tooth loss; caries; calculus; *cribra orbitalia*; osteoarthritis – 2T, bi-lateral temporo-mandibular, left knee, right ankle, right 2nd proximal & distal IP joints (foot); fracture – left ulna; periosteal new bone – tibiae & fibulae shafts; osteophytes – 2 left distal IP joints (foot), right knee joint, 3 right tarsals , right shoulder joints, acetabulae; surface defect – left 1st Mt base; enthesophytes – femur shafts, tibiae shafts, fibula shafts, calcaneum; mv – wormian bones, tarsal coalition – right talus/navicular
10406	*	burial	*c* 40%	ER	neonate *c* 2–6 wks	
10714 (inc 10713)	10712	burial	*c* 66%	ER	neonate *c* 8 wks	
10828	*	burial	*c* 45%	ER	foetal/neonate *c* 38–40 wks *in ut*	
11712	11710	burial	*c* 35%	ER	foetal/neonate *c* 38–40 wks *in ut*	
12214/ 12224b	?disturb-ed from vessel 12222	burial	*c* 15%	MR	foetal/neonate *c* 36 wks *in ut* – 2 wks	
12224	in vessel 12222	burial	*c* 65%	MR	neonate *c* 0–4 wks	
12307	*	burial	*c* 32%	LR	neonate *c* 4–8 wks	
12310	*	burial	*c* 28%	LR	neonate *c* 1 wk	
12409	*	burial	*c* 23% u.l.	LR	foetus *c* 32–36 wks *in ut.*	
16200	16199	burial	*c* 40%	ER	neonate *c* 0–1 wk	
16446	16230	burial	*c* 20% s.a.u.	ER	neonate *c* 0–8 wks	
16641	16655	burial	*c* 22%	ER	neonate *c* 0–1 wk	
16747	16740	redep	*c* 12% u.l.	MR	neonate *c* 0–1 wk	
16863		?redep	*c* 15% u.l.	M/LR	foetal *c* 36–38 wks *in ut*	endosteal new bone – ?frontal
16864	*	burial	*c* 40%	MR	foetal *c* 36–38 wks *in ut*	
16881	16880	redep.	*c* 8% s.l.	?	neonate *c* 0–4 wks	
17043A		?redep/ ?burial	*c* 25% u.l.	MR	foetal/neonate *c* 38–40 wks *in ut*	
17043B		?redep/ ?burial	*c* 18% a.u.l.	MR	neonate *c* 1–4 wks	
17719	17717	redep	1 bone l.	E/MR	neonate *c* 0–1 wk	
17759		?redep/ ?burial	*c* 15% l.	MR	neonate *c* 0–2 wks	
17766	17765	burial	*c* 40%	ER	neonate *c* 1–4 wks	
17801	*	burial	*c* 80%	ER	neonate *c* 1–3 wks	
17879	17876	redep	1 bone l.	MR	neonate *c* 0–3 wks	
17913	*	burial	*c* 48%	ER	neonate *c* 2–5 wks	
17913B		*redep	*c* 5% s.u.	ER	foetus/neonate *c* 38–40 wks *in ut*	
19035	19030	burial	*c* 38% a.u.l.	ER	neonate *c* 1–3 wks	
19080	*	burial	*c* 85%	ER	subadult *c* 13–16 yr	calculus; *cribra orbitalia*; mv – impacted max. right C & mandibular P2, retention mandibular deciduous m2, wormian bones, coronal ossicles
19084	19082	redep.	*c* 8% s.	ER	neonate *c* 5 mths	endosteal new bone – frontal, parietals & occipital
ARC SPH 00						
2118		redep.	1 frag a.	?	neonate	
2139		redep.	*c* 1% a.u.	MR	neonate *c* 0–3 wks	
2166	2165	burial	*c* 24% a.u.l.	ER	neonate *c* 6–8 wks, female	
2223	*	?burial	*c* 10% s.a.u.	E/MR	neonate *c* 1–3 wks	

Table 1 Summary of results from human bone analysis from Springhead (continued)

Context	*Cut*	*Deposit type*	*Quantification*	*Phase*	*Age & sex*	*Pathology*
2309	2308	burial	*c* 94%	MR	adult *c* 50 –60 yr, male	*ante mortem* tooth loss; caries; abscess; calculus; hypercementosis; osteoarthritis – 1st, 8th & 12th costo-vertebral; periosteal new bone – left max. , T11–12 anterior-lateral bodies, 2 left ribs (sternal ends), right tibia shaft; infection – T12, L1–3 body surfaces; fracture – depressed fracture left parietal, left 10–11th ribs, right proximal tibia; soft tissue trauma – left distal ulna, right distal fibula; *o.c. dessicans* – left distal femur; ddd – C3–4, C6–7, T8–12, L3; calcified cartilage – thyroid; vertebral body collapse – T5, L1–2; bowing – distal tibiae; destructive lesion – 2 left metacarpal heads; osteophytes – C1–2 anterior facets, T5–6 transverse facets, T8–S1 bsm, left knee joint, left shoulder, 1 left distal IP (foot), left 2nd MtC–P, right distal ulna, acetabulae; pitting – left acromio-clavicular & sternal-clavicular, right acetabulum; enthesophytes – iliac crest, ischial tuberosities, radial tuberosities, femur shafts, patellae, right tibia shaft, distal fibulae, calcaneum; mv – ossicle at lambda, wormian bones, small triangular man. M3, enamel pearl
2405	2404	burial	*c* 20%	MR	neonate *c* 2–6 wks	
2409		burial	*c* 21%	MR	neonate *c* 2–6 wks	
2427		redep	1 frag l.	ER	foetal *c* 32–36 wks *in ut.*	
2675		redep	1 frag u.	MR	neonate *c* 0–2 wks	
2759	2706	redep	*c* 9% s.u.l.	MR	neonate *c* 2–6 wks	
2845	2555	redep	1 bone u.	MR	neonate *c* 3–6 wks	
2848	2856	redep	1 bone l.	MR	neonate *c* 1–4 wks	
2854	2856	redep	1 frag. u.	MR	neonate *c* 3–6 wks	
2855	2856	redep	1 frag. u.	MR	subadult/adult >15 yr	
2903	2856	redep	*c* 8% a.u.l. 1 frag u.	MR	1) neonate *c* 1–3 wks 2) adult *c* 18–45 yr	
2951	2954	redep	*c* 1% s.	ER	neonate *c* 0–6 mths	
2975	2974	redep	1 bone l.	MR	foetus/neonate 0 wks	
2983	2856	redep	2 bones a.u.	MR	neonate *c* 0–4 wks	
2985	2856	redep	<1% u.	MR	adult *c* 18–45 yr	
2996	2856	redep	1 bone a.	MR	neonate 0–6 mths	
2997	2856	placed	*c* 18% s.	MR	adult *c* 25–35 yr, male	caries; abscess; calculus; periodontal disease; mv – max. M2 absent, wormian bones
3092	3089	redep.	1 frag. u.	MR	adult >18 yr, ??male	
3169	3167	redep = 3172	*c* 10% l.	ER	neonate *c* 2–5 wks	
3172	3170	burial	*c* 24% s.a.u.	ER	neonate *c* 1–3 wks	
3182	3142	burial	*c* 11%	MR	adult *c* 30–45 yr, female	caries; enthesophytes – right femur shaft
3183	3142	redep	*c* 15%	MR	adult *c* 30–45 yr, ??male	caries; osteoarthritis – distal IP joint (hand); hypercementosis
3201	3277	redep	3 bones a.u.	E/MR	neonate *c* 0–1 wk	
3238	3235	redep	1 frag l.	MR	neonate *c* 2–3 wks	
3385	3384	redep	1 bone l.	MR	neonate *c* 0–1 wk	
3420	*	burial	*c* 20% a.u.l.	E/MR	neonate *c* 2–4 wks	
3485	3428	burial	*c* 85%	MR	subadult/adult *c* 17–20 yr, male	caries; calculus; hypoplasia; Schmorl's nodes – T6–13; cortical defect – clavicle
3513	3512	?redep	*c* 10% a.l.	R	neonate *c* 2–5 wks	
3547	2546	burial	*c* 53%	ER	foetus *c* 36–38 wks	
3619	3618	redep	1 bone u.	E/MR	neonate *c* 1–2 wks	
5051	2925	?redep/ ?burial	*c* 18%	ER	neonate *c* 0–1 wk	
5144	5142	burial	*c* 70%	ER	neonate *c* 2–4 wks	
5160	5159	burial	*c* 76%	ER	neonate *c* 0–2 wks	
5164	5162	dual burial	*c* 70%	ER	neonate *c* 0–1 wk	
5165	5162	dual burial	*c* 48%	ER	foetus/neonate *c* 38–40 wks *in ut*	
5172	5170	burial	*c* 35%	ER	neonate *c* 7–9 wks	
5211	5210	redep	*c* 5% a.u.	ER	neonate *c* 0–9 wks	
5438	5437	burial	*c* 88%	MR	foetus *c* 33–36 wks *in ut*	
5571	5570	burial	*c* 33% a.u.l.	E/MR	neonate *c* 1–3 wks	
5600		redep	1 bone u.	R	neonate *c* 1–4 wks	
5692	*	burial	*c* 56%	MR	neonate *c* 6–12 wks	
5694	*	burial	*c* 72%	MR	neonate *c* 0–1 wk	

Table 1 Summary of results from human bone analysis from Springhead (continued)

Context	*Cut*	*Deposit type*	*Quantification*	*Phase*	*Age & sex*	*Pathology*
5696	5697	burial	*c* 97%	MR	neonate *c* 3–4 mths	
5724	5723	redep	3 frags s.	MR	neonate 0–6 mths	
5845	5809	redep	1 frag. l.	R	neonate *c* 3–4 wks	
5928		redep	2 bones u.l.	ER	foetal *c* 20–22 wks *in ut*	
5979	5978	burial	*c* 92%	ER	neonate *c* 3–4 wks	
6035		redep	1 bone u.	ER	neonate *c* 0–1 wk	
6099	6097	burial	*c* 37% s.a.u.	ER	neonate *c* 0–3 wks	
6100	*	burial	*c* 75%	ER	neonate *c* 6–8 wks	
6125	6124	burial	*c* 55%	ER	neonate *c* 1–2 wks	
6129	6128	burial	*c* 96%	ER	neonate *c* 4–6 wks	
6262		redep	3 frags l.	ER	neonate *c* 1–3 wks	
6311	6310	burial	*c* 85%	ER	neonate *c* 4–6 wks	
6568	6571	redep	1 bone + 2 frags a.l.	ER	neonate *c* 3–4 wks	
6613	6607	burial	*c* 19% s.u.	ER	infant *c* 6–9 mths	
U/S		redep	1 frag l.		foetal *c* 36–38 wks *in ut*	

KEY: * grave cut not observed/recorded in excavation; *in ut.* – *in utero*; IP – inter-phalangeal;
Skeletal areas represented where they are not recorded: s. – skull; a. – axial skeleton; u. upper limb; l. – lower limb; mv – morphological variation; C – cervical; T – thoracic; L – lumbar; bsm – body surface margins; R – Roman; ER – early Roman; E/MR – early–mid-Roman; MR – mid-Roman; LR – late Roman

The cremated bone is in excellent visual condition and includes a high proportion of trabecular bone as well as the more taphonomically stable and robust compact bone. The burial was well sealed and the quantity and condition of the bone recovered is likely to reflect closely that of the bone at time of deposition.

Demographic Data

The Roman human bone assemblage contained the remains of a minimum of 62 individuals including the one cremated individual from burial 6355 (1st century AD), an adult female of *c* 25–35 years. A summary of the demographic data from the unburnt remains is given in Table 2.

The remains of most individuals (48) were recovered from *in situ* burial deposits, with five other immature individuals from probable burial remains (one early Roman, one early/middle and three middle Roman; Table 1). Two adults were represented by placed deposits of a cranium (10186, early Roman) and a skull (including mandible; 2997, middle Roman). The redeposited remains of a 20–22 week foetus (6097, early Roman) south of the early road in the Sanctuary area (Fig 2; see Vol 1, Fig 2.25) represent the only remains of such a young individual from the site and consequently have been included in the minimum number count.

There was relatively little redeposited adult bone. Bone fragments were recovered from three contexts within the ritual shaft 2856 (see Vol 1, Fig 2.55), one of the middle fills of which contained the 'placed' skull 2997; the redeposited bone could all have derived from the latter individual. The disarticulated and redeposited remains of an adult male (3183) were recovered from the fill of grave 3142 (burial 3182), which formed the second of two graves (lower grave 3428, burial 3485) cut on the same alignment, parallel to and through the south-west edge of the Sanctuary enclosing ditch (300046, see Vol 1, Fig 2.54); a fragment of bone (3092) from a segment of the ditch excavated to the south could be from the same individual. The presence of the redeposited bone in the uppermost grave suggests the original existence of a third grave on the same alignment, the contents of which were disturbed by the insertion of one or both of the surviving graves. The location of these middle Roman adult graves, aligned with and within the confines of the Sanctuary enclosing ditch, is unusual. The reuse of the grave for two, possibly three consecutive (not simultaneous) burials cannot have been fortuitous in such a location; such non-normative depositions suggest there was something unusual about the individuals buried here. Both burials were clearly of a formal nature, the later deposition of the adult female 3182 being furnished with ceramic and iron grave goods. The burial within the lower surviving grave was that of a very large young man (3485; estimated stature *c* 1.83 m) who was deposited in a prone position (see Vol 1, Fig 2.54). Prone burials of this date, whilst not as rare as they once appeared to be, are not common and have often been recorded in liminal locations leading to the suggestion that the dead treated in this way were criminals or some other form of social outcast (Philpott 1991, 71–5). However, a growing number of otherwise 'normal' burials, in terms of location and associated artefacts, have been recovered in recent years (eg, at Maddington Farm (McKinley and Heaton 1996) and the middle–late Roman cemeteries at Boscombe Down, Wiltshire (Wessex Archaeology in prep.)), and it has been suggested that some such burials could have been the result of accidental inversion (Philpott 1991, 73; McKinley and Heaton 1996) or that the positioning could have been a ruse to confuse the deceased and ensure they remained in the realms of the dead (Harman *et al* 1981). In this instance, the comparatively great height of 3485, well above the average of 1.6 m for males at this time (Roberts and Cox 2003, 163), may have rendered this young male a subject of unease to his contemporaries.

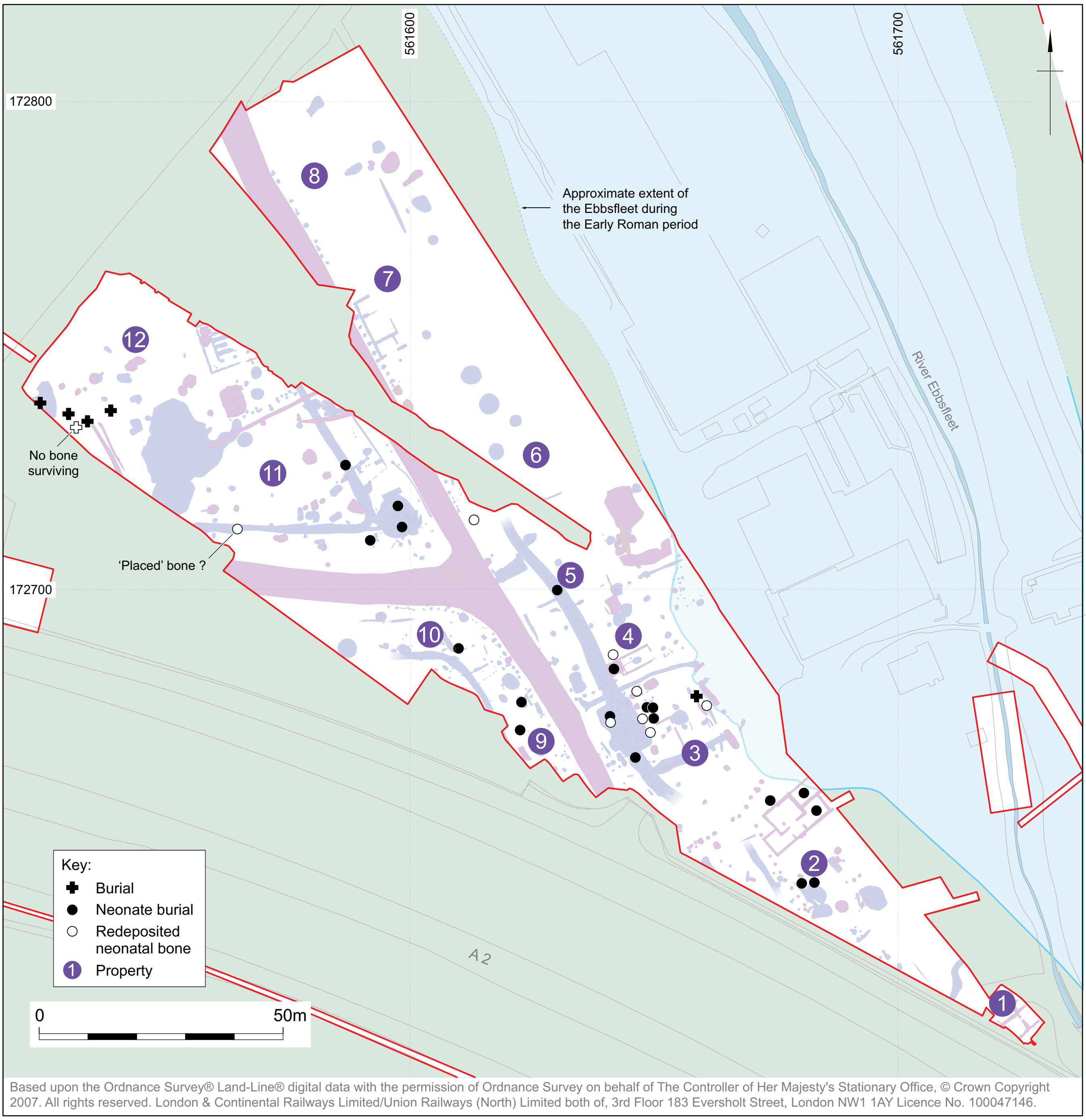


Figure 2 Distribution of burials in properties 1–12 at Springhead Roadside Settlement (ARC SHN02)

Most of the redeposited foetal/neonatal remains were from deposits of middle Roman date and recovered from the Sanctuary area, though a substantial proportion also derived from early Roman contexts and that from the later deposits may have originated from earlier burials. Odd bones or fragments were recovered from various pits within the boundaries of the Sanctuary area, many of which – such as those from the upper levels of the ritual shaft 2856 – could have been redeposited from almost anywhere on the site and already be represented within the minimum number counts. None of the skeletal elements recovered amongst the redeposited material from the north of the early road within (but preceding) the Sanctuary complex (Fig 2) had derived from the adjacent graves and a minimum of one additional (?middle Roman) neonate is likely to be represented amongst this material. The redeposited material recovered to the south of the road could have originated from one or more of the burials in this area.

Using only the minimum number counts of skeletal elements no additional immature individuals are indicated amongst the redeposited remains in the Roadside Settlement area. However, assessment of the context data and distribution of the remains suggests a minimum of two additional foetal/neonatal individuals. The redeposited bone from property 9 (16881) did not derive from the grave in either that property or property 10 to the north and the individual is unlikely to be

Table 2 Age and sex of Roman individuals from Springhead identified by phase

	Early Roman	*Early/Mid-Roman*	*Mid-Roman*	*Mid-Late Roman*	*Late Roman*	*Roman*	*Total*
Immature							
Foetal 20–38 wks *in utero*	2	–	2	–	1	1	6
Foetal/neonate 38 wks *in utero* – 8 weeks	3	–	2	–	–	–	5
Neonate 0–6 months	23 (1??F)	3	8	–	2	2	38
Infant 6–9 mths	1	–	–	–	–	–	1
Subadult *c* 13–16 yr	1	–	–	–	–	–	1
Total	*30*	*3*	*12*	*0*	*3*	*3*	*51*
Adult							
Subadult/adult *c* 17–20 yr	–	–	1 (M)	–	–	–	1
Adult *c* 25–35yr	–	–	1 (M)	–	–	–	1
Adult *c* 30–45 yr	–	–	2 (1M 1F)	2 (1F 1M)	–	–	4
Adult *c* 50–60 yr	–	–	1 (M)	–	–	–	1
Adult >30 yr	1 (F)	–	–	–	–	–	1
Adult >55 yr	–	–	–	2 (M)	–	–	2
Total	*1*	*0*	*5*	*4*	*0*	*0*	*10*
Overall total	31	3	17	4	3	3	61

represented elsewhere in the assemblage. Similarly, the redeposited bone from property 4 (16863) was not from the grave within that property, and although it could potentially have originated from one of the graves in property 3 to the south, there are already duplications between the skeletal elements from the burials and those from the redeposited material within the property itself. Consequently, it is most likely that the redeposited bone from property 4 is the remains of an individual not represented elsewhere within the assemblage. The material from property 6, whilst clearly not from the grave within the adjacent property 5, could have originated from one of those across the road in property 11. The disarticulated material from deposits in property 3 could all have derived from graves within that property.

The demographic structure of the Roman assemblage as a whole is noticeably at odds with that commonly seen in osteological reports for the period and reflects the non-cemetery nature of most of the deposits. Approximately 84% of the assemblage comprises immature individuals, 80.3% being foetal or neonatal. Most of this latter group (*c* 40.8%) appear to have died at between one and eight weeks of age (Table 3), with a peak between weeks one and six (*c* 26.5%) and a second, slightly less pronounced peak between 38 weeks *in utero* and the first week of life (*c* 22.4%). The young foetal remains indicative of death at 20–22 weeks are an unusual find; with major long bones of only *c* 32–33 mm in length (humerus and femur); such young bones have not previously been found on a Romano-British site, possibly – at least in part – due to their small size and the difficulty of recognition/recovery of disturbed shallow deposits rather than the lack of frequency of such implied late miscarriages. Such a young foetus would not have been viable and this example undoubtedly represents a natural still-birth, miscarriages reportedly being commonplace (Scott 1999, 57). Although abortive drugs were known to, and used by, the Romans – medical advice was available on how to produce an abortion though the practice was publicly abhorred by some – they were usually employed in the early stages of pregnancy (Riddle 1997, 35–63; Scott 1999, 36).

The belief that a child did not acquire a soul until '… the age of teething …' (*c* 6 months; Pliny *Nat Hist* VII, 15, after Philpott 1991, 101) is generally seen as the reason that neonates are commonly (but not universally) excluded from Roman cemeteries, their burials frequently being made in domestic settlement locations particularly in association with buildings (Philpott 1991, 97–102; Struck 1993; Scott 1999, 115). They were also separated by different mortuary treatment, their remains commonly being subject to inhumation burial at a time when cremation was the normal mortuary rite, though the remains of two cremated neonates were, for example, recovered from St Stephens cemetery, St Albans (McKinley 1992). This separation of neonates from the rest of society in terms of their mortuary treatment is not unique to the Roman period; in Ancient Greece, for example, neonates were buried below house floors to allow their souls to '… be reborn into the women of the same family' (Becker in Scott 1999, 117; *ibid*, 105 and 124). Such a concept may be one of the factors influential in the placement of many Roman neonates. A second theme within the Roman period, however, was the fear of what appears to have been viewed as 'contrary to nature', in particular twins, the deformed or disabled, and '…aborted, stillborn or short-lived infants', in the belief '…that their souls could be used by *magi* (sorcerers) to bring evil to the living' (*Tertullian de Anima* 57 in Scott 1999, 70 and 118). This 'fear' or unease may have been responsible for the separation and liminal location of at least some neonatal burials, perhaps such as those recorded from the ditch fills in some Roman cemeteries (eg, Oram's Arbour, Winchester; Scott 1999, 115) and within the Sanctuary area at Springhead.

The lack of 'human' status afforded neonates also rendered them potentially at danger from infanticide, which is known to have been undertaken and was, for

Table 3 Distribution of foetal and neonatal (up to 6 months) ages from Springhead by phase

	Early Roman	*Early/Mid-Roman*	*Mid-Roman*	*Late Roman*	*Unspec Roman*	*Total*
Foetal 20–22 wks *in utero*	1	–	–	–	–	1
Foetal 32–36 wks *in utero*	–	–	1	1	–	2
Foetal 36–38 wks *in utero*	1	–	1	–	1	3
Foetal 38–40 wks *in utero*	3	–	1	–	–	4
Foetal/neonate 36 wks *in utero* – 2 wks	–	–	1	–	–	1
Neonate 0–1 wk	4	–	1	1	1	7
Neonate 0–2 wks	1	–	1	–	–	2
Neonate 0–4 wks	1	–	1	–	1	3
Neonate 0–8 wks	1	–	–	–	–	1
Neonate 1–2 wks	1	–	–	–	–	1
Neonate 1–4 wks	4	2	1	–	–	7
Neonate 2–6 wks	3	1	2	–	–	6
Neonate 3–4 wks	1	–	–	–	–	1
Neonate 4–8 wks	4	–	–	1	–	5
Neonate 6–12 wks	–	–	1	–	–	1
Neonate 7–9 wks	2	–	–	–	–	2
Neonate 3–5 mths	1	–	1	–	–	2
Total	*28*	*3*	*12*	*3*	*3*	*49*

most of the Roman period, not illegal. Some contemporaneous sources suggested the use of infanticide to limit population size and as a form of disposal of deformed infants (Mays 1993), though at other times there were laws expressly forbidding the exposure of particular progeny and propaganda promoting larger families (Riddle 1997, 85–6; Scott 1999, 76). Exposure was generally undertaken immediately after birth producing a high number of deaths towards full term (38–40 weeks) and within the first week of life (Mays 1993), though contemporaneous accounts indicate that this is also the stage at which many natural deaths would be expected to occur '… Most are carried off before the seventh day …' (Aristotle *Historia Animalium* vii, quoted by Philpott 1991, 101, after Hooper). Birth and the first few days of life are well recognised 'danger points' for neonates whose inherent fragility renders them highly susceptible to loss as a result of a variety of common illnesses and accidents as well as the trauma of the birth itself (Scott 1999, 30–32). Studies by several researchers have suggested that neonatal assemblages from various Romano-British sites showing a distinctive strong peak in the 38–40 week gestation period (50–70% of the neonatal assemblage) indicate that at least some of these individuals were probably subject to exposure (Mays 1993). At Springhead between 22.4% and 36.7% of the neonates could fall into this peak period, and so viewed overall these figures suggest that most if not all the neonates buried at the site are likely to have died of natural causes.

Some neonatal remains were recovered as singletons or within small groups of up to six burials made within individual properties – domestic or possibly small-scale 'industrial' in nature – within the Roadside Settlement area (Fig 2). A substantial proportion (67.3%), however, were recovered from the vicinity of the springs in the area subsequently to form part of the middle Roman Sanctuary complex (Fig 1), most appearing to predate it by a decade or more. In the late Roman period, the area of the former temple in property 2 on the Roadside Settlement adjacent to the Ebbsfleet river became the focus for a small group of burials (Fig 2; see also Vol 1 Fig 2.65). As discussed above, the recovery of neonatal remains in association with domestic buildings and properties is a common feature in the Roman period (Philpott 1991, 97–102; Mays 1993; Struck 1993), large numbers (up to 97) sometimes being recovered in association with late Romano-British villa complexes (Scott 1999, 110–13), such locations seeming to place them in the realms of the living rather than amongst the dead. In contrast, there is currently limited evidence for their burial in locations of ritual significance such as that apparently held by the springs at Springhead even before the construction of the Roman sanctuary and temple complexes (Philpott 1991, 98; Struck 1993; see also discussion in Vol 1, Chap 4). Nevertheless, small numbers of infants (age range not always clearly specified and at times seeming to cover 'newborn' to the infant/juvenile 'child') have been recovered from several 'ritual' sites including at least three temples/shrines, the highest recorded number being 14 from temple IV at Springhead (Penn 1960, 121–2: aged *c* 6 months; Scott 1999, 86) situated *c* 100 m to the south of the Sanctuary complex and the temple in property 2 within the HS1 excavations (see above). The burials at temple IV, as with others of this type, have been interpreted as sacrificial 'foundation deposits'. The role of neonates and young infants in ritual sacrifice has been analysed and discussed by Scott (1999), who has developed the concept of the neonate as a 'liminal' creature of contrasts, providing a potentially powerful link between, amongst other themes, life and death, rendering them suitable subjects for 'bargaining' with gods and the ancestors.

Unlike those found elsewhere, there is no suggestion at Springhead that the burials within the area of what was to become the Sanctuary formed any sort of 'foundation' deposits, but their location within what was clearly viewed as a place of ritual significance cannot have been accidental. The numbers of recorded neonates undoubtedly represent a minimum for, in addition to the difficulties of recognition of such burials outlined above (*Bone condition and survival*), not all parts of the Sanctuary area were subject to extensive hand excavation. In particular, almost every excavated segment of the sanctuary enclosing ditch contained *in situ* or redeposited human remains but only *c* 15% of the ditch length was excavated. The proximity to water may have been the key factor in the location of many of these burials. In the late Iron Age pools, springs and lakes were viewed as liminal places forming the entrances to and exits from the Otherworld and the easiest places from which to communicate with the gods (Magilton 1995; Bradley 1990; Haselgrove 1996, 76; Sanden 1996, 174). This could also have been a factor in the placing of one other unusual early Roman burial, that of the subadult 19080, who was laid at right-angles to the Ebbsfleet river in property 3.

The clearly age-related bias of the Roman demographic data means that it cannot realistically be used to suggest any details regarding the population burying their dead in this part of Springhead. Although a small late Roman cemetery was located on the north-western periphery of the settlement, other graves associated with which are likely to extend to the west beyond the limits of excavation, the assemblage contained few other adults. The only adult of early Roman date is represented by a redeposited cranium apparently 'placed' within the roadside ditch in property 11, an occurrence which carries connotations of a native late Iron Age practice rather than a Roman one. One of the four middle Roman adults (though the bone could have derived from an earlier deposit) is also represented by a 'placed' deposit of a skull – with the mandible, but probably deposited as dry bone since no cervical vertebrae were recovered – within ritual shaft 2856.

The burial place for the majority of the Roman population lay on the outskirts of Springhead, predominantly to the south at Pepper Hill where *c* 357 inhumation and 165 cremation burials, largely of early Roman date and including no neonates, have been excavated (Boston and Witkin 2006). Several smaller groups – including those within the élite walled cemetery – lay in close proximity (Jessup 1959, 14; Philp and Chenery 1997; Davies 2001). Two further cemeteries, one containing inhumation and the other cremation burials, have recently been found during evaluations (in 1997 and 2006 respectively) to the north along the western bank of the Ebbsfleet river. Whether all the neonatal dead from Springhead relate to those buried within one or more of these cemeteries cannot be ascertained; it may have been the chosen resting place for the young of only one or several of these groups, some may even have been the offspring of pilgrims from a distance visiting the temples, sanctuary and springs (see discussion of the site as a healing sanctuary, Vol 1, Chap 4). At least one neonate from the nearby Northfleet villa was buried, as is commonly observed, within the confines of the villa complex (see below).

Skeletal Indices and Non-metric Traits

A summary of the indices it was possible to calculate is given in Table 4 and some non-metric traits/ morphological variations are indicated in Table 1; all other detail is held in the archive.

Stature could be estimated for only three Roman males. Although the small size of the sample limits the significance which can be attributed with respect to comparable data, the mean is above the average of 1.69 m given for the period by Roberts and Cox (2003, 163). At an estimated 1.83 m (6' 2") the young male (3485) buried in a prone position within the Sanctuary enclosing ditch will have towered over most of his contemporaries.

The cranial index could be calculated for only two Roman males, both readings falling in the dolichocrany (long-headed) range. The platymeric index (demonstrating the degree of anterior-posterior flattening of the proximal femur) was calculated for three Roman males. Where both femora could be measured there is very little variation between the left and the right, suggesting similar stresses on the two sides. The readings for all except one fell in the platymeric (broad) range with one in the eurymeric.

The platycnemic index (illustrating the degree of meso-lateral flattening of the tibia) was calculated for four Roman males. With one exception, where the bones from both sides were measured there was little difference between them. In the case of male 2309 there is a marked difference (13.7) between the left and the right side, the latter bone being noticeably more robust than the left, though both are strong. Both bones show lateral bowing at the proximal end and the distinction between the sides probably reflects stress-related plastic changes with a weakness in the left side. All the bones fall in the eurycnemic range with the exception of the left bone from 2309 which is in the platycnemic range.

The robusticity index, expressing the relative size of the femur shaft, was calculated for three Roman males. In the one instance where measurements could be taken on both femora (3485), the indices were almost identical. Although clearly very tall, the young age of 3485 is likely have been a major factor in the comparatively low index from this individual, since he will have had fewer years over which to build up his muscularity and skeletal robusticity by comparison with the older adult males 2309 and 10197.

Table 4 Summary of metric data from Springhead

	Male	
	range	*mean*
Estimated stature	1.63–1.83 m (5' 4 ¼"–6' 2")	1.71 m (5' 7 ¼")
Cranial index	69.8– 72.0	
Platymeric index	81.2–91.6	86.2 (SD 4.6)
Platycnemic index	70.2–81.8	73.9 (SD 7.9)
Robusticity index	123.3–135.4	127.6 (SD 4.99)

Table 5 Summary of permanent dentitions from Springhead by sex and broad phase

Sex (no dentitions)	*Teeth*	*Socket positions*	*Ante mortem tooth loss*	*Caries*	*Abscesses*
Female (2)	29	–	–	2 (6.9%)	–
Male(7)	120	131	27 (20.6%)	19 (15.8%)	5 (3.8%)
Total (inc 1 unsexed)	188	156	27 (17.3%)	21 (11.2%)	5 (3.2%)

Variations in skeletal morphology may indicate population diversity or homogeneity. The potential interpretative possibilities for individual traits, however, are complex and not, as yet, readily definable, particularly on a 'local' archaeological level (Tyrrell 2000). Some traits have been attributed to developmental abnormalities or mechanical modification (*ibid*, 292). Several common and less frequently occurring non-metric traits were observed and recorded in analysis (Table 1 and archive). Wormian bones (extra ossicles in the lambdoid suture) were observed in four Roman skulls, but this trait is relatively common. Two individuals have impacted maxillary canines (10047 and 19080) which could be indicative of some broad genetic link between the individuals, though no other matching traits were observed (10047 showed only 20% skeletal recovery and was in very poor condition). The individual 19080 also had impaction and non-eruption of the mandibular 2nd premolars, with retention of the deciduous 2nd molars.

Pathology

Pathological changes were observed in the remains of 13 individuals including the one cremated individual. Table 1 contains a summary of the pathological lesions observed and the bones affected. All the rates shown below refer only to remains from the unburnt assemblage.

Dental disease

All or parts of ten erupted permanent dentitions were recovered (Table 5). Dental calculus (calcified plaque/tartar) was observed in seven (including five male and one female) of the dentitions. Slight–mild deposits were most commonly observed, with moderate–heavy deposits on the crowns of the older male 2309. Deposits were slightly more common on the maxillary molars and mandibular canines–premolar than on other teeth, but both the distribution and severity could be misleading since calculus deposits are commonly disturbed and lost during excavation and post-excavation processing.

Periodontal disease (gingivitis) may lead to bone resorption with consequent loosening of the teeth and exposure of more of the tooth surface to caries attack. Slight lesions reflective of the condition were observed around one mandibular molar socket in one male dentition (12.5%; scoring according to Ogden 2005).

Ante mortem loss of between two and 20 teeth were recorded in three male dentitions. First molars and second premolars were amongst those most frequently subject to loss, though the elderly male 10197 had lost all except three of the mandibular left anterior teeth. The overall rate (Table 5) is above that of 14.1% given by Roberts and Cox for their Romano-British sample (29 sites; 2003, table 3.12), though several of the sites listed show similar and higher rates to these recorded at Springhead.

Dental caries, resulting from destruction of the tooth by acids produced by oral bacteria present in dental plaque, was recorded in between one and 13 (average approximately three) teeth from five male and one female dentitions (Table 5). The majority of lesions were in the molar teeth, with a substantial proportion in the premolars, a canine and incisor also being affected. Many lesions had resulted in total destruction of the tooth crown, but where the origin of the lesion was apparent all except one cervical lesion were in the contact area. The overall rate (Table 5) is higher than the 7.5% given by Roberts and Cox for the Roman period (2003, table 3.10), though a few sites within their sample have closely similar rates. The three adult males who had suffered *ante mortem* tooth loss all had carious lesions and it is probable that the former had occurred as a result of the latter. The greatest number and most severe lesions were observed in the dentition of the young male 3485, deposited prone in the Sanctuary enclosing ditch.

Infection had gained access via a carious lesion to the supportive structure in one male dentition resulting in resulting in a dental abscess. In a second adult male excess wear of three anterior teeth had exposed the pulp cavities via which infection spread to the supportive structure. The overall rate is similar to the mean of 3.9% from Roberts' and Cox's sample (2003, table 3.13).

Slight dental hypoplasia (developmental defects in the tooth enamel reflective of periods of illness or nutritional stress in the immature individual; Hillson 1979) was observed in one dentition (11.1%). In the dentition of 3485 faint hypoplastic lines were recorded in the canine and premolar crowns.

Trauma

The two older adult males both had lesions indicative of healed trauma, 2309 showing evidence for repeated injuries at least some of which were undoubtedly the result of interpersonal violence.

A well-healed but misaligned fracture in the distal shaft of the left ulna from 10197 was most likely sustained from a fall onto the hand. The shaft was shortened by *c* 25 mm and there is slight lateral rotation of the distal end. Some disruption in the line of left distal radius shaft suggests there may have been a related soft tissue injury and/or increased muscle activity in the unaffected bone.

Plate 1 Elderly adult male 2309 – adjacent surfaces of 11–12th thoracic vertebrae showing shallow erosive lesions and fine-grained new bone across surfaces; lamellar new bone over anterior and sides of vertebrae just evident in T12 (arrowed)

A slight, *c* 31.5 mm diameter depression in left distal parietal (11 mm from sagittal suture 21 mm from lambda) of 2309, is probably the remains of a well-healed depressed fracture resulting from a blow to the skull with a blunt instrument (Pl 1). This was probably the result of an aggressive attack on the individual. Other traumas experienced by the same individual are more likely, though not conclusively, to have occurred as the result of a series of accidents, though some may have been contemporaneous. Smooth but noticeable bony callusing was observed in the left anterior distal ulna at the junction between *flexor pollicis longus* and *pronator quadratus* attachments and is probably indicative of soft tissue trauma (x-radiograph showed no sign of a fracture). Such an injury may have been sustained at the same time as the subsequently well-healed but slightly mis-aligned fractures in the dorsal portions of the left 10th and 11th rib shafts. Rib fractures are amongst the most common seen in archaeological populations and generally result from a fall against a hard object (Adams 1987, 107). This individual also has a well-healed but slightly distally mis-aligned fracture in the right distal fibula *c* 12 mm from the head, with possibly associated periosteal new bone indicative of soft tissue infection and suggestive of an open wound. A short fissure (describing a 15 x 9 mm area) in the dorsal medial portion of the lateral condyle of the right tibia appears to represent the remains of an incompletely healed fracture. Such fractures may result due to the abduction of the tibia upon the femur while the foot is static, such as may result from a forceful blow at knee level from the lateral side, causing an oblique shearing fracture (Adams 1987, 250). The affected part of the condyle is generally somewhat more extensive in modern clinical cases but the lesion seems most likely to represent an injury of this type.

Overall trauma rates (adult bones) are: one of four left ulnae; one of five left radii; two of 17 left ribs; one of four right tibiae; one of five right fibulae.

Osteochondritis dissecans is generally believed to be traumatic in origin resulting in localised bone necrosis (Rogers and Waldron 1995, 28–30; Roberts and Manchester 1997, 87–9; Aufderheide and Rodríguez-Martín 1998, 81–3; Knüsel 2000, 116). A unilateral example was observed in the left femoral medial condyle of 2309 (1/9 distal femora).

Infections

The elderly male 2309 had shallow erosive lesions accompanied by fine–medium grained new bone across the surfaces of the adjacent T11–12 (Pl 1) and the L1–L3 body surfaces with marked anterior collapse of the L1–2 bodies. There is also periosteal new bone at the sternal ends of two left rib shafts. These lesions demonstrate some of the characteristics associated with tuberculosis infection (Ortner and Putscher 1985, 141–76; Roberts and Manchester 1997, 135–42; Aufderheide and Rodríguez-Martín 1998, 118–41), though brucellosis (occupational disease in individuals working with cattle or other animals which can be debilitating and prolonged; Aufderheide and Rodríguez-Martín 1998, 192–3) could represent a possible alternative. Destructive and reparative processes tend to occur simultaneously in brucellosis in contrast to the

Plate 2 Human remains – calcaneum-talus articular surfaces from 10130 show bi-lateral fine-medium grain reactive new bone with some deeper depressions/macro-pitting

largely destructive processes in tuberculosis, though vertebral body collapse is not normally associated with the former. Neither diagnosis could be made conclusively. The lamellar new bone over the anterior and sides of the T11–12 bodies are suggestive of a separate process of infection possibly associated with the ligaments.

Infection of the periosteal membrane covering bone may lead to the formation of periosteal new bone. Infection may be introduced directly to the bone as a result of trauma, develop in response to an adjacent soft tissue infection, or spread via the blood stream from foci elsewhere in the body. It is frequently difficult to detect the causative factors involved in individual cases and the lesions are commonly classified as indicative of a non-specific infection. In addition to the cases outlined above in association with dental lesions, possible specific infections and traumatic lesions, periosteal new bone was recorded in the remains of two other individuals, both males over 55 years of age (10130 and 10197). The calcaneum-talus articular surfaces from 10130 show bi-lateral fine–medium grain reactive new bone with some deeper depressions/macro-pitting (Pl 2), indicative of some form of non-specific infection. Both sides have marked anterior lateral extensions to the dorsal articular surfaces, creating 18 x 19 mm facets at a *c* 80 degree angle to normal surfaces, though the infection is unlikely to be associated with this morphological variation. Coarse, striated lamellar new bone was recorded bi-laterally on the tibiae and fibulae shafts from 10197, with some fine-grained reactive new bone medio-central in the right fibula shaft. Such lesions in the leg may result from a variety of conditions including ulcerations, varicose veins or the spread of infection from foci elsewhere within the body.

One neonate and possibly one almost full term foetus/neonate had endosteal new bone in one or more parts of the skull vault, and are likely to have died of the indicated meningeal infection.

Joint disease

All or parts of five spines (all male) were recovered from the Roman assemblage (subadult/adult). Extra-spinal joints were recovered from ten (including seven males and two female) subadult/adult individuals. The generally low number of lesions recorded and individuals affected is due to poor bone survival and the preferential destruction of trabecular bone, predominantly those areas affected by joint disease. The following figures can, therefore, only give an indication of how the population was affected and the rates should be viewed with caution.

Schmorl's nodes (a pressure defect resulting from a rupture in the intervertebral disc; Rogers and Waldron 1995, 27; Roberts and Manchester 1997, 107) commonly affect young adult spines. Shallow but sometimes extensive lesions were observed on eight adjacent vertebrae in the lower spine of the young male 3485. The overall rate of 9.5% is much lower than the average 17.7% for the period given by Roberts and Cox (2003, table 3.21). Degenerative disc disease, resulting from the breakdown of the intervertebral disc and reflecting age-related wear-and-tear (Rogers and Waldron 1995, 27), was recorded in one older male spine, with lesions in all areas (Tables 1 and 6). Lesions indicative of osteoarthritis (Rogers and Waldron 1995,

Table 6 Summary of number and rates (%) of spinal lesions from Springhead

	Total no vertebrae	*Osteoarthritis*	*Schmorl's nodes*	*Degenerative disc disease*	*Lone osteophytes*
Male	58 69.0% total	3 *c* 5.2%	8 *c* 13.8%	10 *c* 17.2%	13 *c* 22.4%
Total	84	3 *c* 3.6%	8 *c* 9.5%	10 *c* 11.9%	13 *c* 15.5%

43–4) were seen in the remains of three males. Spinal lesions were recorded in the thoracic region of one individual (Table 6). Extra-spinal lesions were seen in *c* 4.1% of joint surfaces (*c* 5.1% of male joints surfaces) at between one and six sites, the most extensive lesions being in the older adult male 10197. Affected joints include the temporo-mandibular (16.7%) and costo-vertebral joints (11.5%). Most changes were slight to moderate, with severe changes, including extensive eburnation, in the medial surfaces of the left knee joint from 10197.

Lone osteophytes often appear to be a 'normal accompaniment of age', reflective of 'wear-and-tear' (Rogers and Waldron 1995, 25–6). Lesions were recorded in two (including the C1–2 facets of the cremated adult female) spines (Tables 1 and 6). Extra-spinal lesions were recorded at between six and seven sites in the two older males (3.7% of joint surfaces). Some of the lesions may be reflective of the early stages of osteoarthritis. As with osteophytes, macro- and micro-pitting in the surfaces of synovial joints may develop in response to a number of conditions and it is not always possible to ascertain the specific cause of individual lesions, though it is probable that they are most commonly reflective of the early stage of osteoarthritis. Lone extra-spinal lesions were seen at three sites in the remains of one older adult male (*c* 0.8% of joints).

Bony growths may develop at tendon and ligament insertions on the bone; the causative factors of these enthesophytes include advancing age, traumatic stress, or various diseases (Rogers and Waldron 1995, 24–5). It is not always possible to be conclusive with respect to the aetiology of particular lesions, but they are commonly seen – as in three cases here – in the posterior surface of calcanea where they reflect activity related stress. Lesions were observed at between one and 13 sites in the remains of three males and two females (Table 1), the dorsal attachments on the femoral shafts being the most common location.

Metabolic conditions

Cribra orbitalia (manifest as pitting in the orbital roof) is generally believed to result from a metabolic disorder associated with childhood iron deficiency anaemia, though other contributory factors are also recognised (Molleson 1993; Roberts and Manchester 1997, 166–9). Slight lesions were recorded bi-laterally in the orbits of two males (8.7%). The rate is lower than that of 16.9% reported as an average for the Roman period by Roberts and Cox (2003, table 3.17) though this figure was derived from only two sites in their overall sample.

Discussion

It is difficult to gain an overall view of the health, lifestyle and potential status of the Roman population at Springhead due to the low number of adults within the assemblage and the very poor condition of some of the bone. Some of the rates for specific – particularly dental – conditions appear high and, although they may be reflective of the general population it seems more likely that they have been skewed by the difficulties experienced by a few individuals. In general, the low rates of deficiency-related (*cribra orbitalia* and hypoplasia) and dental lesions together with relatively light tooth wear suggest limited dietary-related stresses during childhood and a good diet, probably quite high in meat-protein, with access to self-cleaning foods and/or good dental hygiene. The elderly male 2309 had lost almost all his teeth and suffered extensively from joint disease, both, at least in part, reflective of his advanced years. He also appears to have had a particularly physically stressful life, including repeated fractures, some as a result of interpersonal violence. The young male 3485 had been distinguished from his contemporaries in his mode of burial, having been laid in a prone position. He had an unusually high rate of dental caries for such a young individual, suggesting a markedly different diet to the other individuals buried at Springhead, possibly indicating a lower social status. He was also one of the few individuals to show signs of dental hypoplasia, though his comparative great height does not suggest one who suffered any extensive dietary stress as a child.

Pyre Technology and Cremation Ritual

Most of the cremated bone was white in colour indicating a high level of oxidation (Holden *et al* 1995a and b). Some slight colour variation – hues of blue and grey – indicative of varied levels of oxidation was observed in several fragments of innominate and femur shaft, and in a few fragments of rib, distal radius, finger phalanx, and lower limb bones. The variations are relatively minor, predominantly affecting those areas with dense soft tissue coverage and a few peripheral zones and do not suggest any specific difficulties with the cremation process (McKinley 2008).

The weight of bone recovered from the burial (1155.9 g) is likely to be closely representative of the quantity initially included in the grave. It falls in the upper range of weights recovered from burials of this

Table 7 Summary of results from analysis of the human bone from Northfleet

Context	*Cut*	*Deposit type*	*Phase*	*Quantification*	*Age/sex*	*Comment*
15513	?	*in situ* burial	Mid-Roman	*c* 30% a.u.l.	neonate *c* 0–4 wks	expanded sternal rib–end

KEY: a. – axial skeleton; u. – upper limb; l. – lower limb

date (McKinley 2004b, 295–8) and represents *c* 72% of the average total expected from an adult cremation (McKinley 1993). A large proportion of the remains (70.2%) were identifiable to skeletal element, the distribution within the four skeletal areas being very close to the 'normal' distribution by weight (McKinley 1994, 6) at *c* 20.3% skull, 24.3% axial skeleton, 23.2% upper limb and 32.0% lower limb. As is commonly observed, identifiable fragments from all skeletal areas were included in the burial with no particular bias towards specific elements; however, where the side represented could be discerned, there were almost three times as many fragments from the left side as from the right. No tooth roots were recovered and there were relatively few (given the overall large size of the collection) of the small bones of the hands and feet (14 elements). These two observations may be linked with the mode of recovery employed to collect bone from the pyre site for burial; hand recovery of individual skeletal elements may mitigate against the recovery of many of the smaller bones, and the bias towards the left side may reflect bone being collected from either side of the spent pyre with more people engaged on the left side or more time having been spent collecting from that side.

The majority of the bone was recovered from the 10 mm sieve fraction (*c* 87%) with a maximum fragment size of 71 mm. The depth of the grave was not particularly great (0.15 m) but the deposit was well sealed and had not suffered any disturbance. There is no evidence to suggest any deliberate fragmentation of the bone prior to burial.

Most of the bone (73.4%) was recovered from a concentration (ie, the burial) in the north-east portion of the grave, having originally been contained in a wooden casket or box. The rest of the bone was recovered from the lower part of the surrounding grave fill within the casket/box, though its precise location was not recorded, and it is unclear if at least some of this comprised an additional deposit made external to the casket, material from the casket spread slightly due to bioturbation, or material scattered within the grave fill. Fragments of bone from what appear to represent the two deposits were found to join and, although the bone from the grave fill contained slightly smaller fragments (73.6% from the 10 mm sieve, maximum fragments 64 mm), there is a similar distribution of skeletal elements to that within the burial. The smaller fragment size is most likely due to the bone not benefiting from the physical protection and slightly altered microenvironment within the burial context itself.

Pyre and possibly grave goods in the form of 107.6 g of mostly cremated animal bone were included in the grave. Since the bone from the burial and the grave fill was each excavated as a single sub-context there are no details on the distribution of the various osseous components, though most of the animal bone (93.9%) came from the burial itself. The cremated remains were those of an immature pig (mostly hind leg) with some immature bird and a medium-sized mammal of unidentified species (identifications by Jessica Grimm). The unburnt remains, at least some of which are likely to have been intrusive, included pig, sheep/goat, fish and frog. The inclusion of cremated animal remains in Romano-British burials is a commonly observed characteristic of the rite. There is wide variation in the number of burials with animal bone from different cemeteries, ranging from *c* 3.5% from Westhampnett, West Sussex (McKinley and Smith 1997) to *c* 47% from St Stephens, St Albans, Hertfordshire (McKinley 1992). The inclusion of further animal remains at the time of burial is also well documented for the period, the species of preference often, as here, being pig, though other species are not uncommon (Philpott 1991, 197–9).

Human Remains from Northfleet

Unburnt human bone was recovered from one late 2nd century AD context, an *in situ* burial of a neonate made within the villa complex. A summary of the results is presented in Table 7; full details are held in the archive.

The unburnt bone from 15513 is in good condition. The apparent low level of skeletal recovery is due to non-recovery on site. As is often the case with such young individuals the bone was not recognised as human at the time of excavation and only a sample of the deposit was excavated, leaving an unknown but potentially substantial proportion of the bone *in situ*.

The common exclusion of neonates from Roman cemeteries and their frequent burial in domestic settlements is well documented (see above), and the single case from Northfleet villa, buried within a former structural post-hole, is yet another instance of those buried amongst the living rather than with the dead.

Changes in the visceral surface of the sternal rib ends were observed in only one of the six recovered. The sternal end was expanded over a *c* 4.5 mm length, showing coarse, open woven bone continuous with the normal bone surface. The changes are indicative of increased vascularity, which can be linked with various metabolic conditions. The apparent singularity of this lesion and incomplete skeletal recovery render any attempted diagnosis questionable in this case.

Chapter 2
Animal Bone

by Jessica M Grimm and Fay Worley

Springhead Sanctuary Site (ARC SPH00)

by Jessica M Grimm

Of the 39,357 animal bones recovered from the Sanctuary site, *c* 54% was fully analysed. The fully analysed bones came from undisturbed archaeological contexts. The bulk of the material was hand collected, supplemented by bone from soil samples where appropriate. As the overall assemblage is quite large and can be separated according to several spatial and chronological sub-divisions, it was decided to analyse the bones respecting these sub-divisions. The sub-divisions were grouped largely on the basis of chronology resulting in five assemblages: late Iron Age, early Roman, the Sanctuary complex (middle Roman), middle Roman and Saxon (for the last, see Grimm, Vol 4).

Late Iron Age

Taphonomy

The animal bone come from pits or groups of pits located in several different parts of the excavated area. The bone preservation was moderate and differed between individual pits (Tables 8–9). This is to be expected as every pit is likely to have had its own filling-history and micro-environment. The material from shallow pits was particularly prone to root etching due to its closeness to the surface. Scavenger gnawing, mainly by canids, had marked only *c* 3% of the bones and indicates that gnawing was probably not a significant cause of bone loss.

The proportion of loose teeth (2%) was low and, together with the presence of loose but matching epiphyses and (partial) skeletons, this is seen as an indication that the assemblage was not extensively reworked. With only 8% complete bones, including the small compact ones like carpals and tarsals, the assemblage is heavily fragmented. Apparently, the animal carcasses were heavily used. Generally, only a few bones showed discoloration due to contact with fire, although some pits contained more than 50% burnt fragments.

Species proportions

According to NISP (number of identified specimens), cattle and sheep/goat were equally important, closely followed by pig, with small proportions of horse and domestic fowl (Table 10). As cattle bones are much heavier than sheep/goat or pig bones, it is likely that beef was the main type of meat eaten as bone weight and meat weight correlate. However, MNE (minimum number of elements) counts show that sheep was probably the main livestock species kept (*Tables 11–14*).

The small percentage of wild species suggests that the late Iron Age people at Springhead relied mainly on livestock for their protein needs. The only wild mammal species likely to have been eaten is hare, and parallel cuts resulting from filleting on a pelvis prove that they were consumed. Occasional bones of duck, grey heron, raven and wader were also found, indicating some fowling activities. Their presence suggests that this might have been a year-round activity as grey-heron, mallard, raven and teal are resident birds in this area nowadays, whereas garganey and plover are winter visitors.

Table 8 Condition of the hand collected animal bone fragments from Springhead Sanctuary (%)

Phase	*Very Poor*	*Poor*	*Moderate*	*Good*	*Excellent*	*NISP*
Late Iron Age	0	8	81	11	-	3370
Early Roman	-	3	82	15	-	1306
Sanctuary*	-	2	73	22	-	5855
Late Roman	-	3	94	2	-	564
Total	0	1	78	16	-	11095

* *including ritual shaft*

Table 9 Taphonomic parameters of the hand collected bone fragments from Springhead Sanctuary (%)

Phase	*Complete bones*	*Loose teeth*	*Gnawing*	*Burning*
Late Iron Age	8	2	3	8
Early Roman	19	3	11	3
Sanctuary	25	5	5	4
Ritual shaft	68	2	5	1
Late Roman	6	3	10	4

Table 10 Quantification and taxa identified in each phase from Springhead Sanctuary presented as total number of fragments (NISP) collected by each recovery method

	Taxon	*Late Iron Age*			*Early Roman*			*Sanctuary Complex**			*Late Roman*			*Total*
		Hand collected	*Sieved*	*Total*	*Hand coll*	*Sieved*	*Total*	*Hand coll*	*Sieved*	*Total*	*Hand coll*	*Sieved*	*Total*	
Domestic mammals	Cattle (*Bos taurus*)	907	36	943	376	6	382	920	13	933	131	3	134	2392
	Equid (cf. *Equus caballus*)	15	–	15	32	–	32	63	1	64	11	–	11	122
	Sheep (*Ovis aries*)	115	11	126	30	–	30	29	2	31	9	–	9	196
	Goat (*Capra hircus*)	1	–	1	1	–	1	–	–	–	–	–	–	2
	Sheep/Goat (*Ovis/Capra*)	697	77	774	348	23	371	942	55	997	111	8	119	2321
	Pig (*Sus domesticus*)	548	54	602	77	6	83	249	12	261	27	2	29	975
	Dog (*Canis familiaris*)	5	5	10	10	1	11	83	2	85	–	–	–	106
	Cat (*Felis catus*)	–	–	–	2	–	2	–	–	–	–	–	–	2
Wild mammals	Roe Deer (*Capreolus capreolus*)	–	–	–	–	–	–	2	–	2	–	–	–	2
	Deer (Cervidae)	–	–	–	–	–	–	5	–	5	–	–	–	5
	Hare (*Lepus* sp.)	19	3	22	–	–	–	1	–	1	–	–	–	23
	Common shrew (*Sorex araneus*)	–	–	–	–	1	1	4	1	5	–	–	–	6
	Common/Field vole (*Microtus arvalis/agrestis*)	–	–	–	–	–	–	–	5	5	–	–	–	5
	Hedgehog (*Erinaceus europaeus*)	–	–	–	–	–	–	1	–	1	–	–	–	1
	House mouse (*Mus musculus*)	–	–	–	–	–	–	–	1	1	–	–	–	1
	Water vole (*Arvicola terrestris*)	6	6	12	–	–	–	9	1	10	–	1	1	23
	Weasel (*Mustela nivalis*)	–	–	–	–	–	–	3	–	3	–	–	–	3
	Wood/Yellowneck mouse (*Apodemus sylvaticus/flavicollis*)	–	–	–	–	–	–	2	4	6	–	–	–	6
Indeterminate mammals	Large Mammal	257	27	284	54	12	66	281	49	330	21	2	23	703
	Medium Mammal	592	761	1353	77	281	358	703	445	1148	89	98	187	3046
	Small Mammal	9	3	12	–	–	–	69	–	69	1	1	2	83
	Micro Mammal	–	–	–	–	–	–	19	150	169	–	–	–	169
Birds	Coot (*Fulica atra*)	–	–	–	–	–	–	1	–	1	–	–	–	1
	Crow (*Corvus* sp.)	–	–	–	1	–	1	1	–	1	–	–	–	2
	Domestic fowl (*Gallus gallus* dom.)	6	–	6	6	–	6	19	1	20	–	–	–	32
	Greylag goose (*Anser anser*)	–	–	–	–	–	–	1	–	1	–	–	–	1
	Grey heron (*Ardea cinerea*)	4	–	4	–	–	–	–	–	–	–	–	–	4
	Mallard (*Anas platyrhynchos*)	–	1	1	–	–	–	6	–	6	–	–	–	7
	Teal/Garganey (*Anas crecca/querquedula*)	1	–	1	1	–	1	5	–	5	–	–	–	7

Table 10 Quantification and taxa identified in each phase from Springhead Sanctuary (continued)

	Taxon	Late Iron Age			Early Roman			Sanctuary Complex*			Late Roman			Total
		Hand collected	Sieved	Total	Hand coll	Sieved	Total	Hand coll	Sieved	Total	Hand coll	Sieved	Total	
	Passerine (thrush size)	–	1	1	–	–	–	1	–	1	–	–	–	2
	Passerine (sparrow size)	–	–	–	–	–	–	1	–	1	–	–	–	1
	Peregrine (*Falco peregrinus*)	–	–	–	–	–	–	1	–	1	–	–	–	1
	Raven (*Corvus corax*)	4	–	4	32	–	32	4	–	4	–	–	–	40
	Rock/Stock dove (*Columba livia/oenas*)	–	–	–	1	–	1	3	–	3	–	–	–	4
	Wader (Scolopacidae of plover size)	1	–	1	–	–	–	–	–	–	–	–	–	1
	Water rail (*Rallus aquaticus*)	–	–	–	–	–	–	1	–	1	–	–	–	1
	White-tailed/Golden eagle (*Haliaeetus albicilla/Aquila chrysaetos*)	–	–	–	–	–	–	1	–	1	–	–	–	1
	Woodpigeon (*Columba palumbus*)	–	–	–	1	–	1	–	–	–	–	–	–	1
	Bird (Aves)	1	1	2	3	1	4	10	6	16	1	–	1	23
Fish	Fish (Pisces)	4	8	12	3	5	8	14	25	39		2	2	60
Anura	Common frog (*Rana temporaria*)	–	–	–	–	–	–	26	3	29	160	–	160	189
	Common toad (*Bufo bufo*)	1	–	1	–	–	–	20	–	20	–	–	–	21
	Natterjack toad (*Bufo calamita*)	–	–	–	–	–	–	2	–	2	–	–	–	2
	Frog/Toad (*Rana/Bufo*)	–	1	1	–	–	–	352	10	362	3	–	3	366
All taxa	Grand total	3193	995	4188	1115	336	1451	3854	786	4640	564	117	681	10959
	Weight (kg)	44.6	1.4	46.0	21.5	0.2	21.7	56.4	0.6	57.0	5.9	0.1	6.0	130.7

All skeletons were counted as NISP=1 (actual element numbers can be found in the text). * including ritual shaft

Interestingly, the modern distribution of raven does not include the Springhead area (http://www.rspb.org.uk/wildlife/birdguide/name/r/raven/index.aspx). Grey heron, raven and plover might have been eaten, and Schuster (2001, 91–2) states that the breast meat of grey heron and the young were quite commonly eaten until recently in parts of eastern Europe. The meat of raven was also eaten in recent times, mainly by poorer people, and in eastern Germany, Slavonic areas in Upper-Austria and Romania was even thought of as a delicacy (Schuster 2001, 393). However, corvids have also been associated with death and black magic, and they play an important part in mythology and legends. Their presence in the assemblage might thus have a more ritual meaning, although as corvids are attracted by human food remains their bones might represent natural casualties.

Age at death and sex

Cattle were mainly kept until they reached maturity and only a few juvenile and prime meat individuals were killed. Most cattle were killed at the adult and old adult stages (Fig 3). By comparing the dental age pattern of cattle with the epiphyseal fusion data in *Table 15*, it becomes apparent that juvenile animals are only represented by their mandibles. This is to be expected as the mandible usually survives better than the rest of the skeleton. About a quarter of the animals were killed in their third year and just under half of all the cattle lived beyond five years of age. The age at death pattern for cattle is indicative of the use of secondary products like milk, manure and traction as a large proportion of animals are allowed to reach full maturity and beyond. As the milk yield of an Iron Age cow was probably low, manure and traction are likely to have been the most important uses. Mainly older cattle at the end of their useful lives were eaten. The few juveniles represented in the material are probably natural casualties, or animals that were not needed, or were not fit for other tasks. It is likely that the actual number of juveniles was higher as most of their less resilient bones probably did not survive. The presence of foetal/neonate bone material indicates that the animals were kept on the site, as Reichstein (1994) argues that the meat of stillborn animals was probably not eaten but was, instead, discarded. Due to poor hygiene, the number of miscarriages and the mortality among neonates must have been higher than today. Additionally, until quite recently, fodder was stretched with bark and thus quality was reduced, with the result that miscarriages frequently occurred at the end of winter.

The demographic picture obtained from the sheep dental age data and epiphyseal data is quite similar (Fig 4 and *Table 16*). Most sheep died at the age of 10–20 months when they have an optimum meat yield. Another peak in the killing pattern is seen at the age of 3.5 years, indicating breeding activities. These older sheep would have provided milk, manure and wool as well as meat.

The pigs show a similar kill-off pattern to the sheep, with mainly subadult and adult animals being slaughtered (Fig 5). As this animal is mainly kept for its meat, keeping them beyond the age at which they attain full body size is uneconomic. The epiphyseal fusion data suggests that none of the pigs lived beyond the age of 2–2.5 years (*Table 17*). Sexing the canines, 14 adult jaws could be attributed to sows and eight to boars. The combination of age and sex data for pig shows that some breeding possibly took place on the site. Varro (cited by Benecke 2003) says that the Romans used sows for breeding from 20 months up to seven years, and according to Columella (book 7 chapter 9; Ahrens 1972) a boar can serve at the age of 6–12 months until it is four years of age. Sows can be served twice a year from the age of one year until the age of seven. Müller (1973) states that it was customary in the 19th century countryside to use sows with an age of between two and eight years, and boars up to four years, for breeding. This means that most of the pigs at Springhead could have produced one or two litters.

Phenotype

Only three cattle bones could be used for an estimation of height at the withers. Values range from 0.99–1.14 m. These values are typical for the small short-horned Iron Age cattle breed. Six sheep skulls bear (traces of) horn cores and no hornless skulls were found. The major sheep breed around Springhead was thus probably horned. One of these skulls indicated massive horns and thus probably belonged to a ram. Five bones could be used for a height at the withers estimation resulting in a range from 0.50–0.61 m. These are normal values for late Iron Age sheep. The height at the withers for pig ranged from 0.61–0.81 m and was calculated from four complete bones.

Health

In an attempt to assess the health of the animal population, anomalies and pathologies were recorded. Recent outbreaks of animal diseases such as BSE (cattle), CSF (pig) and blue tongue disease (sheep) show the disruptive nature and the huge economic costs of these epidemics. This, no doubt, would have been similar in the past. Although not many bones show pathological changes, this does not mean that the animals were healthy. As the surrounding soft tissues and cartilage where the lesions possibly originated have disappeared, only the reaction of the bone to an illness can be analysed.

All the pathologies observed on the sheep and sheep/goat bones occurred in the jaws. Siegel (1976, 361) noted that oral disease accounted for the majority of abnormalities in 18 British sites ranging in date from the Neolithic to medieval times. In a left maxilla from Springhead, the teeth were unevenly worn, probably due to malformation of the lower jaw, or a misaligned opposing tooth. A left mandible exhibited a third molar which was heavily worn on the lingual side, possibly again due to malocclusion between the upper and lower jaw. The fourth premolar alveolus in a right sheep mandible was partially infilled, indicating that the tooth and fallen out relatively soon before death. A left

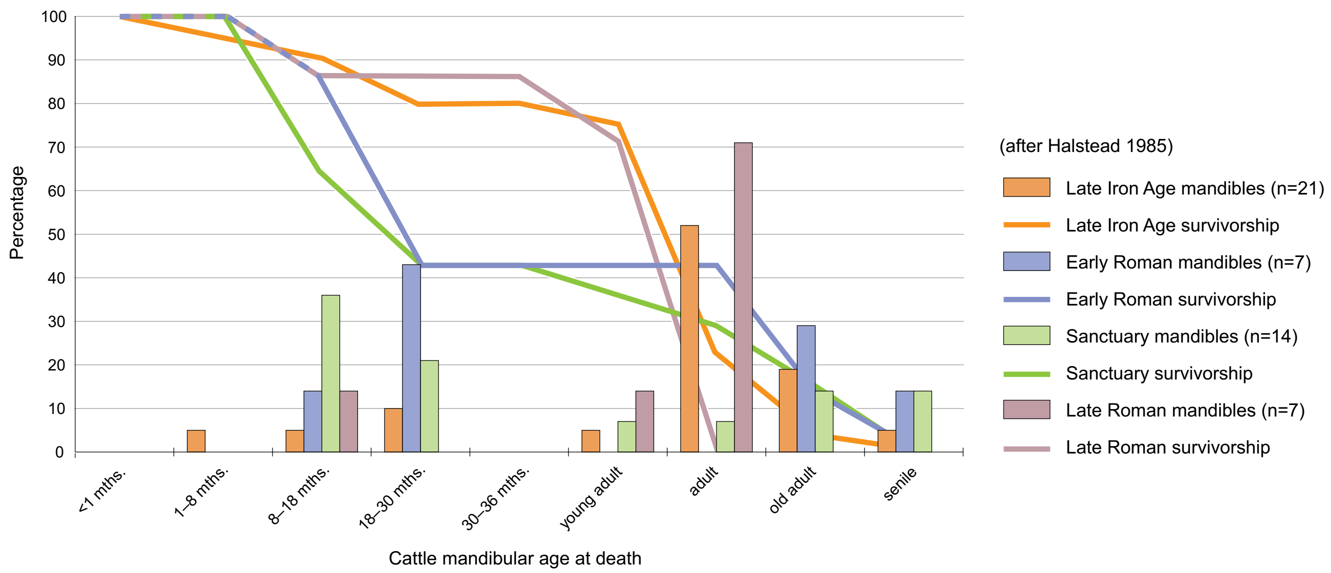


Figure 3 Cattle mortality profile from Springhead Sanctuary

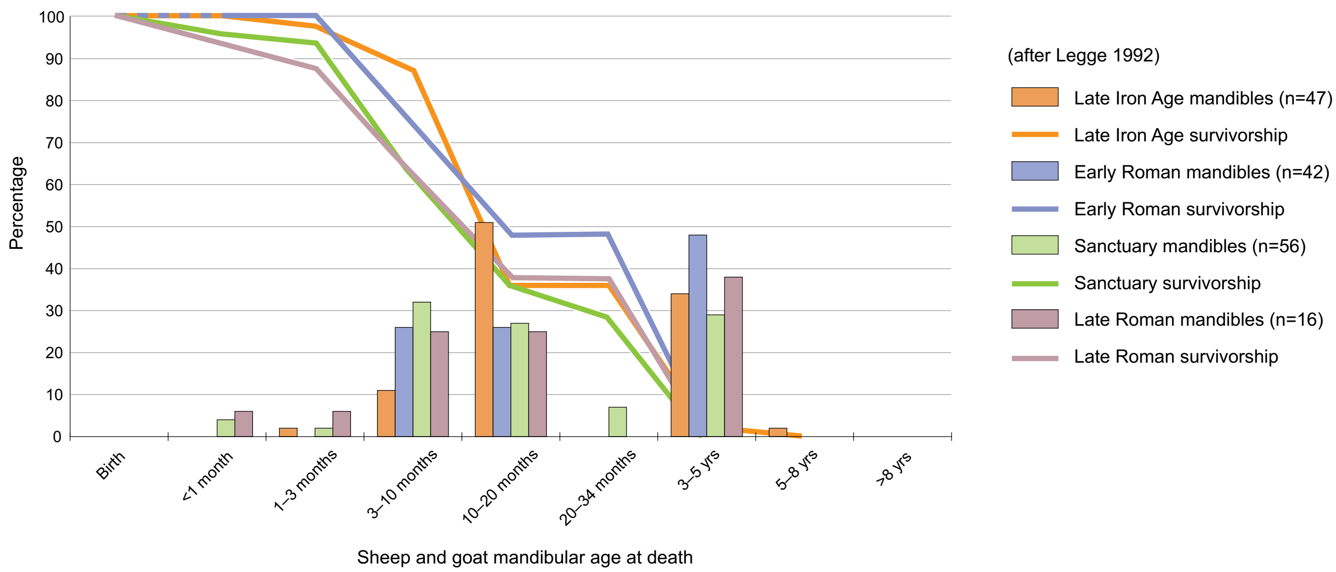


Figure 4 Sheep or goat mortality profile from Springhead Sanctuary

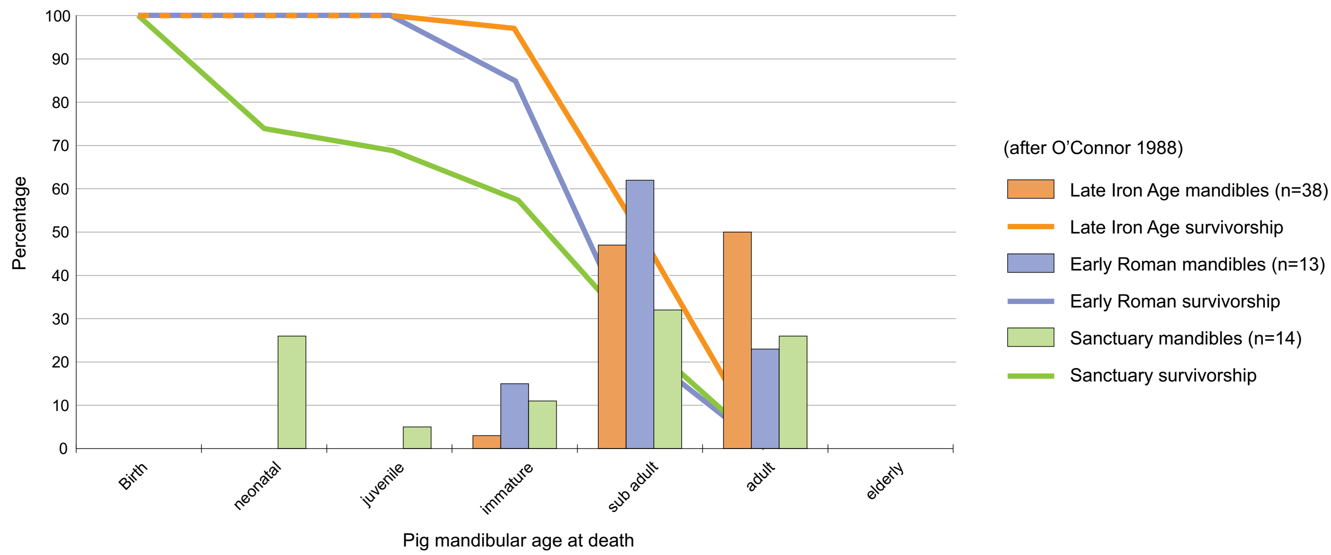


Figure 5 Pig mortality profile from Springhead Sanctuary

mandible from an adult sheep/goat exhibited a small nodule of bone on the buccal side behind the third molar. A second premolar was entirely missing from another sheep/goat mandible (left side). In summary, approximately 10% of all sheep jaws recorded from Springhead were affected by some sort of abnormality.

Pathologies were present on both cranial and post-cranial cattle bones. Oral abnormalities included a mandible with a missing second premolar, while another left mandible had a third molar tooth with a missing hypoconulid (third pillar). Unfortunately, however, the number of recorded specimens is too few to further investigate the prevalence of these two congenital conditions. Two cattle ribs showed patches of newly formed bone tissue on the inside or the outside, probably as a result of an inflammation. Another rib had a thickened area of irregular bone tissue and a newly formed foramen, probably indicating a healed fracture. Two articulating cervical vertebrae had shiny vertical grooves on the cranial lateral articulation surfaces. A metatarsal had extra bone tissue on the proximal articular surface indicating the beginnings of spavin. The last two conditions were probably caused by stress and could be an indication of draught activities; age analysis has already pointed towards the secondary use of cattle for traction.

Element representation and butchery

The minimum number of elements method (MNE) shows that cattle, sheep/goat, pig and equid carcasses were processed on or near the site as most of their skeletal elements are present (*Tables 11–14*). The absence of cattle horn cores might be explained by assuming that this part of the skull remained attached to the skin which was transported elsewhere for tanning and hornworking. At least some of the horns went directly to the hornworkers, as one skull fragment had a chop mark on its base indicating that the horn was removed for processing. It is likely that sheep and goat carcasses were processed in the same way. Apparently, the hooves were not left attached to the skins, as phalanges were found.

Interestingly, the tables also show some similarities and differences in the representation of skeletal elements between the species that are likely to be the result of taphonomic mechanisms. In cattle, the elements of the front and the hind leg are equally distributed so that for every scapula there is approximately one humerus, one radius and ulna, and one metacarpus. In sheep/goat however, (distal) humerus, radius and (distal) tibia are disproportionally frequent as these elements are more resilient. This is due to the fact that the distal humerus, proximal radius and distal tibia were already fused when the majority of the Springhead sheep/goat were killed. A similar pattern can be observed for pig. In all species, apart from serial elements like costae and vertebrae, the mandible seems to survive best. A different explanation, in which large quantities of loose mandibles were transported to the site, is unlikely. Additionally, this phenomenon is quite common in archaeozoological assemblages from different periods, areas and site types (see, for example, Legge and Dorrington 1985, 124, 127).

The accumulation of cut and chop marks on particular skeletal elements provides information on the use of the dead animal's body (see, for example, Uerpmann 1977; Binford 1981; Lauwerier 1988; Ewersen 2004). Some marks occurring during butchery involve skinning and partitioning of the carcass, other marks are the result of food preparation. Not many butchery marks were seen, which is probably due to the heavily root-etched surfaces of many bones. The butchery marks left on cattle bones were mostly caused by a cleaver or a knife and involved skinning, portioning the carcass and filleting. The practice of skinning is illustrated by parallel cut marks on the mandible, the lateral side of the ribs and on the elements of the lower extremities. The portioning marks are particularly found on the elements of the spinal column, ribs and the pelvis.

The smaller size of the carcasses of sheep/goat and pig probably required a different butchery technique, largely carried out with a knife rather than a chopper. However, chopping marks from portioning the sheep/goat carcass were found on the skull, elements of the spinal column (split vertically) and the pelvis. Knife marks from filleting were seen on the scapula, radius and pelvis. The butchery marks left on pig bones were exclusively caused by knives during filleting. They are mainly found on the meat-rich scapula, pelvis and femur. The absence of portioning marks caused by cleavers might point to the custom of roasting whole pigs over a fire.

Special deposits

Equid remains were only found sporadically, apart from a nearly complete skeleton of a small adult, probably a female equid, found near the top of pit 3341. It is safer to class the remains as 'equid' as there is a slight possibility that they derive from donkey (probably a Roman introduction), mule (mare x jack) or the less common hinny (jenny x stallion). However, the measurements of the 1st phalanx fall within the range for horses published by Reichstein (1995) on medieval equids in Northern Germany. Its height at the withers was estimated at 1.20 m; a pony by modern standards. All bones were fused and all permanent teeth had erupted. Parts of the spine, right front limb and the elements of the left front limb were missing. This is probably due to different preservation conditions in the pit. As only a few other bones of domesticated animals were found in this pit, it is likely that the equid carcass represents a special deposition.

Most equid remains were found as two or more articulating elements indicating a different use of the carcass compared to the other domesticated animals. The absence of clear butchery marks suggests that they were probably not regularly eaten. Two pathological conditions found in the assemblage underline the primary use of the animals for riding and draught activities. The first consists of the articulating lower part of the spine of an adult equid of which two of the four lumbar vertebrae were fused with the sacrum. The other consists of a fused left centrotarsal and os tarsi III.

Two (partial) dog skeletons were found in pits. One partial skeleton consisted of the fragmented skull, the left humerus, radius and tibia of an adult dog with a height at the withers of *c* 0.50 m. The dog bones were accompanied by many bones of different species and it is thus likely that the dog's body was disposed of with other waste. The nearly complete skeleton of an adult dog, with a height at the withers of *c* 0.35 m, was also found in what seems to have been a normal rubbish pit.

Upon further examination of the distribution of the animal bones it was found that pits 3010 and 3027 contained the same species in the same proportions, ages and skeletal distributions. These 'twin pits' might be the results of two (sets of) standardised meals.

Early Roman (mid-1st–early 2nd century AD)

Taphonomy

The material of early Roman date came from a series of pits, the fills of three 'box burials' or associated features alongside the early Roman road leading from the springs and a series of dumped deposits sealing this road.

The overall condition of the bones was moderate, with small proportions of very well or poorly preserved material (see Tables 8–9), the bones from the 'box burials' being the best preserved. Furthermore, none of these bones had a root-etched surface, whereas 1% of the material from above the Roman road and 5% of the bones from the pits had a root-etched surface. The proportion of gnawed bone differed more clearly between the assemblages. The bones from the box burials were least affected (2%), which is to be expected as the bones were probably quickly buried, whereas 10% of the bones from the pits were gnawed. This means that at least some of the material was accessible to dogs before final deposition. As expected, the dumped layers above the road exhibited the highest proportion of gnawed bones (17%), and it is likely that this material was more readily accessible to dogs.

The proportion of loose teeth is quite low, ranging from 1% (dumped layers) to 6% (pits). Together with the presence of loose but matching epiphyses or articulating elements, it indicates that the overall assemblage was probably not extensively reworked. This means that even the dumped layers that sealed the Roman road were probably the result of individual, deliberate events and did not accumulate over a longer period of time.

All three groups contained small proportions of burnt bone (0.3–7%). The lowest percentage was found in the dumped material above the road, these fragments having been mainly scorched or charred, indicating lower temperatures. The material from the pits had the highest proportion of burnt fragments and, like the material from the 'box burials', these fragments were mainly calcined. Most of these fragments could only be assigned to the medium mammal category. However, small quantities of burnt cattle, sheep/goat and pig bones were identified.

Species proportions

As seen before with the Iron Age material, the bones largely derive from domesticated mammals (Table 10). Beef was probably the main type of meat eaten, whereas sheep were the main livestock kept. Two immature cat bones found in the dumped layers over the road indicate the introduction of domestic cats to Britain by the Romans. Cat bones were also found at the temple at Great Chesterford (Baxter 2011). Apart from the keeping of domestic fowl, remains of other birds show that the people went fowling. Raven, rook/crow, rock-/stock dove, probably teal and woodpigeon were all resident birds around Springhead.

Age at death and sex

Analysis shows that cattle, sheep and pig were probably slaughtered at a younger age in the early Roman period than in the late Iron Age (Figs 3–5 and *Tables 15–17*). This means that cattle were no longer mainly kept for their secondary products as emphasis shifted towards meat production, and sheep were no longer mainly killed at prime meat age, but increasingly as lambs. The emphasis on killing subadult pigs might indicate a shift from production to mainly consumption at the site, with breeding becoming less important. Further confirmation of these trends is not possible, as only six bones could be sexed. They indicated two sows, one boar, one ewe and two roosters.

Phenotype

Due to the presence of complete skeletons and relatively large number of complete equid long bones, a number of heights at the withers could be estimated. These showed a mean value of 1.24 m for cattle, 0.56 m for sheep (skeleton) and 0.4 m for dog. The equid bones produced heights at the withers ranging from 1.20–1.50 m (n=6, mean 1.29 m) indicating different types of animals. Most of these animals fall within the quite small and small classes as proposed by Vitt (1952) and would qualify as ponies. However, one equid falls within the larger than average class and would not qualify as a pony. The data published by Reichstein (1995) on donkeys indicate that a metacarpal from context 6035 probably belongs to a donkey.

Pathologies and non-metric traits

As seen in the Iron Age assemblage, most pathologies and anomalies were found in the jaws. A subadult cattle jaw exhibited a pitted mandibular hinge and an adult cattle mandible has its second premolar missing and the alveolus had completely filled in. A subadult pig had lost its first molar during life. As usual, the sheep/goat jaws were very prone to pathological changes and anomalies. An adult sheep mandible had two extra foramina around the foramen mentale and signs of an inflammation around the first molar. A second adult mandible was seen with signs of inflammation in the same area (prevalence: 9%). In another mandible the second premolar was lost *ante mortem*. The anomaly of a second foramen underneath the premolar row on the buccal side was seen in 12 mandibles (prevalence: 48%; prevalence: 42% for the Roadside Settlement (see Worley below)). Of these, 58% were located beneath P3 and 42% beneath P2. This anomaly was not seen in the Iron Age assemblage and might indicate breeding development or a change in breed. Based on measurements of the humerus and the position of the femoral nutrient foramen, Baxter (2011) identifies a similar change for Great Chesterford between the late 1st/early 2nd and the mid-2nd/early 3rd century AD. The extra mental foramina were also seen in the material from nearby Chelmsford.

A dog lumbar vertebra shows a thickening of the processus transverses towards the vertebra body. This might be the result of a fracture. An adult chicken tibiotarsus showed patches of new bone formation on its shaft indicating an inflammation on the lower leg. The complete skeleton of a domestic fowl found in one of the 'box burials' displayed several pathological changes and is described below.

Element representation and butchery

The distribution of the skeletal elements is quite similar for cattle, sheep and pig (see *Tables 11–13*). In general, mandibles survive better than other elements, and sheep tibiae and metatarsals survive better than the rest. Compared with the Iron Age assemblage, the number of sheep and pig scapulae, humeri and radii is lower. This might indicate that their over-representation in the Iron Age assemblage is not solely due to taphonomy, but might have an anthropogenic component to it (ie, a preference for sheep and pig front legs). From analysis of the butchery marks it is clear that the chopper was used mainly in dismantling the cattle carcass as 91% of the 35 clear butchery marks were chops. Of these, 63% were caused by disarticulating and portioning the carcass. The sparse cut marks observed were made during skinning or filleting (inside and outside of ribs) and skinning (phalanx I). An equid scapula from one of the pits was heavily butchered as it showed chop marks on the neck and on both sides of the articular surface (disarticulation). The fact that the *spina scapulae* was chopped off indicates filleting.

Of the 19 clear butchery marks seen on sheep/goat bones, 42% were caused by a chopper and 58% by a knife. As with the Iron Age assemblage, the size of the carcass determines the butchery tools used. As seen before for cattle, the chopper is mainly used to disarticulate and portion the carcass and knives are used for skinning and filleting. However, fine parallel cuts on the upper part of the cranial articular surface of an atlas indicates that the carcass was decapitated using a knife. The three butchery marks seen on pig bones involved portioning (chop through rib), filleting (parallel cuts on rib) and disarticulation (chop just below acetabulum).

Special deposits

The so-called 'box burials' 6345 and 6607/6608 contained normal butchery and kitchen waste that probably does not differ from the rest of the early Roman assemblage. However, pit 6104, probably a cenotaph, contained two pots and the skeletons of a puppy and a domestic fowl. According to the tooth eruption in the jaws, the puppy was over 5–6 weeks, but below 4–5 months. The bones showed that it was probably a puppy of a small type of dog.

The complete skeleton of a domestic fowl was placed on top of the puppy. As the tarsometatarsus has a spur scar, the skeleton probably belonged to a young rooster. The humerus, ulna and tibiotarsus show a thickening of parts of the shaft with patches of newly formed bone tissue. The same was seen on the area between the *manubrium sterni* and the *apex cristae sterni* of the sternum. Peters (1997, 47) describes the same pathology for two Roman sites in the Netherlands and Germany and attributes it to a virus infection (*osteopetrosis, leukosis*). The disease is incidental, spontaneous, and mainly encountered in males.

The nearly complete skeleton of an adult horned ewe in pit 2954 might represent a special deposition as no butchery marks were seen. However, complete skeletons are not uncommon even in settlement contexts (see Worley below). They might have been special depositions or represent carcasses of diseased animals. The assemblage from the dumped deposits overlying the early road included the nearly complete skeleton of a raven. The bird might have died of natural causes and thus represent background fauna, or it may have been killed because it was though to represent bad luck or thought of as a pest.

Pit 2958 contained, amongst normal waste, the nearly complete skeleton of a young pig (older than 7 weeks; Pd4 has erupted). As no butchery or gnawing marks were found, it is clear that the carcass was placed in the pit and quickly covered. It is possible that the pig was diseased and not suitable for human consumption. However, ritual deposition cannot be excluded.

Sanctuary Complex (mid-2nd–early 3rd century AD)

Taphonomy

The 4726 bones dating to this period came from a pit alignment, the upper fills of two 'viewing platforms' and the Sanctuary enclosing ditch. Together with the ritual shaft, they probably all belonged to the Sanctuary complex. Due to its special character, the material from the ritual shaft is dealt with separately below.

In general, most bones were moderately well preserved and only low proportions of gnawed or burnt fragments as well as small numbers of loose teeth were encountered (see Tables 8–9). Fragmentation differed widely as some assemblages included (partial) skeletons. Root-etching was seen on many bones and, in particular, those from the 'viewing platforms', which also had the highest proportion of burnt bones, mainly associated with a hearth/oven. Considering all taphonomic characteristics of the assemblages, combined with the presence of articulating bones and loose but matching epiphyses, it is that the material from the 'viewing platforms' and the enclosing ditch was probably reworked.

Species proportions

Upon analysing species proportions a familiar pattern emerges in which beef was the staple meat eaten and sheep/goat probably the main livestock (see Table 10). The presence of a pair of roe deer mandibles and a possible red deer tooth and tibia fragment indicate that some hunting took place as well. Besides keeping domestic fowl (14% juvenile bones), the people were also involved in fowling. The remains of coot, dove, ducks and water rail probably derive from meals. The bones of crow and raven might also derive from meals. However, together with the eagle, these birds might simply have been attracted by carrion on the site. The eagle bone probably belongs to the white-tailed eagle. Prilloff (1994) suggests that they were hunted for their feathers which were used on arrows. Their bones are frequently found on (early) medieval sites on the continent. Peregrines are considered to be the best birds for falconry as they are very swift; they might have been used in this way here.

Large quantities of bone from small mammals and anurans were found in wet-sieved of soil samples. Some of them might be intrusive (due to bioturbation), but it is likely that they belonged to the Roman background fauna. Their high numbers in some pits (2214, 2227 and 2236) indicate natural pit-fall victims rather than 'ritual deposits' as suggested by some (eg, Milne 1995, 110) and suggests that these pits were not or not always sufficiently covered. Indeed, many frogs were rescued by the excavation staff upon falling into excavated features.

Amongst the small mammals and amphibians water vole together with common frog, common toad, and natterjack toad are indicative of a wet environment. The common toad prefers deeper water for mating, whereas the common frog lives most of the time outside the water. The natterjack toad is now an extremely rare species in Britain and mostly found on sandy soils and lowland heaths. The wood mouse is less restricted to woods than the yellow neck mouse and the house mouse is restricted to buildings. House mice were introduced to Britain probably in the Iron Age (Yalden 1999).

Age at death and sex

Classification of the cattle jaws shows that these animals were slaughtered at an even younger age than in the previous periods (Fig 3). Although about one fifth of the cattle population still lived well beyond the age of five years (*Table 15*), the meat of calves gains in importance. The Sanctuary assemblage also shows the highest proportion of lambs being killed (Fig 4). Only a small proportion of animals lived beyond the age of four to five years, according to the epiphyseal fusion data (*Table 16*), indicating that sheep were killed at an earlier age than in the previous phase. Three sheep/goat foetal bones found in the assemblage from a 'viewing platform' show that lambing took place nearby. The pig dental data point to a high proportion of (very) young pigs killed (Fig 5), with 71% killed in their first year. Of the remaining animals, 91% were killed before 24–30 months. This pattern is similar to that of a modern piggery producing meat. Nowadays, piglets are fattened from the age of 10 weeks when they weigh *c* 25 kg, to about 6–8 months when they weigh *c* 100–120 kg and are slaughtered. Four out of seven sexable jaws belonged to boars. Although both boars and sows were present, the slaughter of many young animals suggests that the economic strategy was focused upon meat production rather than the breeding of piglets for fattening elsewhere.

Phenotype

Three cranial fragments and a partial horn core indicate that the cattle breed around Springhead was horned. Two complete adult metacarpi provided heights at the withers of 1.20 and 1.24 m, quite high values that might indicate steers or oxen. Of the four cranial sheep/goat fragments, one was of a naturally polled animal. A further two horn core fragments indicate that at least some of the sheep around Springhead were horned. Alternatively, only the rams were horned and these fragments derive from them. Three complete equid bones provided heights at the withers of 1.20, 1.28 and 1.43 m. According to the tables produced by Vitt (1952), the first two are regarded as small, whereas the animal of 1.43 m is regarded as average. All three are regarded as ponies by modern standards. The heights at the withers for dog are given below (*Special deposits*).

Health

A right cattle mandible from one of the pits had a third molar of which the third pillar was extremely worn down, exposing the root canal. A second right mandible from a 'viewing platform' had an extra foramen beneath the second premolar on the lingual side. An atlas from the enclosing ditch showed an area of porosity and an articular depression on the caudal side where the two halves fuse; this might be a growth disorder. The most interesting pathology is seen on a left acetabulum (pelvis). Bone nodules have formed on the acetabulum rim and the articulation surface moved towards the outside and onto the new bone. It is likely that the rotation of the femur head made a shiny groove on the extension. This particular pathology is possibly caused by (over-) using the animal for draught activities.

The previously encountered anomaly of an extra buccal foramen beneath the premolar row in sheep/goat had a prevalence of 31%. Of these, 47% were located underneath the third premolar, 42% underneath the second premolar and 11% between the two. These figures are consistent with those for the early Roman sheep/goat assemblage. Additionally, a left sheep/goat mandible of a mature animal showed pathological changes. At least one premolar had been lost *ante mortem* and the alveolus had closed. The buccal bone surface underneath the premolar row was pitted. The same pitted surface was also seen on the lingual side beneath the third molar. This condition might point to a nutritional deficiency.

A tibia shaft fragment of pig showed irregular new bone formation. This might have been the result of a healed fracture and a possible inflammation. Pathologies on dog bones are described below (*Special deposits*).

Element representation and butchery

Element representation is very similar to that of the late Iron Age assemblage and quite similar to those from the early Roman period (see *Tables 11–14*). The pattern is characterised by high numbers of mandibles as well as sheep/goat humeri, radii, metacarpals, tibiae and metatarsals. The pattern is indicative of a mixture of butchery and kitchen waste. The slight over representation of elements of the upper legs (meat-rich) of cattle and sheep/goat might indicate a predominance of kitchen waste in the 'viewing platform' assemblage.

Of the 77 butchery marks seen on the cattle bones, 71% were caused by a chopper and 27% by a knife. The scrape mark on a tibia shaft was probably caused during filleting with a chopper. Parallel cuts on the outside of the ribs might indicate skinning and they comprise 26% of all butchery marks. The majority (77%) of butchery marks involved disarticulating and portioning the carcass. A further 22% were probably the result of filleting and the majority of these can be found on the inside of the ribs. A cervical vertebra of an equid displayed parallel cuts and a chop on the distal articular surface. These marks probably originate from disarticulation of the spinal column. Pig carcasses were largely butchered using a chopper, as 73% of the 11 butchery marks were caused using this tool, and 64% of the butchery marks point to disarticulation and portioning of the carcass. The other marks were on the scapula, humerus and ribs and are likely to be the result of filleting. Similarly, 56% of the butchery marks seen on sheep/goat (n=18) were caused by a chopper, of which 39% were caused during disarticulation and portioning, whereas 50% were caused during filleting the portioned carcass. The dominant use of the chopper is a characteristic of Roman butchery practice.

Special deposits

The Sanctuary complex is characterised by a series of pits/shafts and other features containing unusual assemblages that potentially have a ritual character. Shallow pit 2212 contained the complete fragmented skull of an equid with full dentition among some normal waste. An equid skull was found on the edge of the floor (context 5653) of one of the early circular structures interpreted as 'bakeries'. The now heavily fragmented skull belonged to an adult animal. A shallow pit (context 5129) inside the Sanctuary complex yielded another heavily fragmented skull of an adult equid.

Pit 2214 contained, among normal waste, the remains of ten dogs of different ages (*Table 18*) and the nearly complete skeleton of an Atlantic saury (the pre-caudal and caudal vertebra from this fish (see Hamilton and Dyer below)). The normal waste consists of bones from cattle, sheep/goat, and pig, as well as the remains of trapped amphibians (frog, toad and natterjack toad).

The nearly complete skeleton of dog 1 with its remarkable round skull resembles that of a dwarf hound skeleton described by Baxter (2006) from a Roman grave at York Road, Leicester. A blow on the forehead (small cracks) and a more severe blow on the back of the head (cracked and part missing) possibly killed the dog. Possibly due to the small size of its skull and jaws, the left upper first premolar and the third molar were missing in both mandibles. The partial skeleton of dog 2 belonged to an animal aged between 8–12 and 18–24 months with a height at the withers of 0.22 m. Premolar two and molar three are missing from the jaw and the alveoli have closed.

Dog skeletons 3 to 10 are the partial skeletons of puppies and neonate or stillborn animals. Comparing the measurements of the long bones and the scapula and taking into account the tooth eruption as well, it becomes apparent that dog skeletons 5 and 6 may have originated from the same litter (*Table 19*). It is also probable that dog skeletons 9 and 10 were the unborn puppies from dog 2 as there was no os penis to go with this animal. Small dogs are sexually mature earlier than larger dogs so it is possible that dog 2 was in pup.

Pit 2236 contained the remains of six dog skeletons and a bird skeleton (*Table 20*) among normal butchered and gnawed waste of cattle, horse, sheep/goat, pig and fish. The remains of voles, mice and amphibians show that this pit was open at the time. Dogs 1, 2 and 4 were puppies. Dog 3 (complete skeleton) was male with a height at the withers of *c* 0.30 m. Dogs 5 and 6 were represented by the partial skeletons of neonates or foetuses and were probably not from the same litter, as their long bones are not of the same length.

Pit 2236 also contained the nearly complete skeleton of a dove. The dog and bird skeletons came from different contexts and some elements of the same skeleton were scattered over more than one context. This makes it likely that the skeletons were not deposited at the same time. Later deposits might have disturbed earlier ones. The main birthing season for dog was probably March–April, and this means that the foetal/neonate and the 5–6 week old puppies would have been deposited in the spring. The older pup might have been deposited somewhere in late spring/early summer. However, when the birth season was less restricted, deposits might have been made at a different time or all year round. It seems that after the initial depositions of complete animals, the pits were filled with normal refuse, although this could still have represented the remains of ritual feasting (see Vol 1, Chap 2 and 4).

Ritual Shaft 2856 (last quarter 2nd century AD)

Taphonomy

The assemblage from shaft 2856 (see Vol 1, Fig 2.55) associated with the Sanctuary complex (see above) is characterised by a high number of complete skeletons. The good preservation of the bones and the low proportion of gnawed bones and loose teeth indicate primary deposits with little or no subsequent reworking. Only a few of the bones show signs of contact with fire.

Species proportions

The identifiable remains were of mammals, birds and amphibians. Most of the remains belong to domesticates: cattle, horse, sheep/goat, pig and dog. The wild species consist of common shrew, common vole, field mouse, hare, deer, weasel, common frog and common toad. The common vole, common frog and field mouse are the only species represented in the sieved material. The low number of amphibians and small mammals that fell into the shaft suggest the shaft was covered most of the time. Other pits from the same site, although shallower than the ritual shaft, have a greater quantity of small species, indicating that they were left open.

The natural background fauna of small mammals and amphibians is usually indicative of the local environment. Though shrew, vole, field mouse and weasel are burrowing animals, the depth of the level (contexts 6619 and 6620) in the shaft where they were found suggests that their remains are ancient. The common shrew, common vole and field or wood mouse are some of Britain's most abundant mammals and can live virtually everywhere. The weasel is found in a range of habitats, including damp grassland, that can be found at Springhead. Of particular interest is that historically weasels were believed to have magical powers, and were said to be able to bring their dead young back to life (www.arkive.org/species/ARK/mammals/Mustela_nivals/more_info.html). Schuster (2001, 644–5) records that weasels were seen as demonic and an encounter with a weasel was a bad sign. The Romans thought that weasels were poisonous and the natural enemies of snakes (Pliny, *Natural History* Book VIII). Perhaps folklore of this kind accounts for the presence of weasel remains near the bottom of the shaft.

Special deposits

Analysis of contexts 2828, 2848, 2854, 2903, 2983, 2984, 2994 and 5284 showed that they contained ordinary butchery waste and kitchen refuse. Some bones were gnawed or showed signs of contact with fire. Of note is the find of a bone chip that was carefully cut out of a long bone of a large mammal in context 2983; finds such as these are commonly associated with bone working. The following contexts within shaft 2856 contained special depositions among normal butchery waste and kitchen refuse (which is probably the remains of ritual feasting):

Context 2855

In this context the nearly complete skeleton of dog 1 was found together with the butchered articulating atlas, axis and four cervical vertebrae of a young cow (*Table 21*). Apart from the right hind leg and both hind paws, the dog skeleton is complete. As even small elements like the os penis and phalanges were found, it seems unlikely that elements of the right hind leg were overlooked. The skeleton lay with its back against the wall of the shaft and with contracted legs and head pointing south-east. Fragments of an iron chain were found adjacent to the skull, and it is believed that the dog was placed in the shaft together with its chain.

Dog 1 would have been about 0.33 m high at the withers and, as the os penis indicates, a male. The animal was adult as all permanent teeth were fully erupted and in wear, and all long bone epiphyses fused. However, wear on the teeth is only slight and the sutures of the cranium are still visible indicating that it was not old. Like all of the dog skeletons found in shaft 2856, the skull is mesaticephalic with a slight saggital crest and a well-developed occipital crest, characteristic of German Shepherd, Beagle or Setter. In the mandible the fourth premolar and the first molar are crowded and the third molar encroaches on the vertical ramus. The first molar is large compared to the rest of the teeth. In this particular skeleton the skull shows a small lump of irregular bone on the left side of the braincase. The second premolar is missing from both mandibles and their alveoli are no longer visible. The limb bones are all straight and no bowing was seen in the radius or tibia. The distal shaft of the (left) femur is thickened and the *tuberositas supracondylaris* is quite pronounced with sharp edges.

Context 2985

This context contained the special placement of two adult cattle and one adult equid skull close together as a group (Pl 3). In addition, the skeleton of dog 2 was found (*Table 21*). As no field drawing of this dog exists, it is likely that the skeleton was no longer articulated. Both femurs show signs of canid gnawing on their distal part, as is seen on the left humerus mid-shaft, the right tibia distally and the left pelvis.

All permanent teeth show slight wear and premolars three and four are missing (alveoli filled) in both mandibles, leaving a gap in the tooth row. The cephalic index of its skull is 55.9 and the snout index is 52.4. Comparing some of the dog's cranial measurements with the data for modern dogs collected by Clark (1995, fig. 9) indicates that the relationship between least breadth of the braincase and minimum width between the orbits (von den Driesch 1976, measurements 31 and 33) is comparable to that of the modern Jack Russell skull. The first cervical vertebra and the four lower thoracic vertebrae have extra bone tissue around the articular surfaces. The fusing of the different skeletal elements is complete and none of the long bones show signs of bowing.

Plate 3 Cattle and horse skulls from ritual shaft 2856

Furthermore, this context produced a right dog pelvis that did not correspond to the left one as it is smaller and the epiphyses have not yet fused. It might be that some carpals/tarsals and phalanges also derive from this subadult dog 3.

Context 2986

This context contained the remains of two dog partial right hind legs (*Table 21*) and an adult cattle skull with a chop behind the eye socket. Based on the tibia, dog 4 had a height at the withers of *c* 0.32 m. The distal shaft of the (left) femur is enlarged and the *tuberositas supracondylaris* has quite sharp edges and the tibia displays slight bowing. Dog 5 must have been considerably larger (similar to dog 2) and its pelvis shows traces of gnawing.

Context 2996

This context produced the bones of two nearly complete dog skeletons (dogs 6 and 7; *Table 21*) and a human skull. Dog skeleton 6 was found lying with its back to the wall and its head pointing south-east. The dog did not face the human skull. All long bones, pelvis and vertebrae epiphyses have fused. As the permanent teeth show very little wear, the dog was adult but not aged. All long bones are straight and no bowing was seen in the radius or tibia. The second skeleton belongs to a puppy and is less complete (dog 7).

Context 5285

This context yielded the complete skeleton of an adult male dog (dog 8; *Table 21*). The snout width index for its skull is 52.2 and the palatal index is 63.6. All epiphyses have fused and the teeth are significantly worn. The right mandibular canine displays a deep notch caused by rubbing against its maxillar counterpart. The distal parts of the femora are enlarged. The left radius and ulna of this dog show a depression and irregular bone structure around the foramen where the two bones face each other. This might be the result of an inflammation. The axis shows some extra bone on the rim of the distal articular surface. The articulating cervical vertebra has a ring of extra bone tissue as well. As the teeth of this dog are heavily worn and the elements of the spinal column show traces of wear and/or stress, it is probable that this dog was old.

Context 6619

Many of the bones in this context belonged to six (partial) dog skeletons (*Table 21*). The teeth of dog 9 are worn, indicating an older animal. Radius and tibia are slightly bowed and the femur is distally enlarged. Two right ribs were broken but never actually healed, only forming extra bone tissue around the fracture. This dog shows some resemblance to the dwarf hound skeleton found in a Roman grave at Leicester, but bowing in the radius and tibia was not so severe (Baxter 2006).

None of the bones of dogs 11, 12, 13 or 14 had fused (see Grimm 2007 on the aging of the foetal and neonate dog remains from Springhead). Dog 11 was still a pup as the first premolar and first molar perforated the cript and are visible below the head of bone. Dog 12 represents the partial skeleton of a neonate dog. The premolars have perforated the cript but were probably not fully erupted (no teeth preserved) and all skull plates are still separate. Dog 13 (ulna, tibia) is probably a stillborn/neonate and dog 14 (femur, costae) is probably a young puppy.

Context 6620
Most of the bones in this context belonged to six (partial) dog skeletons (*Table 21*) and the skeletons of a calf, pig, domestic fowl, goose and raven. Because the excavation of contexts 6619 and 6620 had to be carried out very rapidly, no detailed recording of the dog skeletons or the pig skeleton took place. As most dogs are of the same height, it is extremely difficult to decide which bones represent which animal, and many ribs and some metapodials could not be assigned with certainty to any of the dogs. Therefore, it should be noted that the precise number and ages of the individuals identified remains subject to some uncertainty. A large part of an iron chain indicates that at least one of the dogs was put into the shaft with its chain.

None of the bones of dogs 15, 16 or 17 had fused. Dog 16 is the youngest of the three as premolars three and four are still erupting. In dogs 15 and 16, the first premolar and first molar are perforating the cript and are visible below the head of bone.

Dog 18 has a strange, keyhole-shaped foramen major (skull), a bony lump in the braincase and two impression-like marks next to premolar three and four in the palatal. All epiphyses have fused but the sutures of the skull are still visible. Comparing some of the dog's cranial measurements with the data for modern dogs collected by Clark (1995, fig. 10) indicates that the relationship between least breath of the braincase and the greatest facial width (von den Driesch 1976, measurements 31 and 32) is comparable with that of the modern juvenile Collie and, to a lesser extent, that of the modern Border Terrier. The cephalic index for the skull is 57.4 and the snout index is 50.2. The second premolar is missing in the right mandible and the alveolus has closed leaving a gap in the tooth row. A massive deposit of irregular, sharp edged bone is deposited on the caudal side of the right femur shaft. The bone is shortened by 13 mm compared to its healthy counterpart. The observed pathological condition is clearly the result of a healed fracture. Both femora are enlarged towards the distal ends.

Dog 19 would have been a small, subadult animal with complete dentition, but mainly unfused bones. Based upon size, preservation and colour, an os penis is assigned to this animal. The third molar is absent in the left mandible and the teeth show only slight wear. Some of the vertebral epiphyses have fused as have those of the scapula, distal humerus, proximal radius and proximal ulna. The epiphyses of the proximal humerus, distal radius, femur and proximal tibia are still unfused. Dog 20 would have been a large, subadult animal with complete dentition, but no fused bones. The teeth show no signs of wear. The distal parts of the femora are enlarged.

The remains of a complete pig and a complete calf (both have their first molars in eruption) were found at the bottom of the shaft (see Vol 1, Fig 2.55). Neither animal was butchered. The field drawing shows that the calf was found in anatomical order, but with the head and the front legs somewhat scrambled. The head faced south. The three (nearly) complete skeletons of raven, domestic fowl and greylag goose were also found in the bottom section of the shaft. Concretions on some of the raven bones indicate that the feathers were allowed to rot on the bone, indicating that a complete bird ended up in the shaft. The domestic fowl and goose were juvenile individuals.

Summary
Ritual shaft 2856 seems to have been repeatedly used to deposit the skeletons and skulls of dogs, pig, cattle, equid, raven, domestic fowl and goose. At least some of the skulls (ie, the two cattle and an equid skull) and skeletons (the calf and the dogs with their chains) were deliberately placed in the shaft (probably with their heads facing south-east or south). It is impossible to tell how the animals were killed as no signs of applied force were found on the skeletal remains. It is, however, striking that all but one of the dog skulls were fragmented. This might indicate the practice of smashing the skulls as a means of killing the dogs. As the shaft contains the remains of at least eight puppies, two subadult animals, eight animals in their prime of which one was not too healthy, and two aged animals, it does not seem that there was a favoured age at which a dog should be ritually disposed of. As only five ossa penis were found, the sex of the animal does not seem to have been important either.

The height at the withers could be estimated for eight of the dogs, and a further dog could be assigned a height at the withers based on comparing the bones with those eight, resulting in three size categories resembling those used by Clark (1995, fig. 5). The first category comprises small dogs with a height at the withers of around 0.33 m. At least five of the dogs, of which three are males, fall within this category. The second category comprises medium-sized dogs with a height at the withers of 0.46 m. At least three dogs, of which one is male, fall within this category. The last category comprises large dogs with a height at the withers of 0.52 m. It is tempting to think of these size categories as breeds, but it is believed that true breeds in the modern sense of the word did not exist at that time and that a lot of uncontrolled cross-breeding took place. Furthermore, probably all dogs showed the same mesaticephalic skull form as well as crowding of the fourth premolar and first molar in the mandible. This indicates certain uniformity.

As no signs of disarticulation (cuts, chops) were found on the bones of the partial skeletons, it is believed that all dogs were deposited as whole carcasses in the shaft. Attempts to complete incomplete skeletons by using elements from other contexts were fruitless, though it is unlikely that larger skeletal parts were overlooked during the excavation. However, local variations in preservation conditions might account for the loss of the rest of the skeleton. Another possibility might be that people removed parts of the skeleton after it had fully decomposed. Maybe those bones were looked upon as good-luck charms. Locker (1999, 150) notes that some bones of the original depositions in ritual shaft F at Keston were pushed to the walls of the shaft to make room for the larger skeletons of two horses and a cow.

The shaft was at least partly filled with normal butchery waste and kitchen refuse. The presence of loose epiphyses, matching diaphyses and articulating bones makes it clear that at least some of these remains were thrown into the shaft when they were still fresh. Others lay around for some time and were gnawed by dogs. This normal bone waste is found throughout the layers filling the shaft. It is difficult to say if those remains derive from ritual meals held near the shaft or if they were lying around the shaft and were thrown or perhaps washed in together with the soil to seal the deposits.

Summarising, it seems that the deposition of animal carcasses started with the placing of a calf, a young pig, six dogs and three skeletons of domestic fowl, raven and goose at the bottom of the shaft (context 6620). Some time after these deposits, a second one comprising six dogs (6619), and a third comprising one dog were made (5285). Part of context 5285 may have been emptied out and filled up with 5284, in which no animal skeletons were found. Both were sealed by 2996, which contained a dog, a puppy and a human skull. The next deposit contained two partial dog skeletons and a cattle skull (2986). Above this two dogs and three skulls, two cattle and one equid, were placed (2985). This layer was then sealed by three contexts (2994, 2984 and 2983) which contained only butchery waste/kitchen refuse, indicating no ritual activities. The last ritual activity took place in the layer on top of this and contained a dog with chain (2855). The rest of the shaft was then filled with butchery waste and kitchen refuse (2854, 2903 and 2848).

Middle Roman (early 2nd–mid-3rd century AD)

Taphonomy

The animal bone of the middle Roman period, excluding that from the Sanctuary complex, comes from just four pits dispersed across the site. The bones are moderately well preserved with 22% of them having a root-etched surface (see Table 8). None of the pits was particularly affected. Only 4% of the bones show signs of contact with fire (see Table 9) and most of these are charred, possibly indicating bone sticking out during roasting. A cattle scapula with a sharply restricted charred articular surface is a particular good example of this. Dog gnawing indicates that the bone was lying around before final deposition.

Species proportions

According to the NISP and bone weight, beef was the staple diet followed by mutton, possibly horse meat and pork (see Table 10). In addition, the MNE counts show that sheep/goat was the main livestock kept. This pattern was also encountered in the late Iron Age and other Roman material. The remains of water vole and common frog represent pit-fall casualties.

Age at death and sex

The small cattle assemblage mainly contains the remains of adult animals (see *Table 15*). However, the dental age data show that some cattle were slaughtered at an earlier age of 8–18 months (Fig 3). Although based on fewer data, it seems that sheep were killed at a variety of ages including lambs, prime meat animals and older animals (Fig 4). This means that meat production and the provision of secondary products were probably equally important. One left sheep/goat metacarpus indicates a still-born animal (136–145 days after gestation), indicating lambing nearby. Not enough ageable pig bones were available for analysis.

Phenotype

Context 2319 (pit 2318) contained a piece of sheep skull from a naturally polled animal, whereas context 2422 (pit 2420) contained a piece of skull with chop marks on the horn core area. It is thus possible that the horn cores were removed and the horn used as a raw material. Pit 2420 contained the distal part of a femur from a small adult equid. The assemblage of equid bones in pit 2318 (left femur, fragmented tibia, astragalus, tarsal and part of the ilium of the pelvis) belong to a very small equid with a height at the withers of *c* 1.12 m. It is possible that these remains represent a donkey.

Pathology

Context 2422 (pit 2420) contained a right upper jaw from an adult cow which had a cavity on the buccal side above the first molar. The cavity probably originated from an inflammation. The right mandible of a subadult animal found in context 2321 had an extra foramen on the buccal side of the diastema. The extra foramen beneath the premolar row in sheep was seen in two of the 14 mandibles with the appropriate region preserved. One was situated below the second premolar and the other below the third premolar.

Element representation and butchery

As the overall assemblage is quite small, the element distribution patterns are less informative (*Tables 11–14*). However, it is believed that the patterns do not differ from those of the earlier periods. Mandibles are generally better preserved than the post-cranial skeleton. In sheep/goat the more resilient elements, such as the radius, metacarpus, tibia and metatarsus, are better preserved as well. The more or less complete representation of the carcasses of cattle, sheep/goat and pig indicates that the animals were slaughtered nearby.

Discussion

The Sanctuary site yielded a large assemblage of animal bone dating from the mid-1st to the early 3rd century AD. Taphonomic analysis showed that most of the material was not re-worked and came from primary deposition. Overall, the material was characterised by butchery and kitchen waste. However, the late Iron Age, early Roman and, particularly, the middle Roman Sanctuary complex were characterised by the deposition of the skeletons of equid, cattle, sheep/goat, pig, dog, domestic fowl, goose, dove, raven, grey heron and Atlantic saury. Dog skeletons were by far the most common. The small quantity of material from the middle Roman non-Sanctuary pits did not contain any skeletons, probably reflecting its 'domestic' character.

Analysis of the proportions of cattle, sheep/goat and pig according to the MNE, shows that sheep/goat are by far the most numerous taxa, followed by pig and cattle. Large proportions of sheep are characteristic for late Iron Age sites in the south of Britain. The age at death patterns of these sites indicate that a fair proportion of young animals were slaughtered and thus the husbandry strategy seems to have been a mixed one based on milk, wool, manure and meat. In most assemblages of this period and this area, cattle were usually slaughtered young, indicating milk and meat production. At Springhead, however, cattle were mainly slaughtered at a mature age. Higher percentages of pig are only encountered on certain high status sites such as oppida. This coincides with finds of Roman material culture and is probably a reflection of the diet of the élite in Gaul who in turn mimicked Roman Italy (King 1991; 1999a).

The change from the late Iron Age to the Roman period is not reflected in any change in the proportions of animals consumed. According to the MNE data, sheep are still in the majority, followed by pig and cattle. As cattle are larger than sheep or pig, beef was probably eaten more often than mutton and pork, despite the smaller size of the cattle of this period. King (2005) points out that this continuation might not simply reflect the preservation of Iron Age dietary behaviour by Roman cults, as the degree of selectivity (see below) is usually much higher at temple sites compared to settlements. Secondly, several temples in Gaul and Germany have high sheep/goat numbers that cannot be traced back to local pre-Roman customs. Other British temple sites with sheep/goat dominance (King 2005, table 1) include Uley (late Iron Age–early Saxon), Harlow (late Iron Age–4th century AD), Great Chesterford (1st–4th century AD), the late Iron Age phase of Hayling Island (Downey *et al* 1979; King and Soffe 1998) and Henley Wood (late Iron Age–4th century AD; Watts and Leech 1996, 134–7).

The change that did take place at Springhead involved the selection of an increasing proportion of young lambs aged 3–10 months. Legge and Dorrington (1985) noted an even stronger preference for sheep aged 3–9 months at Harlow. They argue correctly that the assemblage does not represent a death assemblage drawn from all ages of a breeding population. Instead the lambs were selected from many different breeding populations and taken to the temple to be sacrificed. The authors proposed an autumnal sacrifice whereby the animals were afterwards consumed as no complete deposition of skeletons seems to have taken place. Other temples with evidence for a specific sacrifice age include Chelmsford and Great Chesterford (young sheep), Hayling Island (old sheep), Uley (young goats), the 1st–4th century AD site at Elst in the Netherlands (young cattle; Lauwerier 1988, 116) and the 2nd century AD Fortuna temple at Nijmegen characterised by a high number of burnt domestic fowl bones (Zeiler 1997). As the pattern seen at Springhead is not as exclusive and marked as at some of the above listed temple sites, it is unlikely that strict seasonal sheep offerings took place. The change seen in the age at death from the late Iron Age to the Roman period was not seen at Harlow and Legge *et al* (2000) argue that there was thus continuity in at least some of the cult practices there. Consequently, the change in the kill-off pattern at Springhead most likely indicates a change in cult practices at this site.

With regard to element representation, King and Soffe (1998) found that in the Hayling Island sheep assemblage the upper limb bones and mandibles were most common, while horn cores and phalanges were rare. For pig, mandibles and maxillae were most common elements, followed by the upper limb bones, while lower extremities were rare. They conclude that the assemblage comprises the better cuts of meat together with the skulls. They propose that the lesser cuts of meat were eaten by those making the offerings and the remains disposed of elsewhere. In contrast, Legge and Dorrington (1985) argue that the under-representation of sheep limb bones and the over-representation of pig jaws in the Harlow assemblage are due to taphonomic factors. The virtual absence of sheep metapodials is attributed to skinning practices whereby the lower extremities were left attached to the skin.

The predominance of sheep mandibles and foot bones in the Great Chesterford assemblage, coupled with the fact that most came from the right side, lead Legge *et al* (2000) to the conclusion that the right upper limb and possibly the heads were preferentially consumed at the temple. This practice is also recorded in Exodus (XXIX, 22):

> Take from this ram the fat, the fat tail, the fat around the inner parts, the covering of the liver, both kidneys with the fat on them, and the right thigh. [This is the ram for the ordination.]

and Leviticus (VII, 32):

> You are to give the right thigh of your fellowship offerings to the priest as a contribution.

Where the right thigh (and not shoulder as quoted by the authors) of sacrificial sheep was given to the priests. However, upon closer examination of the figures, the biblical quotations are not supported by the Great Chesterford material as it did not contain many femora and pelves are absent.

The preference for region or body side was not observed in the Springhead material. The distribution of the skeletal elements suggests that complete animals were slaughtered and consumed on the site. The under-representation of horn cores was probably due to them being taken away to the horner. Similarly, shortage of elements of the lower extremities is probably partly due to their small size and partly to the possibility that they were retained in the skin after skinning.

Although articulated skeletons or skulls were found throughout the Sanctuary area, spanning the late Iron Age to Roman period, the fill of ritual shaft 2856 is of particular interest. The large number of articulated skeletons, special placement of skeletons and skulls, and the presence of dogs with their chains, as well as the location of the shaft at the entrance of the Sanctuary enclosure, all point to special activities. Many unusual deposits, similar to those at Springhead, have been found, especially in the south of England, and various researchers have attempted to categorise this archaeological evidence of ritual behaviour in Britain in the Iron Age and Roman period (summarised in Hill 1995; Clark 1995, 10–11; Fulford 2001, 199–201).

Excavations at Springhead in the 1990s recorded several partial sheep skeletons and a dog skeleton (Wilson 1998) and the new excavations also revealed a number of skeletons of sheep and dog in the Roadside Settlement (see Worley below). A series of Roman 'ollae' (jars) from Upchurch Marshes (east of Springhead) each contained the remains of a puppy (about 3–4 weeks old) accompanied by charcoal and, in the same area, a pit with a bitch and two pups was found (Hume 1956). Relatively large groups of complete animal skeletons have also been found in wells, pits and ditches in settlement contexts at Baldock and Portchester (Fulford 2001, 209, 211). At Silchester, there is abundant evidence for special dog burials within the settlement. Noteworthy is a pit situated in insula IX that contained a skeleton of a dog in an upright position as though on guard (Fulford 2001, 201–5).

However, the shaft at Springhead is best paralleled by similar shafts and wells containing large quantities of dog remains which have been found at several sites in southern England. At Ewell, Surrey a group of eight or ten late 1st–early 2nd century shafts was examined in the mid-19th century. They ranged in depth between 3–11 m and at least one contained a decapitated dog. A 4 m deep shaft dated to the late 2nd century contained the remains of up to 17 young dogs (Jonathan Cotton, pers. comm.).

Eight shafts were recorded at the Roman villa site at Keston, Kent (Piercy Fox 1967). Shaft E (late Iron Age) included mostly material from sheep, as well as two dog skeletons. The larger dog had a height at the withers of *c* 0.30 m and was a subadult male. The other skeleton belonged to a very small dog with a height at the withers of only *c* 0.19 m. The skull of this dog was remarkably round and had no sagittal crest. Shaft F (1st–2nd century) contained the skeletons of two horses, two cattle, five pigs, eight sheep and 17 dogs. The two horses and one of the cattle were placed together. One of these horses was about 9–10 years old whereas the other was over 20 years of age. Both animals had a height at the withers of *c* 1.32–1.42 m. The cattle skeleton was older than 3 years and had a height at the withers of 1.27 m. The ages of the pigs and sheep range from newborn to adult, the animals having normal shoulder heights. The skeletons of the dogs indicate animals with ages from newborn to aged and withers heights ranging from *c* 0.32–0.58 m. At least two of these dogs were male. The lower levels of shaft H (2nd–3rd century) contained the skeletons of buzzard, raven and a mature dog. The middle and upper layers of this shaft were filled with domestic butchery debris (Locker 1999, 146–7), a characteristic also found for the upper-layers of the Springhead shaft. Late Roman shaft B contained the remains of two cremated dogs of which one was probably a lapdog.

Disused wells seem to have been foci for possible ritual behaviour, as is demonstrated by two late 2nd century timber-lined pits and a well excavated in Southwark, London in 1974. They contained 42 (nearly) complete pots, glass vessels, little food refuse and at least 20 dogs (Fulford 2001; Drummond-Murray and Thompson 2004). A further well at the Roman settlement at Oakridge, Hampshire went out of use at the end of the 2nd century and was backfilled with a series of deposits until the late 4th century. The well had a depth of almost 26 m and a width at the top of 4 m. It was largely filled with bone waste from butchery and skinning activities, along with some domestic rubbish, but in the late 3rd–early 4th century, several funerary/religious deposits were made including special pottery, a large number of puppy and dog bones and some human remains. In the late 4th century the pit was filled with a number of foetal, neonate and young animal skeletons, possibly originating from one breeding season, as well as the unbutchered skeletons of at least three adult cows, some metal and pottery objects and several human burials (Oliver 1993, 70–88). A Roman well in Staines, Surrey contained the skeletons of at least 16 dogs, the youngest being less than eight months old. The dogs ranged in height from 0.34–0.62 m (Locker 1999, 153). At Yeovilton, Somerset six adult dogs, of which at least two were male and of medium size (0.44–0.57 m), together with two neonate/foetal dogs were found in a Roman well. In addition, the well contained the partial skeletons of sheep, cat and domestic fowl (Lovell 2006).

Although none of the above examples lay near a known Roman sanctuary or temple complex, it seems that they represent practices that were quite common in Roman times. Even the deposition of many dogs of all ages and different 'breeds' was not uncommon, as the shafts and wells at Ewell, Keston, Oakridge, Southwark, Staines and Yeovilton show. Furthermore, the occurrence of dogs among other animals within deposits associated with shrines is documented by the shrine found at Castle Hill, Cambridge. This contained the skeleton of an adult dog, a cow skull with two articulating cervical vertebra, a horse skeleton with the skull split open, three small adult dogs wearing iron collars and forming a triangle, and a cow with a sheep and half of a large adult dog between its legs. The animals were accompanied by pottery and metal objects. However, this shrine seems to be different from the depositions at Springhead as it was clearly a sunken structure and not a shaft (Alexander and Pullinger 2000, 47).

What then was going on at Springhead? The presence of what are likely to have been sacred springs indicates an aquatic and possible healing cult (see discussion in Vol 1, Chap 4). King (2005) tried to group the Roman temples of Britain according to their characteristics and identified five groups. Group A is characterised by mass depositions such as the young lambs at Harlow. Group B is possibly a sub-group of A and is characterised by more individual special deposits of one or a few animals. A third group (C) is characterised by a high proportion of horse and might be specific to temple-mausolea like Bancroft. Group D is characterised by the virtual absence of animal bones during the main phases of use and this might be due to their healing-cult character where sick people did not want to come in contact with potentially disease-carrying animals. The eastern cult sites represent group E and are not relevant here.

Springhead does not seem to fit King's groups A or B as Springhead could only fall within group B if the ritual shaft is excluded and the dominance of young sheep is largely ignored. Similarly, Springhead does not seem to fall within the group of mass depositions (group A) as the number of specific depositions is too large. Neither is the Springhead assemblage characterised by a high proportion of horse and thus does not fit in group C. Again, Springhead does not fully fit the picture of group D as, unlike these temples, relatively large quantities of animal bone were found at Springhead.

It thus seems logical to view the Sanctuary complex separately from the ritual shaft. This does not mean that they are not related; they seem to represent different cult practices associated with the springs. At the Sanctuary complex, mainly lambs were sacrificed in the autumn at a possible religious festival. At the same time, older sheep, cattle, pig and other animals were sacrificed as well in one single event or were sacrificed all year round. The latter seems more likely as the other animals would need to be at year-interval distances in age from the young lambs to make a simultaneous sacrifice possible. The sacrificed animals were mainly processed on the spot and consumed on site as shown by the element distribution patterns. A possibly more private cult practice is seen in the deposition of single skulls or single skeletons in pits throughout the Sanctuary complex.

It is probable that a different cult practice is evidenced by the assemblage from the ritual shaft. The shaft was probably consecrated by the initial deposition of a calf, young pig and birds. The dominance of dogs in the subsequent assemblage is not surprising as research shows that they were common elements in special or ritual deposits (Snyder and Moore 2006) and attributed to a variety of deities in the ancient world and Gaul (Chilardi 2006; Trantalidou 2006; Wilkens 2006). In particular, the practice in the ancient world and Gaul of rubbing a puppy on one's sick body and then killing it and burying it in a sacred place might be of importance as many of the dog remains are of foetal/neonate and juvenile dogs (de Grossi Mazzorin and Minniti 2006). The requirement for the dogs to be buried in a sacred place might explain why they ended up in the ritual shaft and in pits within the Sanctuary complex.

Taking all the archaeozoological evidence together, it seems that the cult practices at Springhead had several dimensions. The presence of many different mammal, bird and possibly even fish species in what seem to be ritual deposits might indicate the veneration of an earth deity associated with life in general rather than with one or two particular animals. A healing aspect does not seem to be out of place.

Springhead Roadside Settlement (ARC SHN02)

by Fay Worley

A total assemblage of 16,293 fragments of animal bone was recovered from the Roadside Settlement excavations at Springhead Nursery. A sample of 54% of the animal bone assemblage was fully recorded and is reported here. The sample was chosen to include only the largest groups of bones from well-dated Roman contexts.

Results – General

Quantification

A total number of identified specimens (NISP) of 7404 (126 kg) from hand collected remains and 1346 (1 kg) from sieved residues were fully recorded. This count includes four sheep, three sheep or goat, one pig, 11 dogs and one rabbit articulated bone groups (ABGs). A total of 41% of the hand collected bone fragments and 12% of the bone fragments from the sieved residues could be identified to species or taxon.

The animal bone assemblage was recovered from contexts dating to the early, middle and late Roman periods, with the majority of bone fragments from the early Roman period (75% of the hand collected assemblage and 92% of the sieved assemblage).

Condition and preservation (hand collected assemblage)

The condition of the hand collected assemblage was generally good to excellent (32% and 64% of fragments respectively). A further 4% of fragments were in moderate condition and less than 1% was in poor condition. The condition of the hand collected fragments declined as the contexts became more recent (*Table 22*). The sieved bone fragments were in slightly worse condition (56% excellent, 35% good, 9% moderate and <1% very poor). Considering only the hand collected assemblage, 20% of fragments exhibited recent breaks and 33% of fragments were scarred by root etching. Evidence for scavenging animals, in the form of gnaw marks, was identified on 6% of fragments, the vast majority of these had been inflicted by canids (dogs or foxes) but ten fragments had been gnawed by

Table 23 Quantification and taxa identified in each phase from Springhead Roadside Settlement presented as total number of fragments (NISP) collected by each recovery method

	Taxon	*Early Roman* *Hand collected*	*Sieved*	*Total*	*Mid-Roman* *Hand collected*	*Sieved*	*Total*	*Late Roman** *Hand collected*	*Total*
Domestic mammals	Cattle (*Bos taurus*)	716	8	724	216	3	219	135	1078
	Equid (cf. *Equus caballus*)	71	1	72	24	–	24	14	110
	Sheep (*Ovis aries*)	134	5	139	17	–	17	3	159
	Goat (*Capra hircus*)	3	–	3	–	–	–	–	3
	Sheep/goat (*Ovis/Capra*)	1004	55	1059	130	2	132	74	1265
	Pig (*Sus domesticus*)	212	9	221	45	2	47	39	307
	Dog (*Canis familiaris*)	35	1	36	11	–	11	3	50
	Cat (*Felis catus*)	–	–	–	1	–	1	1	2
Wild mammals	Red deer (*Cervus elaphus*)	1	–	1	–	–	–	3	4
	Roe deer (*Capreolus capreolus*)	2	–	2	1	–	1	1	4
	Deer (Cervidae)	–	–	–	1	–	1	–	1
	Hare (*Lepus* sp.)	4	–	4	–	–	–	1	5
	Rabbit (*Oryctolagus cuniculus*)	1	–	1	–	–	–	–	1
	Black rat (*Rattus rattus*)	1	–	1	–	–	–	–	1
	Rat (*Rattus* sp.)	–	1	1	–	–	–	–	1
Indeterminate mammals	Large mammal	1431	44	1475	350	3	353	226	2054
	Medium mammal	1260	331	1591	168	38	206	136	1933
	Small mammal	6	1	7	4	1	5	4	16
	Micro-mammal	1	–	1	–	–	–	–	1
	Carnivore	5	–	5	2	–	2	1	8
Birds	Corvid (Corvidae)	1	–	1	–	–	–	–	1
	Crow (*Corvus* sp.)	1	–	1	–	–	–	–	1
	Domestic fowl (*Gallus gallus* dom.)	19	3	22	2	–	2	10	34
	Greylag goose (*Anser anser*)	–	–	–	–	–	–	2	2
	Mallard (*Anas platyrhynchos*)	1	–	1	1	–	1	–	2
	Raptor	1	–	1	–	–	–	–	1
	Raven (*Corvus corax*)	1	–	1	–	–	–	–	1
	Teal/garganey (*Anas crecca/querquedula*)	1	–	1	–	–	–	2	3
	Bird (Aves)	11	4	15	4	2	6	3	24
Fish	Fish (Pisces)	6	51	57	–	2	2	–	59
Anura	Common frog (*Rana temporaria*)	3	3	6	–	–	–	–	6
	Common toad (*Bufo bufo*)	4	1	5	–	–	–	–	5
	Toad (*Bufo* sp.)	–	4	4	1	–	1	5	10
	Frog/toad (*Rana/Bufo*)	3	4	7	–	–	–	33	40
Unidentified	Unidentified	589	711	1300	163	56	219	40	1559
All taxa	Total	5527	1237	6764	1141	109	1250	736	8750
	Weight (kg)	84.9	1.1	86.0	26.0	0.1	26.1	14.8	127.0

All skeletons were counted as NISP=1; * no late Roman samples were analysed for animal bone

rodents. A small proportion of bone fragments (2%) were burnt, half of these were charred and the remainder were scorched or calcined. The good condition of the bone fragments allowed the recognition of butchery marks and pathological lesions; both classes of evidence are discussed for each taxon below.

Species identified

Identified domestic mammals included cattle, pig, sheep, goat, equid (probably horse), dog and cat (Table 23). The bird bone assemblage included domestic fowl and goose which also may be domestic. Evidence for hunted and trapped species included remains of red and roe deer, hare, teal or garganey, mallard, crow, raven, raptor (buzzard, harrier or kite) and fish species (see Hamilton-Dyer below). A rabbit skeleton recovered with the early Roman assemblage is probably intrusive.

Relative proportions of the taxonomic groups

The majority of the animal bone assemblage comprised the remains of domestic mammals (96% identified hand collected fragments, 53% identified sieved fragments) with wild mammals making up less than 1% of each of the hand collected and sieved fractions. This is not surprising given the date and urban nature of the assemblage. The smaller taxa were more common in the sieved assemblage; bird and anuran bones each comprised 13% of the identified sieved and 4% of the identified hand collected assemblages. Fish bones comprised less than 1% of the identified hand collected assemblage but 33% of the identified sieved bone fragments. The relative increase in the bones of smaller taxa is expected in the sieved fraction.

The relative proportion of the main domestic mammals changes through time. The most significant

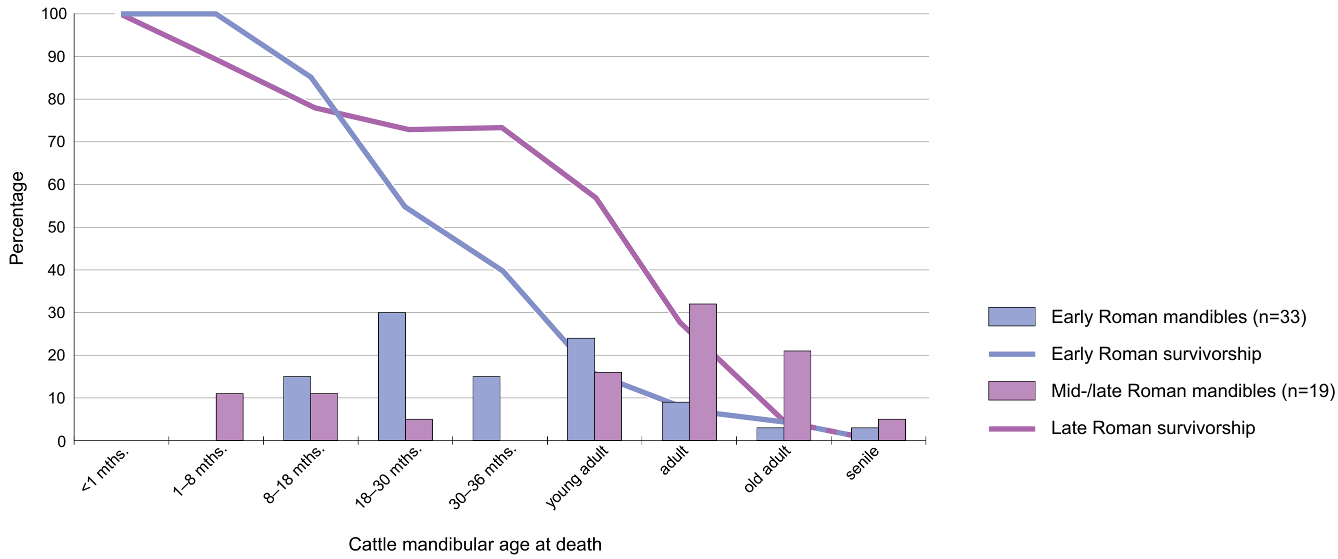


Figure 6 Cattle mortality profile from Springhead Roadside Settlement

change is in the relative proportion of cattle and sheep/goats which switch from sheep/goats dominating the domestic assemblage in the early phase (32% cattle and 52% sheep and goats) to cattle dominating the middle Roman assemblage (49% cattle and 33% sheep or goats). Pig bones become slightly more significant in the late Roman phase at the expense of sheep and goats. The proportion of the species in the late Roman period is similar to that seen in middle and late Roman phases at Northfleet villa (see Worley below).

Domesticates

Cattle

Size/type

There is no evidence for hornless cattle at Springhead. A total of 189 cattle specimens were measured (44% of all measured specimens, excluding ABGs). Withers heights could be estimated from the length of five metapodials. Since no attempt was made to sex the metapodials, the mean for the factors of steer and cow were used (ie, 6.15 for metacarpus and 5.45 for metatarsus). The data suggest that Roman cattle at Springhead stood at 1.12 to 1.24 m (mean = 1.17 m), within the range seen at contemporary sites elsewhere in Britain, including Northfleet villa (see Worley, below). Measured cattle astragali and metacarpals also fall into the same size and shape range as those identified at Northfleet.

Age at death and sex

Insufficient metric data were recovered to investigate sex in the cattle herds through bone size. Two cattle pelves displayed female characteristics; no male pelves were recorded.

Age at death could be estimated from the degree of tooth wear on 33 early Roman cattle mandibles. The data for the middle and late Roman period were combined to provide a dataset of 19 mandibles. The cattle mortality profile (Fig 6) indicates that the majority of individuals were killed either as juveniles between 18 and 30 months old or as young adults in the early Roman period. In the later period the emphasis probably shifts to adult and old adult animals. Very few neonatal mandibles were present in the whole assemblage and there is no additional evidence for neonatal cattle from post-cranial elements (*Table 24*). Some animals did survive into adulthood and some into senility; it is likely that these animals were kept for traction, milk production or breeding prior to slaughter. The overall pattern of mortality seen in the early Roman period suggests that the cattle were primarily husbanded for meat (following Halstead 1985), following very closely the model curves for meat sheep flocks produced by Payne (1973). This is what might be expected if beef cattle were traded into the town from the surrounding countryside. The corresponding survivorship curve contains fewer older animals than the Northfleet villa assemblage (see Worley, below) highlighting differing economic or meat procurement strategies in the villa and town. It can be interpreted as evidence for utilisation of cattle primarily for meat at Springhead while the villa had broader agricultural uses for the animals prior to slaughter.

Pathology and non-metric traits

Pathological conditions were identified on 102 cattle elements (10% NISP); two of these also exhibited non-metric traits and a further 19 exhibited non-metric traits without pathological lesions. The most common pathological condition was the presence of calculus deposits, identified on 53 early Roman elements, 20 middle Roman elements and five late Roman elements. The calculus deposits ranged from ‘slight’ to ‘heavy’ and some had a metallic appearance. A total of 12 specimens exhibited oral pathologies other than calculus, and six oral non-metric traits were identified in the cattle bones. The oral pathologies comprised tooth crowding (one early Roman maxilla), enamel defects (three middle Roman and one late Roman loose teeth), abscesses (on

Plate 4 Cattle scapulae, possibly perforated by a butcher's hook, from Springhead and Northfleet

a middle Roman mandible which also exhibited abnormal tooth wear), abnormal tooth wear (on two early Roman maxillae and one mandible) indicating missing or misaligned opposing teeth, and active bone around the tooth sockets possibly indicating infection (on three early Roman maxilla, one early Roman mandible and one late Roman maxilla). The oral non-metric traits comprised four missing or malformed hypoconulids, three from the early and one from the middle Roman assemblages. In addition, two early Roman mandibles display a double mental foramen.

Additional non-metric traits comprised an early Roman cattle skull exhibiting occipital perforations, and an early Roman first phalanx with a non-metric crease in its distal articulation. A middle Roman metatarsus displayed extra foramina just above the condyles anteriorly. None of these conditions would have affected the animals' well being.

The remaining pathological conditions in cattle involved the skull, the pelvis and bones of the feet. An early Roman cattle skull displayed a patch of woven bone posteriorly on the frontal bone behind the horn core. An early Roman pelvis exhibited a patch of eburnation and lipping around the acetabulum. Lipping or extension of the proximal joint surface and associated active bone growth was recorded on one early and three middle Roman first phalanges. One of these also had a hook-shaped exotosis on its axial distal diaphysis. An early Roman second phalanx had extra bone growth at its distal end. An early Roman metapodial and a late Roman first phalanx had woven bone on their diaphyses. A middle Roman *os carpale tertium* exhibited bone absorption across the distal facet. Two middle Roman and one early Roman metatarsals were pathological; the early Roman metatarsal had an unusually porous proximal articulation. One middle Roman metatarsal exhibited an infected lesion in the anterior proximal diaphysis and the other had asymmetrical condyles with the lateral side longer than the medial. Many of these pathological conditions, particularly those identified on phalanges, metapodials and the pelvis, may indicate that the animals had performed heavy labour.

Element representation and butchery

Substantial quantities of cattle bones were particularly recovered from the early Roman phases. All regions of the skeleton are present in each phase assemblage indicating that the cattle arrived at Springhead on the hoof or as complete carcasses (*Table 25*). There is no evidence for a prevalence of meat bearing elements. Cranial fragments dominate all phased assemblages.

Butchery marks were identified on 19% of early, 25% of middle and 28% of late Roman cattle bones including elements from all skeletal regions. The high frequency of butchery marks reflects a necessity to subdivide the large carcasses during food preparation. The butchery technique was dominated by heavy chops (158 examples), but finer knife butchery was also practiced (82 examples). The butchery marks include evidence for slaughter (cuts on a hyoid), skinning the carcass (cuts on first phalanges and metapodials), disarticulation (hind leg disarticulated at hip and tarsal joint, forelimb disarticulated at the shoulder and elbow, forefoot disarticulated at the distal metacarpal), filleting and utilisation of bone marrow. Notable butchery marks include four scapulae with pierced blades (Pl 4), a characteristic Roman phenomenon often interpreted as evidence for preserving beef joints.

Sheep and goats

The assemblage included sheep and goats in the early Roman phase and positively identified sheep in the middle and late Roman phases. Sheep were more common than goats in the complete assemblage (NISP = 159 sheep: 3 goats: 1265 sheep/goats).

The assemblage included seven early Roman sheep and sheep or goat articulated burials, identified during bone analysis. Many of these had been butchered.

Sheep ABG 1: 11080

A total of 26 elements comprising skull, both mandibles, ribs, cervical and thoracic vertebrae, right forelimb (scapula, humerus, radius and ulna), left and right tibiae, left calcaneum and a proximal phalanx were recovered from context 11080. The bones represent a 1–2 year old sheep which had been butchered and then deposited in pit 11078 (property 10).

Sheep or goat ABG 2: 11796

Although recorded as one ABG (NISP = 1) context 11796 represents the remains of two sheep or goats. The main ABG comprised a 4–6 year old sheep or goat represented by skull (including horn core), right mandible, left and right scapulae, humeri, radii, ulnae, pelvis, femora and calcanea, left tibia and astragali, first phalanges, second phalanges, ribs, cervical, thoracic and lumbar vertebrae, sacrum, patella, carpals and tarsals. Butchery marks on the humerus and astragalus indicate that the carcass may have been defleshed. The remains of an unfused pelvis and scapula mixed in with this skeleton represent a second, younger individual. Sheep or goat(s) ABG 2 was associated with an early structure in property 11.

Sheep or goat ABG 3 and sheep ABG 4: 16129 and 16130

Pit 16464 in property 9 contained two sheep or goat ABGs from two separate contexts. However, biologically, many of the elements from these ABGs may represent the same individual. Partial skeleton sheep or goat ABG 3 was represented by 32 elements comprising both mandibles and maxillae, left scapula, humerus and ulna, right metacarpal, left and right pelves and femora, left tibia, calcaneum and metatarsal, four first phalanges, cervical vertebrae, lumbar vertebrae and ribs from an individual aged 3–4 years old at death. Sheep ABG 4 was also a partial carcass aged over 3.5 years old at death. This sheep was represented by 24 elements including skull, atlas, axis, right radius and ulna, pelvis, femur, tibia, astragalus, left metacarpal, left and right metatarsal. Sheep or goat ABG 4 had been butchered.

Sheep or goat ABG 5: 17074

Pot fill 17074 in property 3 contained 23 elements that may represent a butchered and disarticulated sheep or goat carcass. Recovered elements comprised right mandible, thoracic vertebrae, three ribs, sacrum, left and right scapulae, humeri, radii, tibiae, left pelvis and astragalus, right calcaneum and ulna and a tarsal. The sheep or goat was aged 3.5 years old at death based on a fusing proximal humerus. A second tibia from a younger individual was also recovered from this context. The sheep or goat had been butchered.

Sheep ABG 6: 17302

Post-hole fill 17302 in property 3 contained the butchered skeleton of a 2–3 year old ewe. The length of the humerus was used to calculate a withers height of 0.65 m. A total of 75 elements representing all regions of the skeleton were identified.

Sheep or goat ABG 7: sheep or goat skull and mandibles from 17481

Post-hole fill 17481 contained three skull fragments and left and right mandibles from a 6–8 year old sheep or goat.

Size/type

Both horned and hornless sheep and sheep or goats were identified. Estimated withers heights of 0.56 to 0.59 m (mean = 0.58 m) were calculated for eight sheep and sheep or goats (excluding the articulated bone groups) from Springhead. Although this a small sample, this size range suggests that on average the sheep at Springhead were very similar to those at Northfleet (minimum 0.54 m, maximum 0.63 m, mean 0.59 m). The Springhead sheep were equivalent in size to the modern Soay sheep (based on data from Noddle 1983).

Age at death and sex

Two sheep (including the ABG from context 17302) and four sheep or goat pelves from the early Roman assemblage could be sexed. Both sheep pelves and three further sheep or goat pelves were female, and one pelvis was either female or castrate. The presence of both horned and unhorned sheep may also attest to the presence of male and females in the assemblage.

The assemblage contained a high frequency of ageable sheep and goat mandibles (141 sheep and/or goat compared to 52 cattle and 21 pig mandibles). The sheep and goat mortality data suggest that slaughter occurred at all age categories but with a peak in the 3–10 month old category for the large early Roman assemblage (Fig 7). It may be suggested that these animals were killed in the second half of their first year, implying an autumn or winter slaughter. This mortality profile suggests a meat husbandry strategy. As with the cattle and pig mandibular mortality data from Springhead, this may reflect the nature of the settlement with meat being brought into the town. A different strategy, concentrating on older individuals, is suggested by the middle and late Roman mandibles, but the sample sizes for these periods are much smaller.

Epiphyseal fusion data suggests that in the early Roman period sheep or goats were killed at a range of ages from less than 3–4 months old to over 3.5 years (*Table 26*). Neonatal sheep or goat bones were also identified in early Roman contexts. The small epiphyseal database for the middle Roman and the late Roman assemblages is not suitable for drawing conclusions regarding population structure. However, one middle Roman context (10163) contained the bones of neonatal sheep or goat.

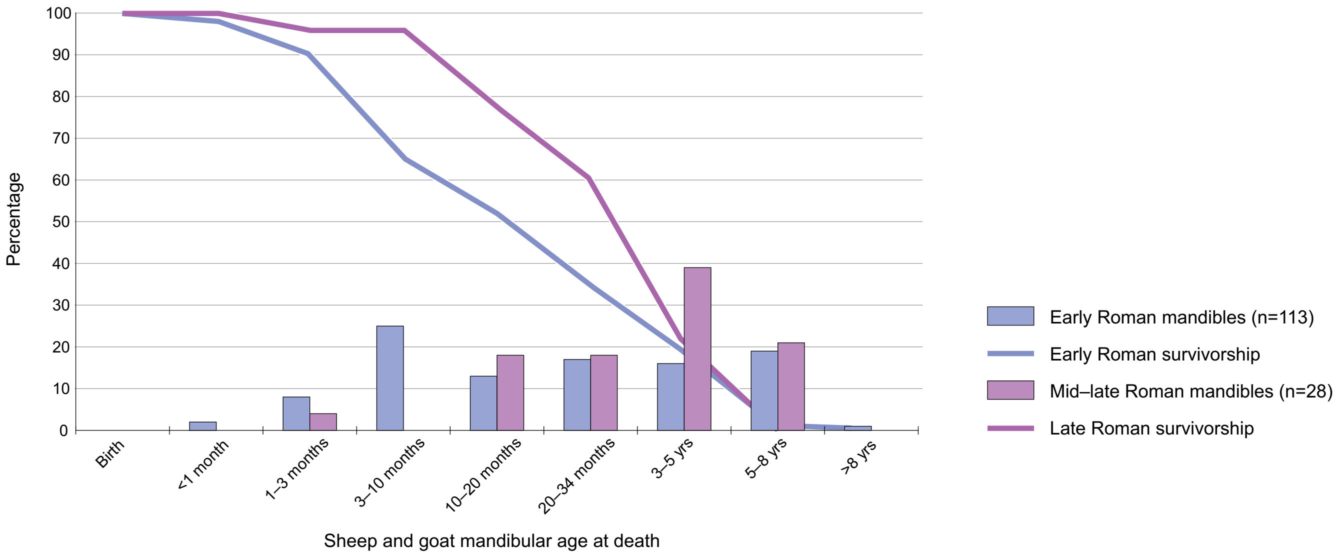


Figure 7 Sheep or goat mortality profile from Springhead Roadside Settlement

Pathology and non-metric traits
A total of 202 (14% NISP) sheep and goat bones exhibited pathological conditions and non-metric traits. The vast majority of these were oral. The most common oral pathologies and non-metric traits were calculus deposits (116 specimens) and additional mandibular foramina (106 specimens). An early Roman mandibular molar displayed coral-like roots and the first molar was impacted upon the fourth milk premolar in a mandible. Another mandible from the same period showed irregular tooth wear. A mandible from the middle Roman period had a residual tooth fragment (probably fourth milk premolar) trapped between the fourth premolar and the first molar. A third molar from a late Roman context has only one true pair of cusps.

The only non-oral conditions noted were an early Roman sheep or goat skull with a patch of active bone in the location of the hornbud or core which may have been caused by polling the animal, and two early Roman femora whose major nutrient foramina were located on the posterior distal diaphysis as opposed to a more common proximal anterior location.

Element representation and butchery
All regions of sheep or goat skeletons were identified in the assemblage suggesting that complete carcasses were present on site (*Table 27*). The relative proportion of identified elements is generally consistent between the phases and does not exhibit a prevalence of meat bearing bones. The sheep and goat element representation is notable for the frequency of mandibles, identified in 61% of the 158 contexts containing sheep or goat remains. Between 18% and 26% of all sheep and/or goat elements identified in the assemblages were mandibles, often near complete. MNE calculations based on the mandibles are significantly higher than MNE based on other elements. Considering the largest, early Roman phase assemblage, mandibles represent an MNI of 103 while tibiae represent an MNI of only 28. A disparity of this size between the representations of different skeletal elements is not seen in the cattle or pig bone assemblages at Springhead. The data suggest that either sheep heads or mandibles were being brought into the town or that post-cranial regions of animals slaughtered in the town were being transported elsewhere but their mandibles deposited at Springhead. Alternatively the disparity could be taphonomic in origin, as these bones are particularly sturdy, not usually damaged during butchery and thus are easily recognisable on site.

Butchery marks were noted on 7% of the early, 8% of the middle and 9% of the late Roman sheep and goat bones including elements from all skeletal regions. This prevalence is lower than that identified on cattle bones, probably reflecting a lesser necessity to divide the carcass for processing. The prevalence is similar to that observed on pig bones at Springhead Sanctuary (see above) and to that observed in contemporary sheep and goat bones from the villa site at Northfleet (see Worley below). The butchery marks are indicative of the use of fine knife butchery techniques (n=30) and heavier cleaver butchery (n=40). Butchery marks were also identified on five ABGs (described below):

Butchery on sheep ABG 1 (Context 11080)
Butchery marks were identified on the left tibia and calcaneum, and ribs. The ribs exhibited cuts which probably relate to filleting the meat. The tibia had a chop mark on the mid posterior diaphysis and the calcaneum had cuts on the proximal end. Butchery marks on the calcaneum probably relate to disarticulating the hind foot while the tibial butchery may relate to processing the meat.

Butchery on sheep ABG 2 (Context 11796)
Cut marks on the proximal humerus and astragalus may relate to filleting meat or defleshing the skeleton.

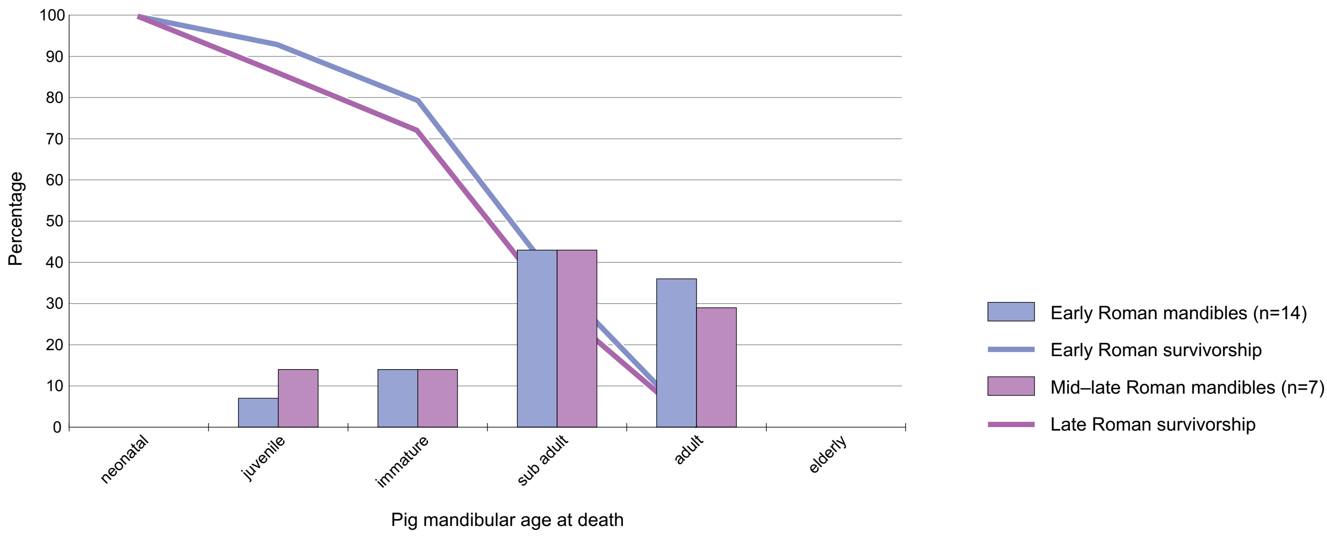


Figure 8 Pig mortality profile from Springhead Roadside Settlement

Butchery on sheep ABG4 (Context 16130)

Butchery marks were identified on the skull, atlas, axis, sacrum, pelvis and femur. The skull, atlas and axis had been cleaved in half; the division occurred while the three elements were in articulation. The sacrum had a longitudinal cut indicating that the caudal regions of the vertebral column were also cut into sides. The pelvis had chops in the acetabulum indicating disarticulation of the hip, and the femur exhibited a chop mark on the distal articulation suggesting division of the hind limb at the knee.

Butchery on sheep ABG 5 (Context 17074)

Butchery marks were identified on a vertebra, rib and left pelvis. Butchery marks indicate that the ribs were chopped from the spinal column, that the meat may have been filleted, and the hind limb was disarticulated by chopping the femur from the hip.

Butchery on sheep ABG 6 (Context 17302)

Butchery marks were identified on 20 elements. The butchery marks indicated that the ewe had been disarticulated and portioned and the meat filleted prior to the bones being deposited together. The hind limb was probably removed with the femur still attached to the pelvis as both ilia and ischia were chopped through and there was no evidence that the heads of the femora were disarticulated. The hind limb was then further divided by disarticulating the knees with a chop to the medial side of the distal femora. The left tibia had transverse cuts on its crest, which may relate to disarticulation of the knee, and on the posterior face of the mid diaphysis which may have been inflicted as meat was removed. The right tibia also had cuts on its diaphysis which might relate to meat removal. The right tibia exhibited cuts on the distal diaphysis which, together with cuts on the calcaneum, may relate to disarticulation of the foot. The hind feet were removed at the tarsal joint with a chop through the left astragalus. Cuts on the right calcaneum suggest that the right hind foot was carefully disarticulated rather than chopped off, possibly indicating that it was removed at a different time or by a second butcher. The forelimb was probably lifted from the underlying muscles. There is no evidence that the limb was subdivided, but the forefeet were removed by carefully disarticulating the distal radii.

The head was carefully disarticulated from the spinal column with fine knife marks identified on the atlas. The skull was then cleaved in two, probably to access the brain or portion the head meat. The mandible exhibited cuts on its posterior ramus which may relate to disarticulation. The remaining carcass was divided into left and right halves; the sternum was chopped through, one cervical vertebra had been divided into left and right halves. This probably occurred after the limbs had been removed. The spinal column had been subdivided into at least four portions by chopping between cervical and lumbar vertebrae. Meat was probably filleted from the vertebrae with cuts on a lumbar vertebra transverse process.

Pig

Articulated burial

A piglet skeleton (17191) was recovered from pit 17184. The skeleton comprised 44 elements including a left occipital, five vertebrae, 14 ribs, a left scapula, humerus, and pelvis, left and right radii, ulnae, femora, tibiae and fibulae, six metapodials, four first phalanges and a second phalanx. The state of epiphyseal fusion suggests that the pig was less than a year old at death.

Size/type

There was no osteometric evidence for the presence of wild boar in the suid bones.

Age at death and sex

Canine teeth can be used to distinguish male from female pigs (following Schmid 1972). The Springhead assemblage included 11 male and 11 female pigs. If only mandibles containing canines are considered and side taken into account, there were a minimum of three sows and two boars in the assemblage.

Evidence for age at death was sparse in the pig bone assemblage, though mandibular tooth wear indicated that animals were slaughtered as sub-adults or adults (Fig 8). Epiphyseal fusion evidence from the early Roman assemblage suggests the slaughter of subadult animals in their second year (*Table 28*). However neonatal pig bones were also recovered from early Roman contexts, which may have come from animals bred in the town or imported as meat. Although pig husbandry was almost certainly focused on meat (pigs have few other products), the evidence suggests that on the whole, the town was not receiving the youngest, choicest pork.

Pathology
Only one early Roman pig element (<1% NISP) exhibited a pathological lesion. A mandibular third molar had slight linear enamel hypoplasia 2.8 mm above the cementum enamel junction (CEJ) on the buccal side of its central cusp and 3.5 mm above the CEJ on the lingual side of the anterior cusp. This can be interpreted as evidence for stress during the pig's second autumn or winter (following Dobney and Ervynck 2000). The stress may have been due to nutritional deficiency.

Element representation and butchery
The pig bone assemblage is far smaller than that of cattle and sheep or goat bones. Only the early Roman pig bone assemblage is of comparable size with the other taxon assemblages. Again, all regions of the skeleton are represented indicating that complete carcasses were present on site (*Table 29*).

Butchery marks were identified on 34 (11% NISP) pig bones and, of these, 17 were from the forelimb, nine were cranial and six were from the hind limb. The butchery marks indicate the use of knives and cleavers to disarticulate and portion the carcass. The carcass was probably split in two halves (lateral portion of a thoracic vertebra chopped off); this may have occurred once the limbs had been removed. The forelimb was probably disarticulated by lifting the scapula from the underlying muscles and then divided by chopping or cutting through the neck of the scapula or the glenoid region, disarticulating the elbow (and cuts on the distal humerus and cuts and chops on the proximal radius and ulna) and chopping through the distal ulna to remove the foot. The hind limb was removed by disarticulating the head of the femur from the pelvis (cuts and chops on ventral ischium and ilium). There is no evidence for further subdivision of this limb. One middle Roman metapodial had cuts on its distal condyle suggesting that pig feet were sometimes removed at this joint. There is evidence for filleting meat and possibly boning out joints on a tibia, and two humeri and two scapulae. There is evidence for utilisation of bone marrow from a split tibia. A similar interpretation can be proposed for a femur with a vertical hole drilled through the medullary bone in the distal diaphysis.

Butchery marks on one skull indicates that the head was removed by chopping through the occipital condyles. There is also an example of the skull being split into halves to portion the head meat or access the brain. A total of seven mandibles were butchered, of which three had been chopped into left and right halves through the symphysis. This may have occurred whilst the head was intact, relating to the same butchery practice as the cleaved skull. Two mandibles exhibited cuts below the molars on the lingual side which were probably inflicted as the tongue was removed.

Equid

Size/type
Equines stood at 1.21–1.36 m at the shoulder (n=12; mean = 1.30 m). They were a similar size to contemporary individuals identified elsewhere and were within the range identified at Northfleet Villa (Worley, below).

Age at death and sex
A total of five equid specimens could be sexed as male from the presence of canine teeth. These were an early Roman skull, a middle Roman skull and three early Roman canines.

Age at death could be estimated for two early Roman mandibles, three early Roman skulls and two early Roman teeth, a middle Roman and a late Roman tooth. The skulls were from two unsexed individuals aged 2.5–3.5 years old and 7–9.5 years old and a stallion over 11 years old at death. The mandibles were from an individual aged 7.5–9.75 years old and a neonate. The early Roman isolated teeth were from animals aged approximately 5 years old at death and 8–11 years old at death. The middle Roman tooth was from an animal aged over 13.75 years old at death and the late Roman tooth was from an individual aged 3–6.5 years old at death. No other neonatal equid elements were recovered. The presence of the neonate suggests that equids, probably, were bred in the vicinity, and the younger two skulls suggests that horses were sometimes slaughtered as relatively young animals, possibly before the end of their potential working lives. Alternatively, these horses may have been victims of disease or trauma. The 2.5–3.5 year old equid skull had been butchered indicating that even if it was a victim of disease its carcass was still utilised, probably skinned.

Pathology
A total of ten (9%) equid bones exhibited pathologies, half of which were cranial. Oral pathologies comprised calculus on a mandible and isolated tooth and an early Roman mandibular cheek tooth with an expanded band of enamel encircling the tooth, located 30 mm from the base of the tooth on the buccal side. This may reflect a developmental disturbance. The remaining cranial pathologies were an early Roman skull (7–9.5 years old at death) which exhibited a small (3 mm diameter), well-

healed, trauma on its right parietal, and a 9 x 5 mm exostosis on the inferior jugal of an early Roman skull.

Post-cranial pathologies were located on two early Roman metacarpals, an early Roman femur and third phalanx and a middle Roman first phalanx. The metacarpals had splint bones (second metacarpals) fused to their midshafts. A small (*c* 6 mm) exostosis was identified on the distal diaphysis of the femur. The third phalanx exhibited a markedly curved dorsal profile and base, and the first phalanx exhibited exostoses on the posterior, lateral and medial margins of the mid-diaphysis with some abnormal bone growth in the proximal and distal ends.

Element representation and butchery

Only the early Roman assemblage was large enough to consider element representation (*Table 30*). The 71 early Roman equid bones represented all regions of the skeleton indicating that complete carcasses were present on site. Skulls (MNE=5) are better represented than all other elements. The next most frequent elements (scapulae and metacarpals) represent a minimum of three and four individuals respectively.

Butchery marks were identified on ten equid bones: two skulls, a radius, two first phalanges, a femur, a metatarsal and three metapodials. The majority of the butchered horse bones were early Roman but one skull and the radius were middle Roman and the metatarsal was late Roman. The butchery marks can be interpreted as evidence that equid carcasses were skinned (transverse cuts identified on both phalanges), disarticulated (the proximal articulation of the metatarsal was chopped through and the radius had a chop into its proximal posterior/medial diaphysis), and sometimes further processed for bone marrow, perhaps for industrial use (longitudinal splitting of the metapodials). The third trochanter of the femur had been chopped off, perhaps during disarticulation of the hip or perhaps as the meat was filleted. The butchery marks on the horse skulls comprise cut marks on the premaxilla of one and on the inferior orbit (zygomatic) of the other. These cuts may relate to skinning or removing cranial soft tissues. The butchery marks may not necessarily indicate that the inhabitants were eating horsemeat, for they could relate to industrial or craft uses of the by-products, or utilisation of the horse flesh as animal food.

Dog

Provenance

The vast majority of dog bones were recovered from partial or complete skeletons (ABGs) associated with properties 2, 3, 4 and 12. A further two (partial) skeletons were not associated with a particular property but came from the roadside ditches. As not all skeletons were recognised in the field, it was not always possible to attribute all dog remains in a context to the appropriate skeleton. Therefore, NISP counts might still be a little too high. Disarticulated dog remains were present in properties 2, 5, 9, 11 and 12 (*Table 31*).

Articulated burials

Dog ABGs 1 to 3: A late Roman dog and two puppy skeletons in pit 12666 (property 2)

Late Roman contexts 12147 and 12161 contained 99 hand collected dog bones comprising the remains of three dog skeletons, one adult and two juvenile partial skeletons. A further 35 dog bones from these skeletons were recovered from a bulk sample from context 12161. The adult dog was represented by skull, both scapulae, tibiae and fibulae, right humerus, radius, ulna, pelvis and femur, left calcaneum, astragalus, fourth metacarpal and fourth metatarsal. The atlas, axis, ten thoracic and six lumbar vertebrae were also present, as were several ribs. Refitting fragments of skull were recovered from both contexts. No butchery marks or pathological lesions were noted on the adult dog. The adult dog could not be sexed but length measurements from the long bones were used to estimate a withers height of 0.3 m, approximately the size of a modern Jack Russell terrier. The adult dog bones were in a much fresher condition than the puppy bones in these contexts.

The remaining immature dog bones from these contexts were identified as two puppy skeletons from the presence of three scapulae (a pair of matching size and one slightly larger) and two skulls. Both puppies had deciduous dentition indicating that they were less than 4–5 months old at death. All long bone epiphyses were unfused. The unfused femora were only slightly smaller than the adult dog in these contexts. The puppies were represented by two skulls, two mandibles, three scapulae, a right humerus, left and right radii, ulnae, pelves, femora, fibulae, tibiae, a left calcaneum, seven metatarsals, four metapodials, a phalanx, cervical, thoracic and lumbar vertebrae and ribs.

Dog ABG 4: A late Roman puppy skeleton in layer 12218 (property 2)

A partial late Roman puppy skeleton came from layer 12218. The recovered partial carcass comprised 38 elements including skull, left and right mandibles, scapulae, humeri, radii and ulnae, 23 ribs and at least four vertebrae. All epiphyses were unfused indicating that the puppy was less than 3–5 months old at death.

Dog AGB 5: Late Roman dog skeleton 12409 (property 2)

Late Roman layer 12409 contained a dog right tibia and pelvis, left articulating metatarsals III and IV, and unsided radius and ulna. These elements could represent the same individual, aged over 8–12 months at death.

Dog ABG 6: Early Roman dog skeleton in layer 17043 (property 4)

Early Roman layer 17043 contained an articulating atlas and axis, three articulating dog thoracic vertebrae and four articulating lumbar vertebrae (L4–L7) which may be from the same individual. The seventh lumbar vertebra had fused to the sacrum (see pathology below). This layer also included a dog left scapula, humerus, articulating left radius and ulna, left and right femora (one pathological, see below), and both tibiae. The femur and humerus were used to estimate a withers height of approximately 0.53 m, the size of a modern Border Collie. Fusion of the femur and tibia suggests that the dog was over 8–12 months old at death.

Dog ABG 7: Early Roman dog skeleton 17146 (property 3)

Early Roman dog skeleton 17146 was recovered from cut 17145. The skeleton included 95 elements comprising all the major bones of the skeleton including many small foot bones. An *os penis* was present identifying the individual as male. All the epiphyses were fused indicating that the dog was over 8–12 months old at death. The length of the major long bones was used to calculate an average withers height of 0.32 m, approximately the size of a modern Jack Russell terrier.

Dog ABG 8: Early Roman dog in layer 17572 (property 3)

This possible skeleton was represented by left and right mandibles, an atlas, 13 ribs, left humerus, radius and ulna, an unsided femur, right tibia, right second metatarsal and an unsided lateral metapodial. The mandibles were noted as a possible pair and the radius and ulna noted as articulating during analysis. If the bones are from a single individual, it would have been aged approximately 5–8 months old at death.

Dog ABG 9: Early–middle Roman puppy in fill 11975 (property 12)

An early–middle Roman fill of sunken-featured building 11892 contained a partial puppy skeleton including the skull, both mandibles, right humerus and femur, left and right radii, ulnae, pelves, tibiae, three metapodials and 22 ribs. All epiphyses were unfused indicating that the puppy was less than 5–7 months old at death.

Dog ABG 10: Early Roman dog in fill 10219 (roadside ditch)

Early Roman dog ABG 10 included 13 bones deposited in fill 10219 of roadside ditch 300387. The dog bones included left and right pelves, femora and tibiae, four ribs and three lumbar vertebrae. Both tibiae had been butchered with horizontal cut marks at their distal ends, suggesting that the dog had been skinned before its partial carcass was discarded in the ditch. The long bones were all fused indicating that the dog was at least 8–12 months old at death. Their lengths were used to calculate a withers height of 0.46 m, approximately the size of a modern Collie.

Dog ABG 11: Middle Roman dog skull and vertebrae in fill 10164 (roadside ditch)

A partial dog skeleton was recovered from middle Roman fill 10164 of roadside ditch 300387. It comprised the skull, both mandibles, a cervical vertebra, two thoracic vertebrae and a lumbar vertebra.

Size/type

In addition to the measured dog ABGs, length measurements from eight dog bones produced withers heights of 0.32–0.54 m (mean = 0.4 m). All these animals are within the diverse size range for Roman dogs recognised elsewhere in Britain (Harcourt 1974; Clark 1995). The smaller individuals at Springhead were approximately the size of a modern Beagle or Jack Russell terrier and the medium-sized individuals approximately the size of a Border Collie.

Age at death and sex

The dog ABGs and disarticulated dog bones come from both adults and juvenile individuals. The ABGs represented six skeletally mature individuals and five puppies. The presence of an *os penis* confirmed the sex of dog ABG 7 and the humerus table test (Ruscillo 2006) also indicated that dog ABG 1 was a male.

Pathology

Pathologies were noted on seven dog elements, the majority of which represent traumas. Two early Roman skulls exhibited anti-mortem tooth loss of premolars. In both cases the maxillae had remodelled, healing over the socket. One of the skulls also exhibited trauma to the upper right maxilla. A small perforation (1.7 mm diameter) was located just anterior to the orbit and showed evidence of remodelling around its margins. This perforation may have been caused by a blow to the skull from a pointed object, possibly evidence for fighting with other dogs. An early Roman fibula had fused to the tibia diaphysis and a misaligned distal femoral epiphysis had active bone formation around the distal end of the bone. The pathological fibula would have caused a degree of immobility in the hind leg and the femur may have caused tenderness in the knee joint. It is hypothesised that this femoral pathology may be due to trauma or stress on the juvenile knee joint. Dog ABG 6 exhibited pathologies of the spine and hind leg. Its femur had fractured in the mid diaphysis and healed leaving a distinct lateral curve at the proximal end and extensive bone remodelling on the posterior portion of the shaft which would have probably left the animal lame and possibly with the affected leg shortened. The individual's last lumbar vertebra had also partially fused to its sacrum. The pathologies of the lower spine and femur were both from the right side of the body and may have been associated. The final pathological dog specimen was a late Roman ulna with extensive active bone growth on its medial diaphysis. The pathology may be interpreted as a fracture of the radius and ulna with subsequent bone infection. Again, the limb would have suffered swelling and pain, probably leading to lameness.

Cat

Two cat femora were recovered from mid- and late Roman contexts in Building 2. It is assumed that they were from domestic cats. Both epiphyses of the mid-Roman femur were in the process of fusing indicating that the animal was approximately 8.5 months old at death (following Habermehl 1975).

Non-domesticates

Red and roe deer

Deer remains were recovered from contexts in properties 2, 3, 4 and 11. The assemblage included five fragments of antler, four identified as red deer. The unspeciated antler was a middle Roman tine. Three of the red deer antler fragments had been worked. One late Roman fragment had been scorched and chopped from a tine, while a second late Roman fragment had been sawn and chopped from a tine. The final red deer antler fragment was an early Roman shed antler burr that had been sawn off an antler beam. The burr was sometimes used to produce antler rings and discs (MacGregor 1985).

Roe deer was represented by four metatarsals, two early, one mid- and one late Roman. One of the early Roman metatarsals and the middle Roman metatarsal had been split longitudinally, presumably to access the bone marrow.

Hare and rabbit

A hare skull, maxillary tooth (probably from the same skull) and scapula were recovered from early Roman contexts in property 5 and a tibia was recovered from the late Roman assemblage in property 2. The rabbit specimen was a near-complete skeleton recovered from pit 11734. This feature was phased as early Roman but the rabbit is probably intrusive, as rabbits were not introduced into Britain until the Norman period (Yalden 1999, 138, 158).

Birds

Species identified

A small proportion (2%) of the identified assemblage comprised bird bones. The vast majority of bird bones which could be identified were domestic fowl, but a small number of (wild) goose, wild duck (including teal or garganey), crow, raven and raptor bones were also recovered.

Bird size, age at death and sex

A single domestic fowl tarsometatarsus with a spur was recovered. This individual would probably have been a cock or a capon. No other bird bones could be sexed. In addition to adult bird bones, two juvenile domestic fowl bones and two juvenile unspeciated bird bones were recovered from early Roman contexts and both (wild) goose bones from a late Roman context were juvenile. A total of 17 bird bones were measured; ten domestic fowl bones, three antanid, one teal/garganey, one raven and two unspeciated bird bones. Osteometric data can be found with the site archive.

Element representation and evidence for carcass utilisation

All the major long bones are represented in the domestic fowl assemblage, with no significant overall bias towards either the leg or wing bones. Butchery marks were identified on two domestic fowl bones: an early Roman right scapula and femur. The scapula had a cut across the glenoid facet, probably inflicted by cutting the wing from the carcass. The femur had a cut on the lateral proximal diaphysis, probably inflicted as the leg was disarticulated. In addition to these bones, a late Roman fowl tibiotarsus had a small pierced hole on its lateral distal diaphysis. It is not clear whether this damage relates to butchery practice or was inflicted by a scavenging carnivore.

Microfauna

The presence of black rat in the Roman assemblage is in keeping with urban Roman sites elsewhere (Armitage 1984; Yalden 1999), although the Springhead specimen was recovered from an early Roman context in property 2, whereas examples elsewhere tend to be late Roman. The majority of micro-fauna consist of anuran bones including common frog and common toad.

Discussion

The animal bone assemblage from the Springhead Roadside Settlement provides evidence for an animal economy almost entirely dependant on domestic stock. There was a prevalence of sheep in the early Roman period but beef probably formed the majority of the meat consumed. The prevalence of sheep may reflect a continuation of a native diet in the town as has been suggested for previous excavated assemblages from Springhead (Wilson 1998) and elsewhere (King 1991), but may also be attributed to other functions for the sheep (see below). Meat was primarily sourced from prime age cattle, sheep and pigs which would most likely have been brought into the town on the hoof. A significant number of dog fragments and equids are also represented in the assemblage. The horses were of expected size for the period and include neonatal to older adult individuals, suggesting that there was a breeding population in or around the town. The dogs were not of uniform size and included individuals of different 'breeds', from small terrier-sized animals to medium-sized dogs. Butchery marks on both equine and dog remains indicate that the carcasses were sometimes processed, although it is uncertain if they were actually eaten. The prevalence of trauma (in two femora, one ulna and a skull) and immobility of the tibia and fibula suggests that some dogs at Springhead led tough lives, perhaps considered as working dogs or unwanted scavengers around the town.

The animal bone assemblage from the Roadside Settlement does hint at less profane aspects of human animal interaction in the town through two features of the assemblage. Firstly, the assemblage includes a relatively large number of dog skeletons, several of which were in the region of the temple in property 2. The dogs buried in the town included adults and younger puppies. While they may have been victims of disease or natural casualties, and there is no evidence for slaughter, the prevalence of dog burials in the Roadside Settlement area, together with the distribution of dog remains in the Springhead Sanctuary (see above), suggests that they may have had a sacred association. Dogs are known to have had religious associations elsewhere in the Roman world and to have been considered a suitable and economical sacrifice at a number of festivals and agricultural events such as harvests and the festival of *robigalia* (see Simoons 1994). Evidence for the association of dogs with the 4th century healing cult centre of Nodens in Lydney, Gloucestershire (Toynbee 1973, 123–4) and inclusion of dogs in funerary contexts in Britain (for example in a late Roman inhumation burial at Asthall, Oxfordshire (Booth *et al* 1996) and in Roman cremation burials such as those at Brougham (Bond and Worley 2004)) suggest that dogs may also have held ritual significance in Roman Britain.

The second aspect of the assemblage to hint at a ritual association of the animal remains is the prevalence of sheep articulated bone groups and mandibles. Wilson (1998) suggests that a number of sheep skeletons recovered from pits elsewhere in the Roman town may have a ritual function. Many of the sheep burials reported here were butchered, with the carcasses disarticulated and sometimes their meat removed. They may represent domestic slaughter of livestock with the carcasses stripped and then all waste bones deposited in one event. The sheep may have been slaughtered for meat in this way in association with a religious calendar or as a purely profane practice. Sheep were used in religious festivals or celebrations elsewhere in Roman Britain as evidenced by the temple sites such as Harlow and Great Chesterford (Legge *et al* 2000).

Northfleet Roman villa

by Fay Worley

An assemblage of 12,623 fragments of animal bone was recovered from archaeological excavations at Northfleet in 2001. These fragments were recovered from contexts dated from the Bronze Age to modern periods, and from undated features or unstratified contexts. This report documents the faunal assemblage recovered from features associated with Northfleet Roman villa. The report concerning the Saxon water mill can be found in Vol 4.

Results – General

Quantification

A total of 2,397 fragments (100.3 kg) of animal bone was hand collected from contexts dated from the late Iron Age or early Roman period to the late Roman period (Table 32). The assemblage included five articulated bone groups comprising 686 individual skeletal elements. In addition to the hand collected animal bone assemblage, a further 373 fragments (460 g) of animal bone were recovered from sieved sample residues (Table 32). For the purpose of creating datasets comparable to those from Springhead, the total assemblage was grouped into early Roman, mid-Roman, late Roman and Roman.

Condition and preservation (hand collected assemblage)

The condition of the Roman assemblages is generally good to excellent, but also included a few poorly preserved fragments (*Table 33*). Despite being in very good condition, 43% of the bone fragments exhibited recent breaks. Root etching was identified on 22% of the bone fragments. The condition of the bone fragments allowed the recognition of surface modification including scavenger gnawing, butchery marks and pathological lesions. Evidence from gnaw marks suggests that a small proportion (2%) of the assemblage was accessible to scavenging animals. The majority of gnawing had been inflicted by carnivores (probably canids), but four fragments of bone had been gnawed by rodents. The rodent gnawed fragments were recovered from the early Roman fill of pit 16393, from mid-Roman layer 10060, deposit 16586 and well fill 15274. Butchery marks were identified on 219 bone fragments, and pathological lesions were identified on 91 fragments (both butchery and pathology are discussed by taxon below). A small proportion of the assemblage (2%) comprised burnt bone fragments, the majority of which were charred or partially burnt and only a few fully calcined.

Species identified

The Roman animal bone assemblage comprised both domestic and wild mammals and birds, anura (frogs and toads) and fish. Domestic mammals included cattle, pig, sheep or goat, equid (probably horse) and dog. No specimens were identified as goat. Wild mammals included badger, red deer, hare, house mouse, water vole and wood mouse. Bird species identified comprised domestic fowl, goose, mallard, rook or jackdaw and a wader (probably godwit *Limosa* sp.). Other taxa identified in Roman deposits include common frog, common toad and fish (Table 32). The assemblage included five articulated skeletons (one cattle, one equid, two sheep and one pig) which are discussed below.

Relative proportions of taxonomic groups

The vast majority of the identifiable animal bone fragments comprised the remains of domestic mammals (Table 32). The proportion of all wild mammals (to all identified species) is 2%, however this includes mice, voles and pieces of deer antler. Despite the sieving of soil samples, the proportion of bird remains is only 1%. The Roman assemblage indicated a strong emphasis on cattle bones (61% of cattle+sheep/goat+pig NISP), with sheep or goat bones representing 27% and pigs the remaining 12%. These proportions change little when looked at in terms of the MNE.

Table 32 Quantification and taxa identified in each phase from Northfleet Roman villa presented as total number of fragments (NISP) collected by each recovery method

	Taxon	*Early Roman* *Hand collected*	*Early Roman* *Sieved*	*Early Roman* *Total*	*Mid-Roman* *Hand coll*	*Mid-Roman* *Sieved*	*Mid-Roman* *Total*	*Late Roman* *Hand coll*	*Late Roman* *Sieved*	*Late Roman* *Total*	*Roman* *Hand coll*	*Roman* *Sieved*	*Roman* *Total*	*Total*
Domestic mammals	Cattle (*Bos taurus*)	13	–	13	107	9	116	201	–	201	24	–	24	354
	Equid (cf. *Equus caballus*)	5	–	5	48	–	48	42	–	42	7	–	7	102
	Sheep (*Ovis aries*)	1	–	1	2	–	2	2	–	2	1	–	1	6
	Sheep/goat (*Ovis/Capra*)	7	1	8	45	3	48	90	–	90	3	1	4	150
	Pig (*Sus domesticus*)	2	–	2	15	7	22	41	–	41	2	–	2	67
	Dog (*Canis familiaris*)	–	–	–	4	–	4	4	–	4	–	–	–	8
Wild mammals	Badger (*Meles meles*)	–	–	–	1	–	1	–	–	–	–	–	–	1
	Red deer (*Cervus elaphus*)	1	–	1	4	–	4	4	–	4	2	–	2	11
	Deer (Cervidae)	–	–	–	–	–	–	5	–	5	–	–	–	5
	Hare (*Lepus* sp.)	–	–	–	1	–	1	–	–	–	–	–	–	1
	House mouse (*Mus musculus*)*	–	–	–	–	2	2	–	–	–	–	–	–	2
	Water vole (*Arvicola terrestris*)	–	–	–	–	1	1	–	–	–	–	–	–	1
	Wood mouse (*Apodemus sylvaticus*)	–	–	–	–	1	1	–	–	–	–	–	–	1
Indeterminate mammals	Large mammal	106	–	106	348	20	368	624	1	625	133	–	133	1232
	Medium mammal	32	–	32	90	45	135	153	27	180	10	–	10	357
	Small mammal	–	–	–	–	–	–	7	3	10	–	–	–	10
	Micro-mammal**	–	–	–	–	4	4	–	2	2	–	–	–	6
	Carnivore	–	–	–	1	–	1	–	–	–	–	–	–	1
Bird	Rook/jackdaw (*Corvus frugilegus/monedula*)	–	–	–	1	–	1	–	–	–	–	–	–	1
	Domestic fowl (*Gallus gallus* dom.)	1	–	1	3	1	4	1	–	1	–	–	–	6
	Greylag goose/goose (*Anser anser/A. anser* dom.)	–	–	–	–	–	–	2	–	2	–	–	–	2
	Mallard (*Anas platyrhynchos*)	–	–	–	2	–	2	–	–	–	–	–	–	2
	Wader (Scolopacidae of plover size)	–	–	–	–	–	–	1	–	1	–	–	–	1
	Bird (Aves)	–	–	–	–	–	–	1	–	1	–	–	–	1
Fish	Fish (Pisces)	–	–	–	–	–	–	1	–	1	–	–	–	1
Anura	Common frog (*Rana temporaria*)	–	–	–	1	18	19	–	1	1	–	–	–	20
	Common toad/toad (*Bufo bufo*)	–	–	–	1	15	16	–	–	–	–	–	–	16
	Frog/toad (*Rana/Bufo*)	–	–	–		161	161	–	1	1	–	–	–	162
Unidentified	Unidentified	19	–	19	28	33	61	134	14	148	13	2	15	243
All taxa	Total	187	1	188	702	320	1022	1313	49	1362	195	3	198	2770
	Weight (kg)	4.2	–	4.2	36.5	0.4	36.9	53.5		53.5	6.2		6.2	100.8

All skeletons were counted as NISP=1 (actual element numbers can be found in the text); * Includes probable identification, ** includes rodent

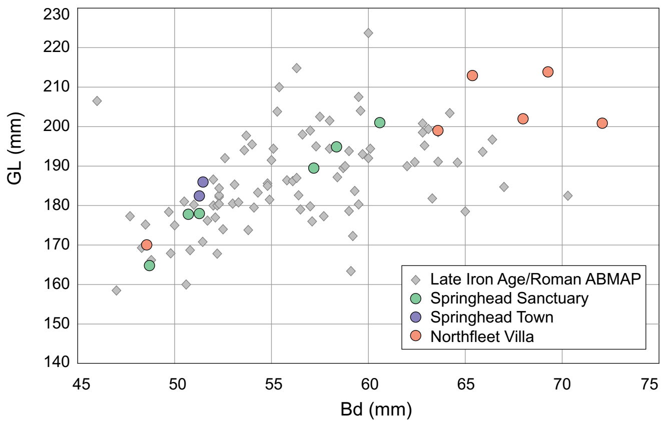


Figure 9 Comparison of cattle metacarpal osteometric data from Springhead, Northfleet and sites recorded on ABMAP

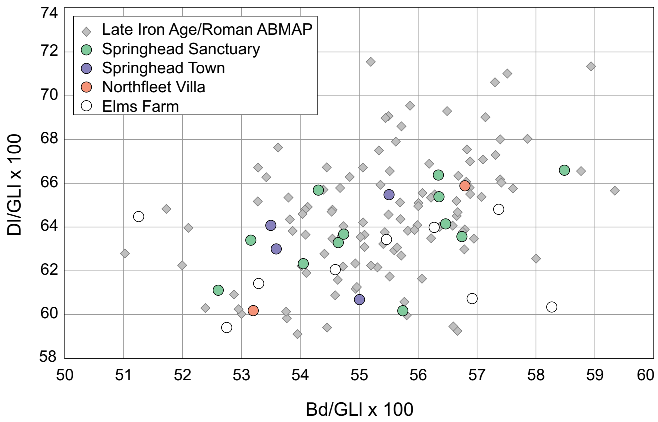


Figure 10 Comparison of cattle astragali osteometric data from Northfleet, Springhead, Elms Farm and sites recorded on ABMAP

Domesticates

Cattle

Articulated burial

A partial late Roman cattle skeleton (15155) was recovered from the upper fill of quarry pit 10400. Identified elements comprised a skull, mandible, six cervical vertebrae (including atlas and axis), six thoracic vertebrae, six ribs, four sternebra, a partial right forelimb (scapula, radius and metacarpal) and hind limb (femur, astragalus and calcaneum) and five phalanges. The proximal calcaneum was fusing and the femoral epiphyses unfused but present in the assemblage indicating that the animal died around the age of 36 months and that the skeleton had been relatively undisturbed after decomposition. Mandibular tooth attrition was more advanced than would be expected for an animal of that age and indicated that the animal lived into senility (all three molars recorded as stage *k*; Grant 1982). The greatest length of the metacarpal indicated that the animal had a withers height of 1.24 m. Several pathologies were noted on the skeleton. Both anterior first phalanges and a second phalanx exhibited slight lipping extending over one or both of their articular facets, a third phalanx exhibited active bone on all faces and extra bone growth towards the articular facet, a thoracic vertebra also exhibited an extended facet and the metacarpal was slightly flared distally. These pathologies may indicate that this animal was used as a draught animal (see health below), especially if assumed to be only 36 months old at death. Two non-metric features were also identified; the second premolar socket was missing from the mandible (with no evidence that the tooth had been lost ante-mortem) and a notch was present in the edge of a scapula blade fragment.

Size/type

All cattle crania were horned. A mid-Roman horn core fragment (context 15408) was particularly large, with an oro-aboral diameter at the base greater than 79 mm. This is larger than any of the 138 Roman and early medieval cattle horn cores recorded in the ABMAP database (http://ads.ahds.ac.uk:81/abmap accessed 22/05/2007).

A total of 67 cattle specimens were measured, representing 56% of all measured bones in the assemblage. The most frequently measured cattle elements were first phalanges (n=18), second phalanges (n=8) and metatarsals (n=8). Although the dataset is small, the cattle metric data allow investigation of the size of the animals. Withers heights were calculated for 11 cattle specimens and for late Roman cattle burial 15155. The Roman cattle stood at 1.05 m to 1.37 m (mean: 1.26 m). Four of the cattle metacarpal measurements from Northfleet Villa fall outside the range for LIA/Roman cattle metacarpals on the ABMAP database (Fig 9). These bones represent particularly large animals with broad distal articulations. It is possible that these metacarpals once belonged to large males performing draught activities. Metacarpals from Springhead are all more in line with the ABMAP data.

Johnstone and Albarella (2002) suggest that astragali are particularly good for measuring the robustness of animals. Figure 10 uses a shape index for cattle astragali to illustrate that cattle from Northfleet Villa and Springhead (see Grimm and Worley above) fall within the shape range known for LIA/Roman cattle as can be found on the ABMAP database.

Age at death and sex

No cattle specimens could be sexed through dimorphic criteria, and insufficient metric data were available to conclusively investigate sex through animal size, although some suggestion of sexual dimorphism was revealed in the osteometric data (see above). The cattle mortality profile (Fig 11; *Table 34*) indicates that cattle were killed at a range of ages from very young to senile. The majority of the cattle were however killed at an advanced age. This indicates that cattle were probably utilised for a range of functions, 66–76% of ageable cattle mandibles (epiphyseal fusion data: 61%) were from adult or older animals which were most likely used for traction, breeding or milking prior to slaughter.

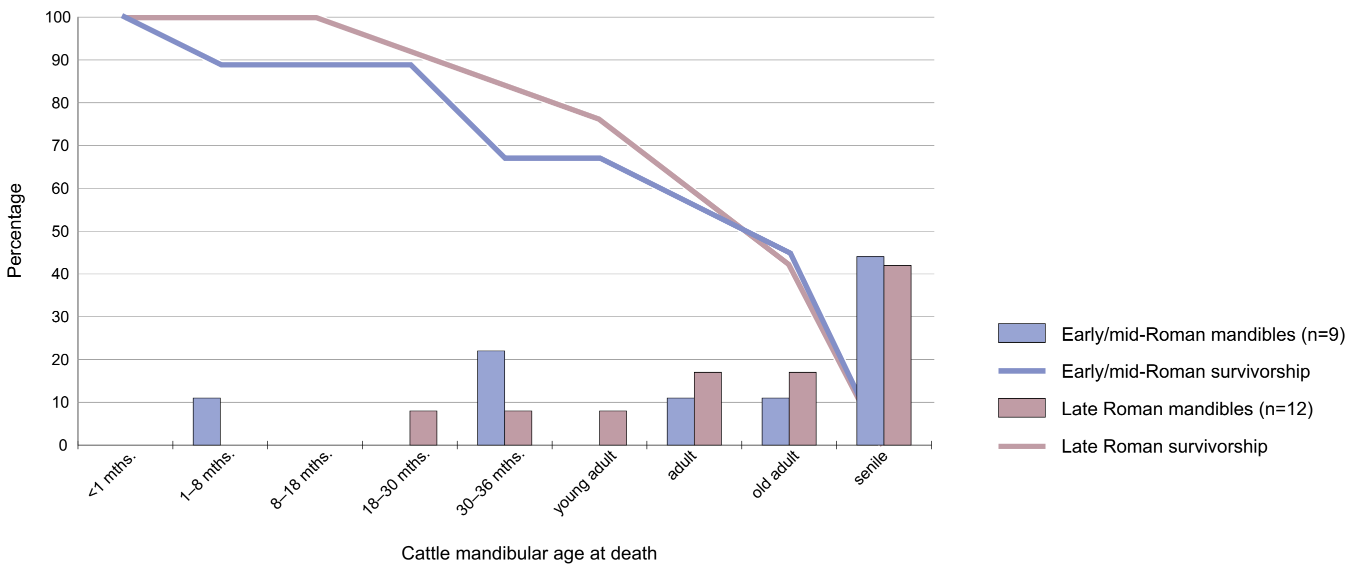


Figure 11 Cattle mortality profile from Northfleet Roman villa

Pathology and non-metric traits

Cattle bones exhibited more pathologies or non-metric traits than any other taxa; a total of 53 Roman specimens were identified. The majority of these (n=41) comprised or included calculus deposits on teeth (included here as a pathological condition following Baker and Brothwell 1980). The assemblage also included five further pathological mandibles: *ante mortem* tooth loss of a fourth premolar, two examples of bone regression around the roots of a fourth premolar and first molar, abnormal wear suggesting a malocclusion with maxillary teeth and lipping and active bone around a mandibular hinge. In addition, a maxillary tooth exhibited extreme wear and a possible abscess at the cemento-enamel junction. The remaining pathological specimens included two jugal fragments exhibiting active bone, an extension of a metatarsal medial condyle facet, and a lateral extension of a proximal first phalanx articulation with further additional bone growth on the medial diaphysis. The metatarsal and phalanx pathologies may be a result of traction work (see below). The assemblage included elements exhibiting non-metric traits: a pelvis with a foramen in the acetabulum between the pubis and the ilium (either non-metric or pathological), a missing hypoconulid on a mandibular third molar, a sub-circular lesion in a metacarpal proximal articulation, and a missing mandibular premolar.

Element representation and butchery

Detailed analysis of the element representation was only possible for the large mid-Roman and the late Roman phase assemblages (*Table 35*). All areas of the skeleton were present but mandible fragments or loose teeth were the most common elements represented. Considering the MNE data, in the mid-Roman phase scapulae are slightly over represented. In the late Roman phase metatarsals are over represented and metacarpals under represented. Due to the small size of both assemblages however, these differences might be accidental. Neither of the two phases are exclusively focused on meat-bearing elements.

A total of 14% of the cattle bone elements exhibited butchery marks including all major appendicular bones. This frequency is higher than that seen in the pig and sheep or goat bone assemblages and probably reflects a greater need to divide the larger cattle carcasses for preparation and consumption. The butchery marks were dominated by cleaver chops and knife cuts. The butchery marks included evidence for skinning, dismemberment, disarticulation, filleting meat and removal of horncores. Notable butchery marks include two pierced late Roman scapulae (context 12272); a characteristic butchery mark interpreted as evidence of hanging beef joints for smoking. One of these scapulae and a further juvenile late Roman scapula from 10402 also exhibited a series of fine cut marks across the blade interpreted as evidence for filleting meat.

Sheep and goats

Articulated burials

Early Roman sheep skeleton 16289 was recovered from a small pit (16288) which had been cut by a wall. The skeleton comprised 228 fragments of bone representing most skeletal regions but with many individual bones missing and many others fragmented. No mandibular teeth were recovered and no phalanges were present. The skeleton was identified as that of a ewe from the morphology of the pelvis and is estimated to have been 36–42 months old at death based on epiphyseal fusion. A complete right metacarpal was used to estimate a withers height of 0.63 m. The ewe was hornless. A lumbar vertebra had suffered trauma with a horizontal fracture running through the fused vertebral plate. The fracture did not appear to have penetrated into the centrum. The skeleton had been butchered (see below).

Early to mid-Roman sheep skeleton 16481 was also recovered from a small pit (16480). The skeleton comprised 207 fragments of bone representing most

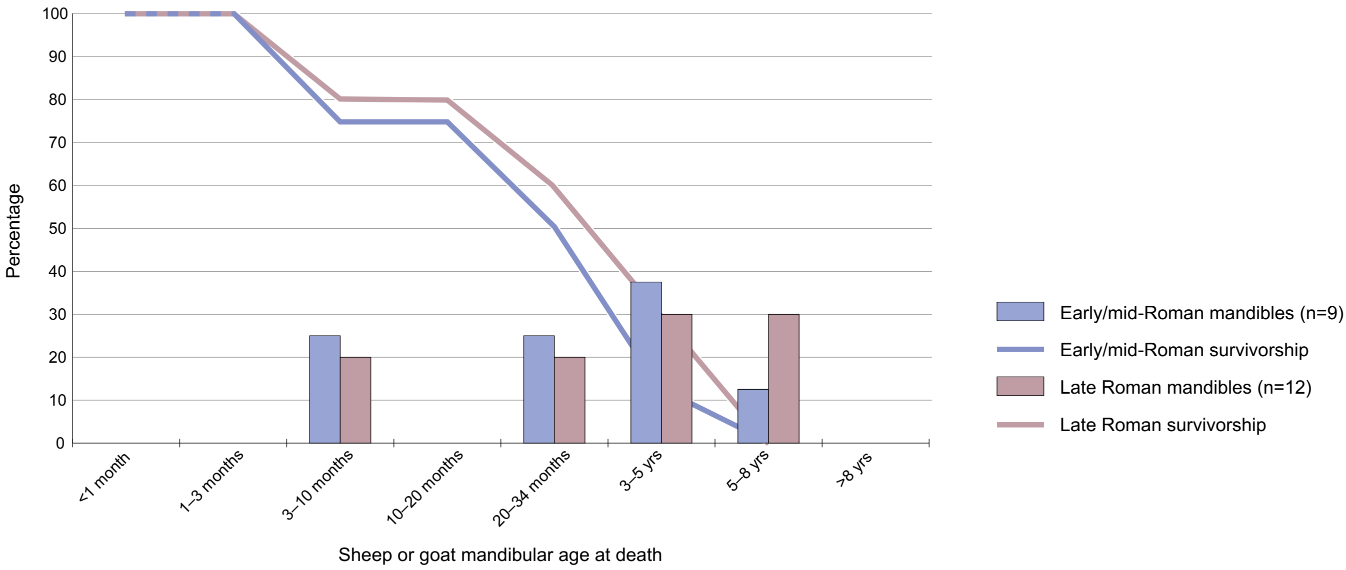


Figure 12 Sheep or goat mortality profile from Northfleet Roman villa

skeletal regions. The distal left hind limb was not present and some smaller elements were also missing. The skeleton was identified as a possible castrate from the morphology of the pelvis; however the skull was completely hornless, which may indicate that it was actually a ewe. The animal was aged at approximately 20–34 months old at death from attrition of the mandibular teeth and 36 months old at death from epiphyseal fusion. The average withers height calculated from complete long bones was 0.59 m. Like ewe 16289, 16481 had also been butchered (see below). In addition the right astragalus had been charred. An advanced pathological condition was noted on a second and third phalanx; a severe infection had immobilised the joint, also ankylosing the distal sesamoids.

Size/type

Both sheep burials were hornless and no other sheep or goat skulls including the horn core region were recovered. Withers heights could be calculated for five disarticulated sheep or goat bones. One early Roman sheep or goat stood at 0.63 m, a mid-Roman sheep or goat stood at 0.59 m and three late Roman sheep or goat metapodials (from the same context) were from animals that stood between 0.54–0.6 m (mean = 0.56 m). The sheep burials had withers heights of 0.59 m and 0.63 m (see above).

Age at death and sex

The sheep or goat mortality profiles (Fig 12; *Table 36*) show that these animals were slaughtered at a variety of ages during the Roman period. Lambs and subadult animals indicate breeding of sheep for their meat, whereas the large proportion of adult animals show that secondary products like milk, wool and manure were important as well. The size and unfused state of some sheep or goat bones in the mid-Roman assemblage indicates that some animals were killed as neonates.

The Roman assemblage included six sheep and sheep or goat specimens or individuals which could be sexed based on the morphology of the pelvis (following Hatting 1995 and Boessneck 1969); five were identified as female. The female individuals were articulated burial 16289 (early Roman) and four late Roman sheep or goat pelves (contexts 12309, 16391 and 10270). Early to mid-Roman sheep burial 16481 may have been a castrate.

Pathology and non-metric traits

A total of 23 sheep or goat specimens exhibited pathological lesions or non-metric traits. The majority of the pathologies (n=17) comprised or included calculus deposits on the teeth. In addition to the pathologies described on the sheep burials (see above), the remaining pathological specimens comprised a mandible with the third molar impacted on the second molar, a mandible with unusual wear on the second deciduous premolar suggesting a missing or misaligned opposing tooth, and a pelvis with a swelling of the ischium and a protruding spear of bone which may be an age-related ossification of soft tissue. Three mandibles had extra, non-metric foramina on the buccal surfaces below the second or third premolars.

Element representation and butchery

The mid-Roman and late Roman periods had NISP >40 sheep or goat elements (*Table 37*). All regions of the skeleton are present and mandible fragments and loose teeth dominate the assemblages. No femora or calcanea are present in the assemblage but the presence of tibiae, an astragalus and metatarsals indicates that the hind legs were present on site. The scarcity of phalanges may be due to the largely hand collected nature of the assemblage. However, only one phalanx was recovered from processed samples. When the data are quantified by MNE, mandibles, tibiae and metatarsals are particularly well represented. This may be because these elements are readily identifiable in fragmented assemblages.

A total of 8% of the sheep or goat elements exhibited butchery marks. In addition to these, articulated sheep burials 16289 and 16481 both exhibited butchery marks, and are considered separately below. Butchery marks were only identified on a restricted range of disarticulated sheep or goat elements; three scapulae, a humerus, two radii, two pelves, two metatarsals, two tibiae, a metapodial and a lumbar vertebra. The butchery marks represent disarticulation of the lumbar vertebra, disarticulation and portioning of the forelimb using cuts and chops at the elbow, dismemberment of the hind limb using chops on the pelvis, disarticulation of the hind foot with cuts on the distal astragalus and cuts and chops on the proximal metatarsal. There is also possible evidence for meat preparation with cuts on the anterior radius diaphysis and of marrow utilisation with a tibia fragment which had been split longitudinally.

Butchery marks on sheep burial 16289 indicated that the animal had been disarticulated prior to deposition. The remains probably represent butchery waste once the meat had been removed. Both metatarsals and the left metacarpal had been severed mid-shaft, all three with chops from the medial side. This would have removed the feet which may have been taken away with the animal's skin (no phalanges were recovered). However, a portion of the right metatarsal distal to the chop was also recovered. A chop on the right ilium and cut mark on the right ischiatic tuberocity may have been inflicted as the hind limb was removed. The vertebral column had been divided with transverse chops to a cervical vertebra, a thoracic vertebra (the chop did not extend through this bone) and two lumbar vertebrae. Three rib fragments bore cut marks on their medial faces which may relate to filleting meat. The skull had been split sagittally between the parietals and frontals (the caudal frontals were missing) and transversely on the recovered parietal. These butchery marks probably relate to utilisation of the brain and facial meat.

Butchery marks on sheep burial 16481 also indicated that the animal had been portioned and disarticulated prior to deposition. A fine transverse cut on the ventral atlas may have been inflicted as the sheep's neck was slit during slaughter. The head had then been removed with several diagonal cleaver blows through both the atlas and axis. The skull had also been chopped sagittally to prepare the head meat or offal. The vertebral column had been divided with chops to two cervical vertebrae and two lumbar vertebrae. Butchery marks on rib fragments include two specimens which had been chopped transversely approximately 60 mm from the rib head. Further blade fragments had cuts on their lateral and medial faces, some towards the ventral end, and one had been cut into a 90 mm long portion. The butchery marks on the ribs indicate preparation of meat for consumption and possibly removal of internal organs. The left humerus had a helical fracture on its mid diaphysis which may have resulted from man-handling the carcass during processing. The right scapula had two puncture holes in the blade, one from each side. These suggest that either the forelimb was hung or perhaps that a spike was used to stabilise the limb or joint for further preparation. It is unlikely that the limb was away from the carcass for long as all the bones were deposited together. The left pelvis had chop marks on the rim of the acetabulum, on the cranial ilium, below the acetabulum and on the caudal rim of the foramen obturatum. The sacrum had chops on the ventral side of both wings; these marks probably relate to dismembering the hind limbs. The left hind limb had been subdivided at the knee, with the lower limb probably removed elsewhere (cut marks were identified on the distal femur and no elements distal to this were recovered). Cut marks on the right astragalus and metacarpal probably relate to removal of the feet, which were retained with the carcass.

Pigs

Articulated burial

A partial neonatal piglet skeleton was recovered from mid-Roman upper ditch fill 20507. Identified elements comprised skull, a metapodial, left pelvis and left and right humeri, ulnae and radii. No butchery marks or pathological lesions were identified. Further indeterminate fragments may include ribs. The size of the long bones indicated that the animal was probably perinatal at death. It is not clear why this animal was not eaten, perhaps it was a victim of disease or stillborn and therefore considered inedible.

Size/type

It was not possible to estimate any withers heights from the recovered assemblage.

Age at death and sex

Due to the small dataset, only five mandibles could be used for age at death analysis. Of these, three were classified as juvenile, one as subadult and one as adult. Although based on only a few bones, the epiphyseal age data (*Table 38*) indicate the slaughter of pigs in their first year. No evidence of pigs beyond the age of two years was found. The appearance, texture and epiphyseal fusion of a mid-Roman articulated partial skeleton and a late Roman radius suggest that neonatal pigs were also slaughtered. The assemblage contained three boar canines and three sow canines.

Pathology

Only one pig bone had evidence for pathologies; the fourth premolar in a late Roman mandible had impacted into the first molar.

Element representation and butchery

Element representation in the small pig bone assemblage indicates that all regions of the skeleton are present and thus that complete carcasses were once present on site (*Table 39*). The small dataset does not permit further conclusions on particular regions of the skeleton being over- or under-represented. Only four pig bones showed

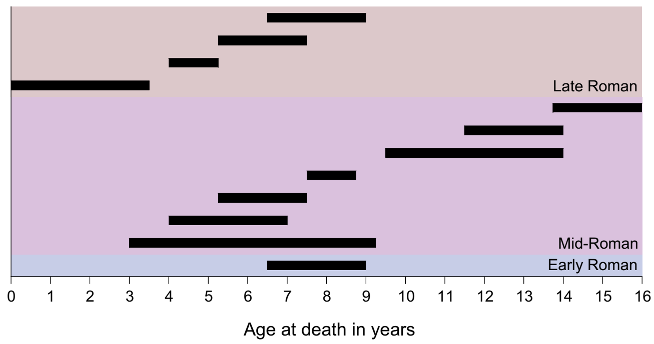


Figure 13 Equid age at death from Northfleet Roman villa based on tooth eruption and wear (each bar represents a single tooth or mandible)

butchery marks. The butchered bones comprised three scapulae and an ulna. The marks on the scapulae indicate division of the scapula from the humerus using fine cuts and possibly meat removal. The butchered ulna indicates that it had been disarticulated from the humerus by a heavy chop.

Equids

Articulated burial

Equid skeleton 16545 was deposited in silted up wood-lined cistern 16170. The equid was approximately 1.38 m tall (13–14 hands), 7.5–8.75 years old at death and probably female (based on the morphology of the pelvis). The skeleton was nearly complete with only the left scapula and femur and right forelimb excluding the scapula missing. The skeleton had been scavenged by canids with extensive gnawing identified on many projecting regions of the skeleton (proximal calcanea, proximal femora, most vertebral spinous processes, some lumbar vertebral lateral processes, ventral ribs, ilium). Tooth puncture holes were also present on thoracic and lumbar vertebral centra. The gnawing indicates that the carcass was exposed for long enough for one or more canids to scavenge, but not long enough for it to become dismembered and for regions to be taken away, with the possible exception of the right forelimb. There was no evidence from butchery marks that the carcass had been skinned. The mare did exhibit some non-metric traits; the distal articular facet of both hind second phalanges exhibited small lesions.

Size/type

Equids were the second most common taxon measured with a NISP of 27 specimens or bone groups measured. However, this small dataset means that there are too few data for meaningful analysis. Withers heights were calculated for 12 equid specimens and for mid-Roman equid burial 16545. The data suggest that the Roman equids stood at 1.21 m to 1.5 m (mean = 1.38 m), calculations for the articulated burial ranged from 1.3 to 1.46 m.

Age at death and sex

Age at death was estimated for 10 equid teeth and two mandibles. These represented a wide range of animals from immature individuals through to the elderly (Fig 13). Mid-Roman equid skeleton 16545 was estimated to be 7.5–8.75 years old at death. This skeleton was identified as probably female from the morphology of the pelvis (following Getty 1975). A worn canine tooth from fill 16597 in the same feature was from a male individual.

Pathology

In addition to the non-metric traits noted on mid-Roman equid burial 16545 (see above), two Roman phalanges were pathological. A late Roman phalanx had active bone on its lateral and medial diaphysis and a severe infection was evident through active bone on the anterior, medial and lateral diaphysis of a mid-Roman second phalanx. The distal articulation of the second phalanx had also become infected. Phalangeal pathologies can have complicated aetiologies but may be a result of heavy riding or traction, particularly on hard surfaces (Levine *et al* 2000).

Element representation and butchery

The hand collected equid bone assemblages comprised 102 specimens, including the articulated burial (*Table 40*). They represent all regions of the skeleton indicating that complete carcasses were present on site. Butchery marks were rare on equid bones but were noted on a mid-Roman pelvis and radius/ulna. The ulna had been disarticulated with a heavy upward chop cutting through the body of the olecranon and the radius exhibited downward blows with a blade on its anterior lateral diaphysis. The pelvis had a chop on the lateral aspect of the cranial ilium. This blow may relate to dismembering the carcass. The butchered equid bones were recovered from different areas of the site (the final fill of ditch 20022 and a deposit in ditch 15749) and are therefore unlikely to have belonged to the same individual.

Dogs

A total of eight dog bones were recovered from the hand collected assemblage. No dog bones were recovered from sieved deposits. The bones come from a minimum of two late Roman and one mid-Roman dogs.

Size/type

Three dog bones were measured: a mid-Roman mandible, a late Roman ulna and a late Roman tibia. It is not possible to calculate an accurate withers height from any of these measurements but the late Roman tibia was in excess of 170 mm indicating a dog over 0.51 m tall at the shoulder; approximately the size of a modern Border Collie. This size falls into expected ranges for contemporary dogs (Harcourt 1974). As the proximal end of the tibia was missing, we do not know whether the animal was mature and thus may in fact have been a much larger type. The length of the mandible indicates a medium sized dog, with a skull also approximately the size of a modern Border Collie (von den Driesch (1976) measurement '5' ranging from 100–118 mm). These dogs are an appropriate size for working animals.

Age at death and sex
Bone fusion evidence was available for the three dog bones (two tibiae and an ulna). The evidence suggests that the animals were over 5–8 months old at death. No evidence for sex was recovered from the dog bones.

Pathology
Two late Roman pathological dog bones were recovered; a mandible and an ulna. The mandible had lost the fourth premolar ante-mortem and the socket had healed over. The ulna exhibited a pathological olecranon joint (Pl 5). While the loss of the tooth would have had no significant effect on the animal, the arthropathy may have caused a limp in the forelimb.

Plate 5 Dog ulna showing a pathological joint. Late Roman wetlands deposit 12214

Element representation and butchery
Dog bone element representation included cranial and long bone elements. No dog bones exhibited evidence for butchery.

Non-domesticates

Despite the dominance of domestic mammals in the animal bone assemblage, some hunted wild mammals were identified. The assemblage contained the remains of badger, hare and red deer.

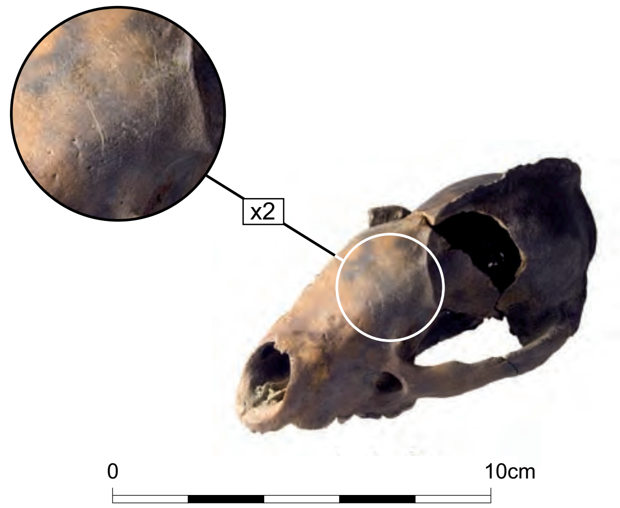


Plate 6 Badger skull with skinning cuts on frontal bones anterior to the left orbit. Context 16597, fill of Roman well 16731

Badger
A single badger skull was recovered from the mid-Roman fill of a wood-lined cistern (16170). The skull exhibited fine cut marks characteristic of skinning on the frontal bones anterior to the left orbit (Pl 6).

Hare
Part of a left hare tibia diaphysis was found in mid-Roman context 16093. The tibia belonged to a young animal as none of the epiphyses had fused.

Red deer
The 16 hand collected deer remains predominantly comprise antler fragments but other elements were also identified. The assemblage included nine red deer antler fragments and five unspeciated antler fragments. Given the absence of any other deer species in the assemblage, these may also be of red deer. All the antler fragments had been worked or sawn. The antler fragments were therefore on site as a raw material. At least one antler fragment had been naturally shed from the deer and there was no evidence that any had been cut from deer skulls. Although the antler may have arrived at the site through trade or been gathered from the surrounding area, there is also some evidence that red deer were hunted in the early and late Roman periods. The distal end of a red deer humerus was recovered from early Roman wall footing 10152 and the distal end of a red deer scapula was recovered from late Roman interface layer 12272 in the wetlands area. With such slight evidence for deer hunting in the Roman period it may be that both these post-cranial elements are intrusive from later periods.

Microfauna
The mouse and vole species present in the assemblage would have inhabited grassland and scrubland surrounding the site. House mouse had become established in Britain by the Roman period (Yalden 1999). Anuran bones are frequent in the sample residues and include both common toad and frog.

Birds

Species identified
Occasional domestic fowl, (greylag) goose and mallard bones were identified in the assemblage. Some wild birds were also identified. A corvid femur (rook (*Corvus frugilegus*) or jackdaw (*Corvus monedula*), following the criteria of Tomek and Bochenski 2000)) was recovered from a mid-Roman backfill of ditch 16803, and the tarsometatarsus of a wading bird, probably a godwit (*Limosa* sp.), was recovered from late Roman silting layer 10401.

Size, age at death and sex
No bird remains could be sexed and no juvenile bones were identified. Only three domestic fowl bones were measured; an early Roman ulna and a mid-Roman femur and tibiotarsus. The femur and ulna fall within the size range of the few comparative measurements available on ABMAP (accessed 24 May 2007).

Health
No pathological bird bones were seen.

Element representation and evidence for carcass utilisation
No butchery marks were identified on the bird bones. A domestic fowl femur from mid-Roman layer 16597 had been charred but the burning was restricted to the distal condyles. This pattern of burning may result from roasting the carcass with the lower legs removed. Too few skeletal elements were recovered to consider any implications of skeletal representation.

Conclusions

The assemblage was strongly focused on the utilisation of domestic mammals, almost to the exclusion of wild species. Cattle bones dominated the assemblage and beef would have dominated the meats consumed. King (1978) and others have suggested that a higher proportion of cattle relative to sheep, is characteristic of a Romanised economy. On this basis the villa at Northfleet represents a Romanised consumption pattern as might be expected from a site of this type. The neighbouring villa at Keston had a similar proportion of the three species (*Table 41*). The relative proportion of cattle, sheep or goat and pig in Roman contexts of differing site types and geographical locations has been extensively studied by King (1978; 1999a; 1999b). When plotted on a tripolar graph, the relative proportion of the three taxa at Northfleet villa fall well within the range King identified at other British villa sites but also within that of *vici* and other Romanised settlements, and on the margins of the range found at *coloniae* and Romanised towns and auxiliary sites (King 1999b, 140). The 'Romanisation' of the villa economy, as opposed to the native Iron Age economy, can also be illustrated by characteristic Roman butchery techniques, both the presence of pierced cattle scapulae and the general heavy-handed technique and use of cleaver chops rather than delicate finer disarticulation (Grant 1987).

The data suggest that cattle were not only utilised for meat, but would also have been used for other functions probably including traction and milk production. The assemblage includes some particularly large individuals. Although no neonates were recovered from the assemblage, cattle may well have been bred on site; certainly complete carcasses were present and the bones were not all imported as in joints of beef. Sheep and goats were bred in the vicinity (as evidenced by the presence of neonates) and probably primarily used for meat, with no evidence for individuals surviving over the age of eight years. Wool and milk may also have been exploited as females and castrates were identified in the assemblage. The sheep bone assemblage includes two individuals which were butchered and then deposited in small pits. It is not clear whether these represent discrete deposits of butchery waste from animals slaughtered on site for day-to-day meat consumption, or particular events. The Roman calendar, at least on the Continent, included many festivals marked by the sacrifice of livestock (see Simoons 1994). Pig husbandry focused on pork production with breeding taking place in the vicinity and both males and females present.

Equids and dogs were kept at the villa. The equids stood between 1.21 and 1.50 m tall (12–15 hands) and the dogs were medium sized. Both horses and dogs were probably working animals. It is unlikely that the equids were seen as a source of meat for human consumption but butchery marks indicate that after death they were disarticulated, possibly for industrial processing or as food for the dogs. One equid carcass was left for some time to be scavenged by canids and then deposited in a cistern. In addition to traction and herd/flock husbandry, the horses and dogs may have been used for hunting. Although infrequent, Roman utilisation of wild mammals included use of badger pelts and antler and possibly the consumption of venison and hare.

Summary of the animal bone assemblages from Springhead and Northfleet

by Jessica M Grimm

The animal bone assemblages from Springhead and Northfleet can be utilised to study the use of animal products in a small town, a villa and a sanctuary from the late Iron Age to the middle/late Roman period. In terms of species proportions the late Iron Age assemblage from the Springhead Sanctuary is dominated by sheep/goat, followed by pig and cattle. A higher proportion of pig is not uncommon at certain high status Iron Age sites in the south of England; authors like King (1991 and 1999) have associated this with mimicking the diet of the Romanised Gallic population, who in turn were adopting the diet of Rome. The overall proportion of species at the Sanctuary changes little into the early Roman period, suggesting continuity of dietary and/or ritual traditions.

The mid- to late Roman assemblage from Springhead town is more strongly dominated by sheep/goat and the proportion of pig is much smaller, whilst the assemblage from the broadly contemporaneous villa at Northfleet is dominated by cattle, followed by sheep/goat and pig. The higher proportion of cattle can perhaps be explained by the use of these animals for traction in the various production stages of ale manufactured at the villa site. The higher pig proportion from the villa compared to the town is probably related to a more Romanised way of life. Contemporary with the heyday of both the town and the villa, is the Springhead Sanctuary complex with its ritual shaft. With regard to species proportions, sheep/goat still dominates, although the proportion of pig is quite notable.

A number of observations can be made comparing the age at death of cattle and sheep/goat between the sites and through time. The assemblages from the Sanctuary and from the town are comparable, with cattle slaughtered at earlier ages in the early Roman period compared to the middle/late Roman period. This perhaps indicates that secondary use (ie, traction, milk and/or manure) took prevalence over the production of meat. At Northfleet villa cattle were slaughtered even later in life throughout the Roman period, again suggesting greater dependence on cattle for secondary by-products. Sheep/goat were generally slaughtered at an earlier age at the Sanctuary than in the town or the villa, suggesting activity specifically related to the Sanctuary, perhaps even sacrifice. Overall – as with cattle – sheep/goat were slaughtered at earlier ages in the early Roman period compared to the middle/late Roman period in both the town and the villa, perhaps suggesting a greater dependence through time on by-products like wool, manure and milk, rather than the quality of the meat.

Many complete animal skeletons were found in the different areas of Springhead and Northfleet. An increasing number of such animal burials have been found, especially in the south of England, with much academic research suggesting that they potentially represent ritual behaviour in the Iron Age and Romano-British period (eg, see Hill 1995; Clark 1995, 10–11; Fulford 2001, 199–201).

Fish Bone from Springhead and Northfleet

by Sheila Hamilton-Dyer

Springhead Sanctuary

A total of 230 individual specimens were recovered by sieving and hand collection from 33 contexts. At least six taxa are represented. Numerically, at 170 specimens, most of the bones are of the Atlantic saury or skipper *Scomberesox saurus* but these all come from one findspot (context 2215) and may even be a single fish. In terms of frequency it is flatfish that is the most common taxon, occurring in 14 contexts and totalling 16 bones. Some of these bones are comparable with plaice and all are likely to be of plaice (*Pleuronectes platessa*), flounder or dab. Other remains are few; a total of five eel (*Anguilla anguilla*) vertebrae were recovered from three contexts, a herring (*Clupea harengus*) maxilla from 2994, and the vertebra of a large salmon (*Salmo salar*) from 2831, while five contexts contained single bones of haddock (*Melanogrammus aeglefinus*). These last were two vertebrae, two cleithra and a supracleithrum, all of large fish.

Springhead Roadside Settlement

Sixty submitted fragments were derived from 55 individual specimens. At least four different taxa are represented; eel *Anguilla anguilla*, haddock *Melanogrammus aeglefinus*, flatfish and a cyprinid. Most of the material originates from sieved samples and, as is common for sieved material, much of the bone is indeterminate. These 35 specimens (64% of the total) are of fin rays, ribs, vertebral spines and other fragments not readily identifiable to species. Of the remaining 20 bones 16 (80%) are of flatfish. These include specimens comparable with plaice *Pleuronectes platessa* of a range of sizes. The other flatfish remains were not identified to species but are likely to be of plaice or the other common species such as flounder or dab. One flatfish caudal vertebra, from 10207, is crushed in a manner usually thought to indicate human digestion (Jones A K G 1986). The other bones are a single caudal vertebra of a small cyprinid (such as dace or roach), an articular and a precaudal vertebra of eel and the partial cleithrum of a haddock. This bone is from a large individual; the maximal depth of 21.9 mm (Beerenhout 1994) gives an estimated fish length of 0.789 mm. This would be a fish of the 13–14th year class and probably weighing over 4 kg. Fish of this size are rare today but are relatively common in archaeological assemblages. The bone is typically hyperostosed and sufficiently sturdy to have survived dog or cat gnawing.

Northfleet villa

A single bone of haddock was recovered from the late Roman post-hole 15446.

Discussion

The range of taxa that have been identified from Roman assemblages in Britain is wide and covers both marine and freshwater species. This small collection offers a new species. The saury or skipper is rarely identified in any British assemblages. No recent material was even available for comparison in the author's reference collection; the bones were identified from a specimen in the collections of Wim Van Neer, Belgium. This is a pelagic, shoaling fish similar to the garfish. The shoals move northwards in late autumn and mass strandings sometimes occur on North Sea coasts (Wheeler 1978). This appears to be the first record of its occurrence in Roman deposits in Britain, as it is not previously known to this author and was not encountered in the survey by Locker (2007); it was also found in the Saxon deposits at Northfleet. The other species are typical of Roman deposits in the south and more generally. The high representation of flatfish is similar to that at several sites in the same region such as London, Colchester and Canterbury, but the relative frequency of haddock is unusual. It should be stressed however, that these are all relatively small samples and small differences can be exaggerated.

The haddock is a marine species of 40 m depth and more and therefore not likely to have come from the estuary but from deeper water in the North Sea. Large specimens such as these are no longer common in this area but appear to have been more frequent in the past. Plaice (and flounder) are common inshore fish and may also be found far up the tidal reaches in shallow and brackish waters. Eels may also be caught in this environment as well as in entirely fresh waters. Cyprinids are freshwater fish and small individuals of roach, dace and other species are common in most streams, lakes and rivers. Salmon is migratory and large, breeding-size, fish such as the one represented here can be caught both in the sea and in the river on the spawning run. The herring is a marine shoaling fish, although usually associated with large northern shoals it can also occur near the North Sea coast.

Chapter 3

Prehistoric – Roman Sedimentary Sequences and Landscape

Geoarchaeological and Environmental Investigations in the Upper Ebbsfleet Valley at Springhead

by Catherine Barnett

The extensive archaeological investigations in the Upper Ebbsfleet Valley at Springhead provided excellent opportunities to recover contemporary environmental sequences and remains. The conditions and modes of preservation vary across the sites, with waterlogged, sometimes acidic, deep alluvial and peat sequences associated with the edge of the River Ebbsfleet contrasting with thin, calcareous, superficial deposits and soils upslope. Of particular significance is the occurrence of thick layers of colluvium of prehistoric and later date at Springhead which sealed archaeological features and landsurfaces. These layers are in themselves a record of human activity upslope, having been triggered by agricultural ploughing and cultivation (see for instance Bell and Boardman 1992) and their formation enabled by weathering and the sometimes steep slopes locally.

The numerous sequences and remains from late Iron Age and Roman layers and feature fills were assessed in light of the Project Design Aims for the Springhead and Northfleet Principal Study, and key questions and issues on chronology, landscape and human activity which might be addressed with these remains were formulated. Full analysis was targeted at these questions and the findings are reported in this volume. A summary of the key sequences and remains targeted, the questions posed by the analysts and excavators and the environmental analyses undertaken is given below. Several of the sedimentary sequences span multiple periods and their investigation cannot be sensibly split, hence some deposits of prehistoric date have been reported briefly in this volume and will be expanded upon in the Prehistoric Ebbsfleet volume. These are, however, useful in providing a longer view of environmental changes and give a record of and context for human access and activity at these somewhat dynamic spring and floodplain edge sites.

A number of categories of environmental remains, chosen on the basis of their presence in any given environment, their preservation and taphonomy, have been used to provide complementary evidence to examine landscape. These include land and aquatic molluscs, sediment and soil micromorphology, pollen, diatoms, ostracods and waterlogged plant remains as appropriate. Specialist reports for each are given below.

Summary of Environmental Analyses

Ebbsfleet River Crossing (ARC ERC01)

This area, which lay to the north of the Springhead Sanctuary (ARC SPH00), is dominated by prehistoric sediments and environmental remains, although Roman and Saxon layers occur near the top of some sequences. In order to put these layers in their sedimentary and chronological framework, they are therefore reported here. The sequences and samples taken to analysis are summarised in Table 42. Where individual types of remains were found to be poorly preserved or not capable of directly contributing to the Project Design Aims or duplicated the data gained elsewhere on the site, they have not been reported here but details may be found in the relevant assessment document in the site archive.

Roadside Settlement (ARC SHN02)

This area of excavation was dominated by layers and features of early–middle Roman date, with more restricted late Roman activity. The sequences analysed are summarised in Table 43.

Sanctuary Site (ARC SPH00)

In addition to early Roman activity and the subsequent middle Roman Sanctuary complex, a series of prehistoric sedimentary sequences was excavated, both alluvial and dryland, the latter mainly colluvial. The sequences analysed are summarised in Table 44.

Geoarchaeological and Environmental Investigations in the Lower Ebbsfleet Valley at Northfleet

by Elizabeth Stafford

In the Lower Ebbsfleet Valley an extensive programme of archaeological evaluation and excavation prior to the construction of the HS1, along with the STDR4 investigations funded by Kent County Council, has allowed the deep and complex deposits of waterlogged

Table 42 Springhead River Crossing (ARC ERC01) summary of environmental analyses on sedimentary sequences

Feature/ Trench no	*Section illustrated*	*Comments on sequence*	*Environmental analyses undertaken*
Tr 1	Vol 1, fig 2.39; Fig 14	N end of site, Roman (contexts 411–2) & post-Roman channel, inc peat sealing Roman deposits elsewhere	Sediment description monoliths 151, 154–1 Molluscs <143> (5)
Assoc with Tr 1		Roman ditch fill	Molluscs <2871> (1)
Tr 4	Fig 14	Edge of channel (Ebbsfleet) with overlying & intercalating colluvial sequence to Early Neolithic	Sediment description, monoliths 160–1, 160–2, 161 Pollen <160–1, 160–2, 161> (16) Diatoms <160–1, 160–2, 161> (8) Radiocarbon dating of top & base of peats + top context 489
Tr 4	Fig 14	To E of 160–1, colluvial sequence adjacent to mollusc & OSL sequences at edge of dryland. Sequence RB or earlier (prob late prehistoric) cut by Roman channel (not sampled here)	Sediment description monolith 162
Tr 5		Roman colluvium, repeated elsewhere	Sediment description monolith 157
Tr 5		Possibly Neolithic/Bronze Age ditch 529 at base, contains burnt flint prob related to adjacent burnt mound, overlain by dominant Roman–post-Roman colluvium	Sediment description monoliths 155–1, 155–2 Radiocarbon dating for ditch
N end	Vol 1, fig 2.39; Fig 14	Prehistoric to post-Roman colluvium	Molluscs <148>, <152> (7)

Table 43 Springhead Roadside Settlement (ARC SHN02) summary of environmental analyses on sedimentary sequences

Feature/ Trench no	*Section illustrated*	*Comments on sequence*	*Environmental analyses undertaken*
(context 17709)	Vol 1, fig 2.75	Edge of waterfront, shallow slope, Early–late Roman	Sediment description monolith 14293
17432	Vol 1, fig 2.78	Edge of Roman waterfront, alluvial & colluvial interaction with archaeological layers	Sediment description monoliths 14252, 14254 Pollen <14252> (4)

alluvium and peat preserved in the valley bottom to be examined in some detail. Extensive borehole surveys and evaluation trenching carried out during these investigations have demonstrated that the Holocene sequences reach up to 10 m in thickness in the lowest lying areas of the valley, preserving a record of environmental change dating from the early Mesolithic through to the medieval period. During the lifetime of both projects, a substantial amount of geoarchaeological deposit modelling has been carried out, along with assessment of palaeoenvironmental remains (pollen, macroscopic plant remains, diatoms, foramininera, ostracods and insects), coupled with a programme of radiocarbon dating (OAU 1997; 2000b; OA 2006; URL 1997b; 2002b). This work has served well in characterising the sedimentary architecture and associated environments of deposition. Prior to the most recent phase of analysis, however, no single profile had been examined in any great detail. In order to rectify this, one master 'off-site' sequence, considered to be the most complete and representative of the Holocene sequence from the valley bottom, was chosen for detailed analysis. The chosen borehole (STDR4, borehole 7) was retrieved during an evaluation phase of the STDR4 and the subsequent post-excavation analysis has been funded by both Rail Link Engineering and Kent County Council. Additional sequences retrieved from slightly further up the valley have also been analysed as part of the STDR4 post-excavation phase. Between the two projects a total 49 radiocarbon dates have been processed from waterlogged organic deposits in the valley bottom. These dates demonstrate that much of the sedimentary sequence, including the major peat beds, was deposited during the prehistoric period. The results of this analysis therefore are reported in full in the Prehistoric Ebbsfleet volume. The upper largely minerogenic, parts of the sequences (the Upper Clay Silts), however, provide information pertinent to the historic period and for this reason a summary of the results of the analysis has been referenced below.

The Northfleet villa complex was situated on a gravel promontory or 'spur' extending from the western slopes of the valley. This spur remained as an area of higher ground throughout much of the Holocene as wetland environments developed on the lower lying ground to the north and west. Consequently, dry colluvial processes dominated over alluvial accretion in this area. Waterlogged preservation was restricted to the deeper features such as wells and cisterns and fringing alluvial deposits. Although a large number of disturbed bulk and intact monolith samples were retrieved from the waterfront area to the north of the main villa complex, these were largely associated with the Saxon mill and millpond (see Vol 4). The alluvial sequences in this area were very complex and fragmentary due to the effects of both later channel activity and Saxon waterfront management. Initial assessment of the elevations and stratigraphy of the deposits suggested that a number of discrete organic soil or stabilisation horizons were present which may date to the Roman period and later.

Table 44 Springhead Roman Town (ARC SPH00) summary of environmental analyses on sedimentary sequences

Feature/ Trench no	*Section illustrated?*	*Comments on sequence*	*Environmental analyses undertaken*
3053	Vol 1, fig 2.9	Late Iron Age Viewing platform with turf layers curving into section	Sediment description monolith 8025 Pollen <8025> (4)
3134	Vol 1, fig 2.53	Early–mid-Roman enclosure ditch	Molluscs <8065> (16)
3192	Vol 1, fig 2.33	Roman Viewing platform	Sediment description monolith 8147
(context 2528)		Sloping deposits inc alluvium/colluvium late Bronze Age/Iron Age, (Iron Age/Roman of same above not sampled) & burnt mound in infilled spring/pond at base of slope area C	Sediment description monolith 8244 Radiocarbon dating on context 2528 to assess age compared to burnt mounds on ARC ERC01
5002		Periglacial–Pre-middle Bronze Age (under burnt mound). Master sequence by spring, but kubienas for upper sequence, not monolith, same layers represented in Tr 4 ARC ERC01). Kubienas from burnt mound (including soil with charcoal): see <8374–5>	Sediment description monolith 8450, soil micromorphology and chemistry <8374–5>, Pollen <8450> (5), pollen series <8396> (11) <8450>, Molluscs <8397-8> (10) & <8420> (12), Radiocarbon dating on material from kubienas <8374–5> if possible or CPR/ charcoal from bulk sample <8328>
(context 5641)		Sequence over layer with near *in situ* late Upper Palaeolithic flints (not recoverable). Bronze Age and (pre-Roman) colluvium over, adjacent to barrow ditch, see also 5002, but here better as not reworked (colluvium)	Sediment description monoliths 8499, 8500 Pollen <8499–8500> (12) Molluscs <8501> (1)
(context 6408/10, 6418–20)		Dominantly Roman (possible prehistoric to base) near later Upper Palaeolithic area. Q: "*are the silts road wash-off deposits/ dumped/ water-sorted*"	Sediment description monoliths 8601, 8602
6525	Vol 1, fig 2.17	Clay (?alluvial) fills in feature (late Bronze Age?) in drier layers above gravel base overlain by Roman river bed (deliberately consolidated). Q: "*where were the springs/was this wet*"	Sediment description monoliths 8603 Diatoms <8603>
(context 6378/6536/6221/5492)	Vol 1, fig 2.43	Grassy slope in front of temple	Sediment description monolith 8599
(context 6576–7)	Vol 1, fig 2.17	Roman spring deposits: over sands & gravel, replicated in <8623>	Sediment description monolith 8600

However, subsequent stratigraphic analysis and radiocarbon dating has revealed the surfaces to be truncated prehistoric sequences dating to the Bronze Age. Unfortunately little stratigraphy remained intact relating to Roman activity associated with the main villa complex following excavation of the site in the 1909–11. The majority of the environmental samples retrieved comprised bulk samples from the previously unexcavated features, primarily recovered for charred plant remains (see W Smith, Chap 4). A series of colluvial deposits was examined during the evaluation trenching in areas peripheral to the main villa complex. These deposits were assessed, but not analysed in detail due to poor dating potential.

Summary of Environmental Analyses

Table 45 summarises the analyses carried out on the main offsite sequences from the Lower Ebbsfleet Valley that provide background data for the onsite environmental interpretations. Table 46 summarises the analyses carried out on sequences from features associated with the Roman phase of activity at Northfleet villa. For reasons of continuity alluvial deposits of potential Roman date associated with waterfront activity are discussed with the sediment sequences associated with the Saxon mill structure in Vol 4.

Springhead Sediments and soils

by Catherine Barnett, David Norcott, and Elizabeth Stafford

As summarised in Tables 42–44, a number of questions remained following excavation at Springhead that could be addressed using detailed geoarchaeological examination of soil and sediment sequences. The findings heighten understanding of the archaeological layers and features in question and have enabled a larger scale overview of the relatively complex sedimentary architecture of Springhead to be gained. The latter has been achieved through construction of two transects across the Ebbsfleet River Crossing and Springhead Roman Town using both detailed descriptions of sequences sampled by monolith and the original field observations of other sequences recorded during excavation.

Methods

The monoliths were cleaned prior to recording and standard descriptions used (following Hodgson 1976) including Munsell colour, texture, structure and nature of boundaries. Particular attention was paid to any stases or landsurfaces within the sequences and any requirements for microstratigraphic/soil micromorphological analysis considered. A sequence of two kubienas was subsequently analysed for a buried soil and burnt mound at Springhead (ARCSPH00, contexts 5102–5103), however this profile is of middle Bronze

Table 45 Environmental analyses of principal off-site sequences in the Lower Ebbsfleet Valley

Trench/borehole no	*Comments on sequence*	*Environmental analyses undertaken*
Borehole 7 (STDR4)	Master sediment sequence from the Outer Basin. 10.34 m in depth, early Mesolithic–Saxon	Sediment description, pollen, diatoms, ostracods, foramnifera, radiocarbon dating
Trench 9 (STDR4)	Master sediment sequence from Inner Basin, late Mesolithic–Saxon	Sediment description, macroscopic plant remains, pollen, diatoms, insects, ostracods, foramnifera, radiocarbon dating

Age date and therefore reported by Macphail and Crowther under the Prehistoric Ebbsfleet volume. The full sequence that spans these layers is interpreted below in light of those findings. The detailed sediment descriptions are tabulated in *Tables 48–58* and summarised and interpreted in this report. A number of the sections and sequences described are illustrated in the site narrative in Vol 1, Chap 2 (Figs 2.9, 2.17, 2.33, 2.39, 2.43, 2.53, 2.75 and 2.78), while others are illustrated here in Figure 14.

In order to examine the broad framework of the site, correlation of the major stratigraphic units between individual profiles was undertaken using geological modelling software (Rockworks 2004). This allowed a series of representative cross-sections to be drawn together to form transects across the southern and northern parts of the Ebbsfleet River Crossing (see Fig 14). Those at the southern end proved to be dominated by prehistoric sediments, the findings are described in brief below but the transects are presented and fully discussed in the Prehistoric Ebbsfleet volume.

Results – The broad sedimentary architecture at Springhead

The Springhead group of sites (ARC SHN00, ARC SPH00 and ARC ERC01) are situated at the head of the Ebbsfleet Valley, occupying the slopes and valley bottom on both sides of the current River Ebbsfleet. The modern topography of this area is variable. On the eastern side of the River the north-eastern part of the excavations at Springhead Sanctuary were situated on a relatively flat plateau area at elevations of *c* 27 m OD. Adjacent to this plateau, the ground fell away steeply to the south-west descending to 6.1 m OD into the valley bottom. The Ebbsfleet River Crossing excavation was situated a little further downstream on the eastern bank of the river at elevations between 8 m and 4 m OD. On the western side of the river the excavations at Springhead Roadside Settlement occupied a gentler slope with elevations reaching up to 13 m OD in the north-west. Prior to excavation, the modern Ebbsfleet channel was very narrow, lying centrally within a clearly defined floodplain which predominantly comprised *Phragmites* reed beds and displayed some drowned trees. A steep river cliff up to 1.5 m high defined each side of the floodplain. It appears that both the floodplain and the river channel at this location were, at least during some periods, managed.

The geology of the area around Springhead is mapped as Upper Chalk overlain by a complex of Pleistocene and Holocene fluvial terrace and floodplain deposits (BGS Sheet 272). Gravels capping the higher elevations are recorded by the BGS as plateau gravels and Woolwich Beds. However, Drs Michael J Allen and Richard Macphail noted during a site visit that the gravels exposed in this area contained disturbed 'Blackheath pebble beds' pebbles, and stained flints and therefore more likely to be associated with the Pleistocene terrace gravels. The recovery of an ovate Palaeolithic axe from these deposits strongly indicates that all the gravels are the basement bed of the Boyn Hill gravels associated with the Swanscombe sequence. The lower part of this unit is a clay-rich deposit over Thanet Sands. The Thanet Sands form the majority of the hill overlooking the main excavations. At the top they are largely loose unconsolidated medium 'beach' sands, although the silt and clay content increases with depth, at one point forming a mixed sandy loam with a strong aeolian component akin to brickearth. At extreme depth they are green and glauconitic. The Thanet Sands overlies Bullhead flints over chalk. These are contorted flints, which represent the base of deep, weathered tropical soils lying on old land surfaces, formed during phases of temporary terrestrial land. These deposits are discontinuous across the chalk surface. The chalk occurs under Thanet Sands or Bullhead beds, and dips strongly northwards. In valley bottom locations it is mantled with periglacial solifluction or coombe deposits, and recent (Holocene) alluvium and colluvium. The full depth of the Holocene sequences in these locations was investigated in detail through a series of deep sondages.

At the Ebbsfleet River Crossing weathered chalk bedrock and solifluction deposits were encountered at the base of the sequences sloping towards the south-west part of the site. Alluvial deposits overlying the chalk in this area indicate the presence of relict channels and associated edge deposits, running broadly north–south, associated with former river activity. The earliest Holocene deposits comprised alluvium, recorded in detail at the south-western edge of the excavation (Fig 14 sections 1012 and 1013). These deposits extended northwards and thinned against the rise of the chalk to the west, although they were found to be entirely absent at the northern edge of excavation (Fig 14 sections 1008 and 7431). The deposits comprised fine grained minerogenic silts clays and sands, often with chalky fragments, and most likely derive from colluvial deposits reworked by alluvial processes. Stratigraphic analysis suggests that these deposits are of prehistoric date with the basal sequence most likely deposited some time in

Table 46 Environmental analyses of Roman features at Northfleet villa

Group number	*Cut number*	*Section illustrated?*	*Comments on sequence*	*Environmental analyses undertaken*
16731	16170	Vol 1, fig 3.11	Villa Phase (VP) 1–2 (AD 70–150/60). Profile through basal silting layers within wood-lined well. Basal silting layers 1st century AD but feature continued in use through the later villa phases	Sediment description (M13071, M13072, M13073, M13039, M13040, M13041, M13042,) Pollen, waterlogged & charred plant remains, insects
16516	16090	Vol 1, fig 3.16	VP 2 (AD 120–150/60) Profile through basal silting layers within wood-lined well	Sediment description (M13026). Waterlogged plant remains, insects

the early to mid Holocene. Within these deposits, in section 1012/1013, an organic horizon (546), representing a former marshy land surface, recovered in monolith 161, was identified. This layer was subsequently radiocarbon dated to the earlier Neolithic period (3370–3080 cal BC, NZA-28773, see *Table 47*).

A further thick unit of minerogenic sandy silt colluvium (545) was recorded overlying horizon 546 in section 1012/13. This deposit most likely correlates with similar units recorded in the area excavations in the higher eastern parts of the site, the surface of which was cut by a series of early Bronze Age features. In section 1012/13 this early sequence of deposits was cut by later channelling, followed by the deposition of a series of intercalated minerogenic and organic alluvial deposits. The lowest organic horizon has been dated to the late Bronze Age/early Iron Age (830–770 cal BC, NZA-28795) which suggests a significant hiatus in the sedimentary record between the lower part of this sequence and the truncated earlier edge sequence to the east (represented in monolith 161). The upper organic channel fills and fully stabilised peat horizon (493) in this profile formed during the early to mid-Saxon period (see *Table 47*), indicating a second hiatus between the peat and the thin alluvial and organic layers of context 493, perhaps due to increased erosive channel activity during the Roman period.

The channel sequence can be traced northwards: in sections 1008 and 7431 (see Fig 14) the channel cuts late prehistoric features and a soil horizon (405) that formed directly on chalk bedrock. The channel fills at this location can be correlated with the upper part of the sequence in section 1013. Here, however, the basal deposits comprised coarse flint gravels which have been interpreted as a deliberate Roman consolidation layer (413). Sealing the channel fills and the archaeological features to the west were further thick deposits of colluvium. It is likely that the lower part of the colluvium dates to the later Saxon or medieval period and the upper part to the post-medieval, artefactual material providing a *terminus post quem* for deposition.

Similar sedimentary sequences were examined further upstream at the head of the springs in the vicinity of the Sanctuary complex. The base of the sequences in the lower lying areas comprised weathered chalk bedrock and chalk solifluction deposits. A series of colluvial deposits was recorded overlying this in a number of sections. Again the basal parts of the sequence were probably deposited in the early to mid-Holocene. A significant amount of worked flint was recovered from these deposits, although analysis has revealed the assemblages to be rather mixed, suggesting the reworking of older deposits dating from the late Pleistocene to the early Bronze Age from further upslope. Cut into the surface of these colluvial deposits in the south-western part of the site was a series of middle Bronze Age features, including two ring-ditches (sub-groups 30001 and 30002) associated with *in situ* contemporary soils and a number of burnt flint spreads.

These features were subsequently buried by a further band of colluvium deposited during the late Bronze Age or Iron Age. During the late Iron Age or early Roman period the prehistoric sequences in the area below the Sanctuary complex were extensively truncated by channel activity. As at the Ebbsfleet River Crossing, the base of the channel in several sections was filled with coarse gravel interpreted as Roman consolidation layers and contained a number of potsherds and other artefacts. In places, these gravels lay directly above chalk solifluction deposits, suggesting that the channel bed may have been intentionally cleaned out prior to consolidation. Above the gravels, further deposits of colluvial material were recorded infilling the spring area and extending further upslope onto the higher drier ground. Although dating evidence is rather limited for these colluvial deposits it is likely that some of the initial deposits were laid down during the later Roman and Saxon periods.

Overall, a dynamic colluvial and alluvial landscape can be suggested, with repeated phases of destabilisation of terrestrial and rivers edge surfaces throughout the late Iron Age to the post-medieval periods. This was due in part to the steeply sloping nature of the valley sides but also to human activity, probably including arable agriculture, stock trampling and construction works. The resulting movement of sediment downslope culminated in the deposition of thick layers of colluvium adjacent to the River Ebbsfleet, which effectively sealed a number of land surfaces and features, so increasing the degree of archaeological preservation in this area. In addition, associated water run-off and probable gullying, coupled with the increased sediment load provided to the river by this destabilisation, caused episodes of higher energy fluvial activity, leading to erosion, down-cutting and increased fine sedimentation. A direct impact on the local sedimentary environments, particularly by Roman and Saxon populations, is demonstrated.

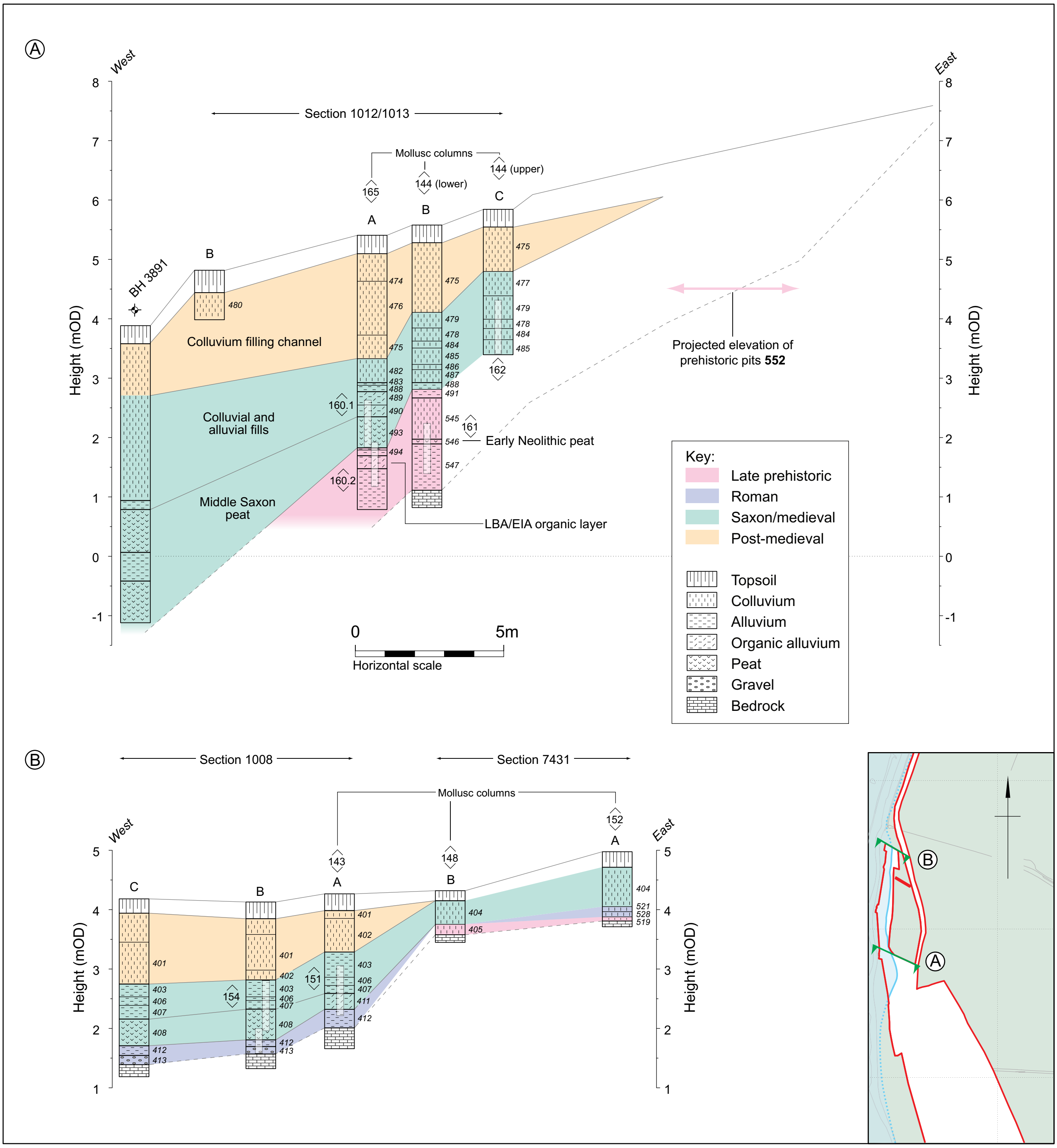


Figure 14 Sediment sequences at Ebbsfleet River Crossing (ARC ERC01)

Results – The Feature-Related Soils and Sediments

Ebbsfleet channel edge, Tr 4, sections 1012–1013

A series of overlapping and adjacent monoliths (160–1, 160–2, 161) was examined for the channel edge and one (162) further back from the edge to the east (*Table 48*; see Fig 14). These demonstrate the complex interplay and intercalation of colluvial and alluvial deposition at the edge of the valley and base of the slope from prehistory onwards. Alluvium dominated the edge environment but its silty nature and inclusion of small chalk fragments suggest that this was commonly formed of reworked colluvium. Early on (pre-early Neolithic) the alluvium was highly calcareous and indicates the presence of the calcium-charged waters of the spring(s) but this input decreased over time, and the channel shifted or water levels dropped to enable gyttja-like (fine, black, humic, waterlain) layers and peats to form. The earliest (monolith 161, context 546) has been dated to the early Neolithic, 3370–3080 cal BC (NZA-28773, 4519±45 BP). This layer had been tentatively correlated with the thin lower peat in monolith 160–2 (also therefore described as context 546), but radiocarbon dating of the latter shows this to be of late Bronze Age–early Iron Age date at 830–770 BC (NZA-28795, 2625±30 BP). It is apparent, therefore, that the later channel cut the (Neolithic) peaty landsurface. This channel too then began to shift and infill, with growth of further peat providing evidence of marshy conditions at the water's edge.

That early landsurface (monolith 161, context 546) was overlain by a wedge (0.3 m thick in 161) of fine sandy silt colluvium (context 545), deposited under rapid downslope movement, as indicated by the disturbance and mixing-in of the underlying peat. The presence of this colluvium indicates instability, with hillwash being a feature of the area prior to the late Bronze Age, probably relating to early agriculture upslope.

The channel fills overlying the late Bronze Age–early Iron Age lower peat in 160–2 were silts and silty clays, often humic and sometimes laminated indicating regular higher water conditions. As noted, their particle size and inclusion of small stones and chalk fragments indicate the layers included reworked colluvium. Away from the channel, thicker bodies of calcareous silty clay colluvium continued to be laid down, with three phases represented in 162 forming a 0.89 m thick sequence. A second body of humic alluvium and peat, 'the upper peat' (complex 494) recorded in the later channel has proved to be significantly later in date, with the base dated to the mid-Saxon period at cal AD 650–730 (73.0%), cal AD 740–770 (22.4%) (NZA-28866, 1318±25 BP).

Fills of ditch 529 (300248), Tr 5, section 1020

A 1.69 m long sedimentary sequence was collected adjacent to mollusc column 156 through this ditch fill and later sequence in monoliths 155–1 and 155–2 (*Table 49*). The ditch cuts a spread of burnt flint and charcoal (context 536) dated to the late Neolithic/early Bronze Age (2560–2530 cal BC (3.0%), 2500–2290 cal BC (92.4%), NZA-28608, 3930±30 BP). A primary fill of massive silty clay was laid in shallow water after the creation of the ditch. The subsequent secondary fills were of friable calcareous silt colluvium with occasional small flint stones and chalk fragments. The ditch contains a discrete deposit of burnt flint and charcoal, including a piece of field maple wood charcoal dated to the early Iron Age 750–400 cal BC (NZA-28619, 2419±30 BP).

The alluvial and colluvial sequence, Tr 5, section 1017

Examination of the top of a shallow sequence of calcareous silty and sandy clay alluvium (contexts 539–538), collected in monolith 157 adjacent to mollusc column 158 near ditch 529 (*Table 49*), indicates that a period of drying and stabilisation occurred in this location in prehistory (the spread of burnt flint and charcoal (context 536) close to this sequence was dated to the late Neolithic/early Bronze Age, see above), prior to being cut by the Roman channel. The latter was partially infilled with *c* 0.4 m of slightly humic alluvium (context 537) before the deposition of friable sandy silt colluvium (context 502), also during the Roman period.

Roman and post-Roman channel, Tr 1, section 1008

Examination of monoliths 151, 154–1 and 154–2 (*Table 50*) shows a dominantly alluvial sequence (see Fig 14). A compact layer of angular to subrounded gravel containing residual struck flint (context 413) was collected in the base of monolith 154–2. The layer indicates deliberate consolidation of the river bed/edge early in the development of this sequence. The gravel was overlain by a series of calcareous silty and sandy silt loam alluvial layers (oxidised to the top) and a discontinuous terrestrial fen peat (context 408) laid down in the Roman to post-Roman periods at the northern end of the site. A low-energy riverine and marshy edge environment is indicated and the presence of laminae suggests regular but small-scale overbank floods. The discontinuous peat was thought on site to correlate with the upper peat described above (Tr 4) which has been dated to the mid-Saxon period.

The edge of the Roman waterfront, sections 13739 and 13784

As shown in *Table 51*, examination of monolith 14252 revealed a basal alluvium of fine-grained material (context 17445) reworked from the 'natural', dominantly silt, derived from local loessic (Brickearth) deposits. These had been relain in shallow, puddled water at the waterfront (see Vol 1, Fig 2.78). Damp conditions are indicated throughout the sequence, but water levels dropped sufficiently to enable churning up of the top of this alluvium by trampling, for example, as indicated by the disrupted upper boundary of context 17755 (= 17445). The overlying layers all indicate anthropogenic influence, with a charcoal-rich probable dump (17442) overlain by mixed humic deposits. The sediment input to these archaeological layers is mixed in terms of particle size and humic content. Run-off from the immediate area (which may include material originally of both colluvial and alluvial source) seemingly dominates and the area was clearly well-vegetated/supplied with organic matter. Relatively slow accumulation of the upper layers (17435 and 17436 (= 17304)) is indicated. Monolith 14254 showed a sequence akin to that of monolith 14252, though shallower and missing the basal alluvial (puddled water) deposits due to the relative position, being further back from the waterfront edge. Mixed humic archaeological deposits again dominate.

The base of the sequence shown in monolith 14293, from a shallow slope, 5 m or so back from the waterfront edge (see Vol 1, Fig 2.75), differs slightly from the others from this area. It comprises weathered natural (Brickearth) overlain by a massive humic silt (context 17755), the particle size of which indicates it is derived from the weathered natural, most likely reworked and relain in water (run-off or low-energy shallow water). The upper boundary of this layer was disturbed and turbated. There was no clear evidence of rooting at the boundary so trampling (eg, by livestock or humans) may be indicated. The early stages of soil development are indicated for this layer prior to deposition of the full depth of the overlying archaeological layers. The upper sequence comprises a thick mixed dump deposit of organic silt loam containing common archaeological materials (context 17710, ceramic building material, charcoal, rare oyster shell noted) overlain by a dump of silt loam (context 17709). The decreased artefactual content and the homogeneity of the latter (though comprising similar sediment) suggest more rapid deposition than for the underlying deposit. A possible levelling layer is represented.

The prehistoric spring side sequences (ARC SPH00), sections 7486 and 7630

The Devensian to pre-middle Bronze Age sequence (section 7486) by the spring including basal soliflucт, calcareous colluvium and a thin soil under the burnt mound, plus the mound itself, was examined from monolith 8450 and kubienas 8374–5. Sediment descriptions and soil micromorphological analysis were undertaken and are reported in the Prehistoric Ebbsfleet volume. The upper levels of this sequence (recorded on site but not recovered) can be directly correlated with the deposits described for the Ebbsfleet channel edge sequence exposed at the River Crossing to the north (in Tr 4, sections 1012–1013).

Two monoliths, 8499 and 8500, were taken from section 7630 adjacent to the spring and middle Bronze Age ring-ditch, with a more complete sequence (*c* 1 m) collected in the latter. Section 7630 is close to the near *in situ* late Upper Palaeolthic flints (group 400005), and the basal context 5876 contains some possible soliflucted chalk, though this is reworked into a highly calcareous alluvium related to the spring which post-dates the late Upper Palaeolithic material. Because the overlying calcareous colluvial and ring-ditch fill sequence is all of prehistoric (predominantly middle Bronze Age) date, this too is examined more closely in the Prehistoric Ebbsfleet volume.

Late Bronze Age feature 6525, section 7749

This feature, a shallow pit, was sealed beneath the Roman riverbed at the head of the Ebbsfleet (see Vol 1, Fig 2.17) and the question was therefore raised whether this pit was dug under wet conditions. The sequence, collected in monolith 8603 (*Table 52*), shows that its initial creation and use (represented by anthropogenic dump context 6465) was in relatively dry conditions, but shortly after, low energy flowing water encroached, eroding its top and depositing massive silty clay alluvium (contexts 6466–7) prior to the deliberate consolidation of the riverbed in Roman times.

Late Iron Age terrace 3053/400011, section 7028

This sequence in monolith 8025 represents a collapse or deliberate dump of material in this terraced feature on the steeply sloping valley side (see Vol 1, Fig 2.9). As detailed in *Table 53*, a series of preserved turves with varying amounts of attached underlying humic soil was stacked inverted on top of each other (rootlets can clearly be seen running upwards from one of the turves into the overlying material). These only seem to be preserved in one part of section 7028 – it is quite possible that more turf material was deposited in the remainder of the feature, but unless sufficiently sealed the organic material in the turves would not have been preserved. The turves themselves indicate the presence of short sward grassland in the immediate area.

Roman spring deposits, section 7756

A series of alluvial/spring deposits over sands and gravels (Roman riverbed consolidation) was exposed in section 7756 and collected in monolith 8600 (see Vol 1, Fig 2.17). The sequence is well dated due to the inclusion of substantial quantities of archaeological remains. The deposits show that in contrast to the early prehistoric spring deposits, the water here was less highly charged with calcium from local chalk outcrops. Instead, a series of humic fine-grained silt to clay loam layers was observed. These interleaved with and incorporated layers of charcoal- and artefact-rich deposits in contexts 6576–7 as shown in *Table 54*. Silty clay colluvium (upper context 6576) sealed the sequence showing that water levels had dropped, allowing hillwash sediments to dominate in this area later in or following the Roman period.

Roman 'Viewing platform'/terrace 3192/400044, section 7210

This sequence, collected in monolith 8147 (*Table 55*), represents a series of layers arising from the deliberate stacking of turves or rapid collapse of the steeply sloping edge on the north-east side of this terraced feature (see Vol 1, Fig 2.33). A number of turf/topsoil layers have been recorded, most inverted, with attached and unattached humic B horizon and colluvium. Turflines may have been more widespread in section but were insufficiently sealed and so decomposed. The sequence is similar to that of the late Iron Age terrace 3053/400011 (see above), with the addition of colluvial material (3195) indicating an episode of colluviation within the sequence.

Roman roadside, section 7736

Monoliths 8601 and 8602 were collected through a series of shallow deposits adjacent to the early road, near to where it ran into the water at the head of the River Ebbsfleet. These deposits (*Table 56*) include fine laminations of sand, with charcoal washed or in some instances wind blown into the sequence. Evidence of soil formation occurs throughout, demonstrating that a generally stable landsurface/series of landsurfaces of silt loam existed. The on-site suggestion that the deposits might be washed off the adjacent Roman road is supported.

The slope between the Roman Sanctuary temple and spring, section 7750

Monolith 8599 was taken through deposits on the slope between the Sanctuary temple and spring (see Vol 1, Fig 2.43) in order to clarify the character of the immediately local Roman landscape. The presence of repeated layers of colluvium with poorly developed soils in each (*Table 57*) indicates that the slope was relatively unstable and prone to movement under heavy rain conditions. It also indicates that vegetation was sparse and probably comprised grassland. Unfortunately the colluvial and therefore redeposited nature of the sequence precludes further environmental analysis to elucidate this. Some anthropogenic discard or dumping is indicated for two of the layers (contexts 6221 and 6378), with mortar, charcoal, ceramic building material, slag, oyster and mussel shells present.

The pre- to post-Roman sequence including a 'burnt mound', section 7341
A deep (>3 m) sequence of deposits occurred in this area within a former (pre-Roman) spring. A monolith (8244) was collected for part of the middle, mainly Roman portion of the sequence (believed to be prehistoric during excavation) and is described in *Table 58*). The base was of 0.2 m of colluvium reworked in water (context 2529), with animal bone, pottery/ceramic building material and charcoal at its top. This was overlain by 'burnt mound' material (lower context 2528) including copious burnt flint and charcoal, of probable early Roman date (on the basis of a few sherds of pottery and the nature of the charred plant assemblage, dominated by spelt wheat). Some downslope movement is suggested, but only locally. The mound was sealed by further colluvium of Roman or later date (contexts 2527 and the upper part of 2528) that had been reworked and relain by water. Subsequent colluvial layers of probable medieval or later date were recorded on site overlying those described here but were not sampled.

Northfleet Sediments and Soils

by Martin Bates and Elizabeth Stafford

The Broad Sedimentary Architecture of the Lower Ebbsfleet Valley and Northfleet Villa

The pre-Holocene sequences
The Northfleet villa site is situated in the Lower Ebbsfleet Valley approximately 1.5 km downstream of Springhead. The current channel of the Ebbsfleet stream meanders north from the villa site for approximately 1 km, before joining the River Thames at Robin's Creek, Northfleet. The Thames flows west–east at this point, parallel with the late Cretaceous northern dipslope of the Wealden anticline. Pleistocene deposits, known as the Boyn Hill gravels or more properly the Orsett Heath gravel unit, line the higher ground above its southern bank, cut into the late Cretaceous/early Tertiary bedrock at a height of *c* 25–27 m OD. Previously it was thought that the Ebbsfleet Valley cut transversely through these deposits into the underlying Chalk bedrock, and was filled with a complex sequence of Pleistocene deposits post-dating the Orsett Heath gravel unit. However, recent analysis of deposits from the HS1 site at Southfleet Road on the western side of the valley (Wenban-Smith *et al* 2006) suggests that the sequence at this location is in part an Ebbsfleet sequence, but is contemporary with the Orsett Heath gravel. Sediments at Eastern Quarry to the north-east (Wenban-Smith 2002; *et al* 2006) still comprise Thames gravels, indicating that the confluence was along the line of Southfleet Road, somewhere south of Eastern Quarry. The Pleistocene deposits fall into two main categories: water-lain deposits (fluvial sands, silts and gravels); and colluvial and solifluction deposits. Because of the past history of quarrying little is now left of these once extensive bodies of sediment and the challenge today is integrating pockets of preserved sediment within a local lithological framework. At least three main episodes of fluvial sedimentation separated by phases of erosion and downcutting are present in the valley spanning parts of the last 250,000 years. Important palaeoenvironmental remains area sometimes preserved in the finer grained fluvial sediments and there is also potential for the preservation of *in situ* artefactual material.

In most cases colluvial and solifluction deposits mantle the valley sides burying the fluvial sediments. The solifluction deposits represent sequences accumulating in colder periods when the banks were exposed and the surrounding land surface was de-stabilised resulting in erosion and the accumulation of sediment downslope and in the valley bottom. Detailed analysis of the Pleistocene sequences exposed during the construction of the HS1 is reported on in the Prehistoric Ebbsfleet volume. Combined knowledge of the distribution and elevation of the Pleistocene deposits has enabled the form of the early Holocene topography to be realised. This is important as this landform feature dictated patterns of later sediment accumulation. Reconstruction of this surface through the use of borehole and trench data has revealed a deep outer basin downstream of Northfleet villa. This feature would have seen the first inundation of the valley by freshwater and later by brackish conditions following sea level rise during the earlier part of the Holocene. A shallower Inner Basin is located upstream of the villa site and was only inundated by wetland conditions during the Neolithic. The site of Northfleet villa itself is located on a promontory or gravel 'spur' extending from the western slopes of the valley. This would have remained an area of higher drier ground throughout much of the Holocene. Mapping of the position of the dry ground/wet ground interface during the early Neolithic, Bronze Age and the period of Roman occupation is intended to assist in interpretation of the archaeological evidence within its topographical context (Fig 15). These projections are based on time/depth estimates for onset of organic sedimentation onto gravel surfaces in the Lower Thames as previously calculated by Bates (1998). The projections show the gradual expansion of the wetland zone and the loss of dry ground habitats. This model has subsequently been confirmed through radiocarbon dating of the sequences from the Ebbsfleet Valley itself. The reconstruction for the Roman period illustrates Northfleet villa strategically positioned on an area of

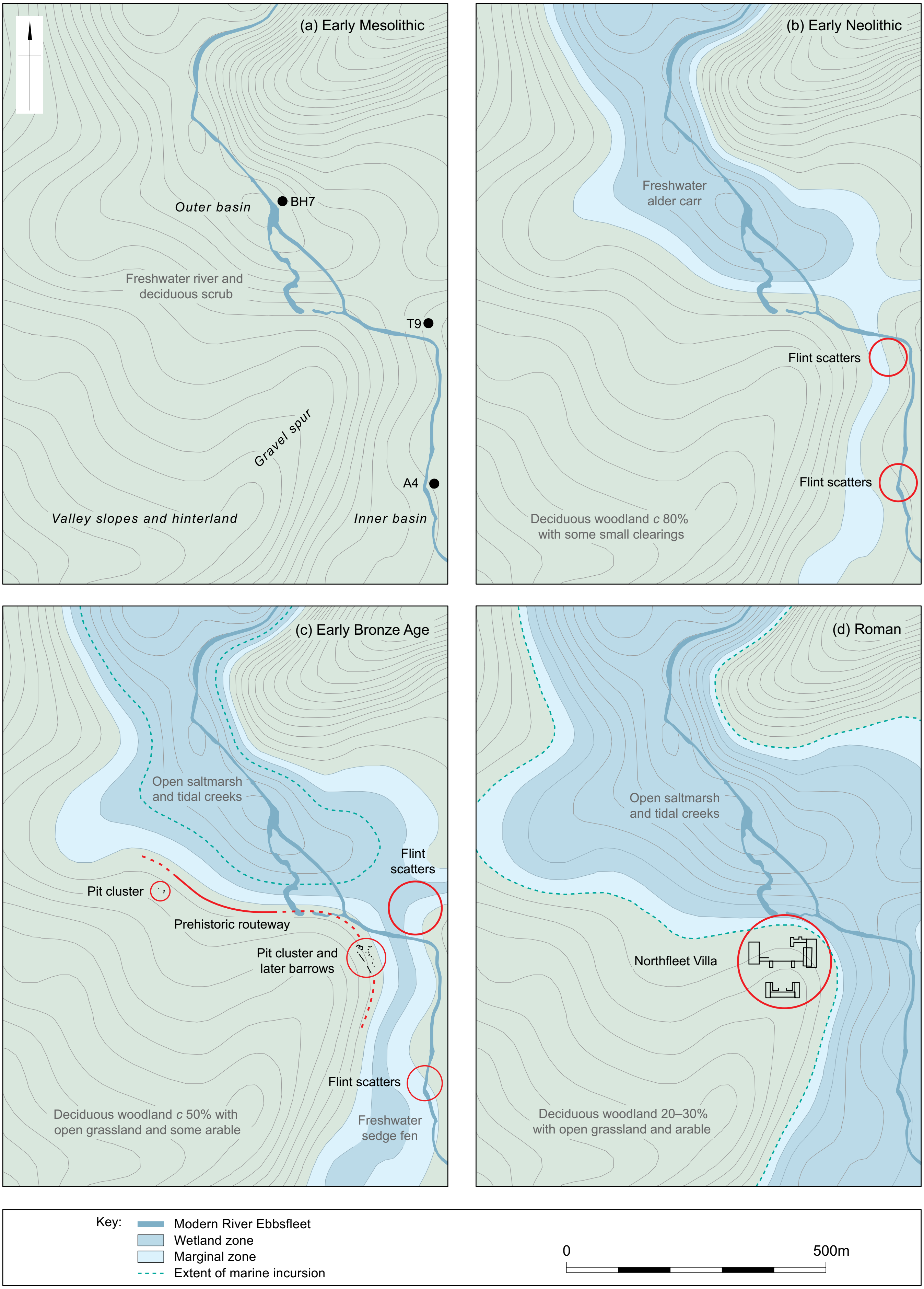


Figure 15 Topographical reconstructions of the Lower Ebbsfleet Valley (Holocene)

high ground adjacent to the wetland edge. The Roman harbour was positioned in the low-lying area immediately to the north.

The Wetlands

The broad sequence of Holocene alluvial deposits identified in the Lower Ebbsfleet Valley is summarised as follows:

Stratigraphic Unit	*Inferred environment of deposition*
Made Ground	Recent dumping/landfill
Upper Peat	Reed swamp
Upper Clay Silt	Inter-tidal/estuarine mudflats
Reed Peat	Reed swamp
Wood Peat	Alder carr wetland
Lower Clay Silt	Inter-tidal/estuarine mudflats
Organic Silts	Freshwater infilled creeks
Sand	Fluvial channel laterally becoming colluvial slope wash
Gravel	Braided fluvial channel
Solifuction deposits	Periglacial

An organic sandy silt (correlated with the organic silts) in BH7 (STDR4, *Table 59*), at -6.73 m OD, was radiocarbon dated to the earlier part of the Holocene at 8540–8240 cal BC (NZA-28766, 9122±55 BP). The sandy texture of these deposits suggests deposition in moderately flowing water. Pollen assemblages were dominated by tree and shrub pollen (AP >70%) and suggest rather open scrubby deciduous woodland with birch (*Betula*), hazel (*Corylus avellana*) and an understorey of grasses (Poaceae) and ferns (Pteropsida), growing on the banks of the river. Clumps of birch pollen were found which suggests that a birch tree(s) was overhanging the site. Pollen taxa associated with reed swamp or marsh were rare. More closed deciduous woodland with a mosaic of lime (*Tilia cordata*), on the drier soils, and oak (*Quercus*), elm (*Ulmus*) and hazel, probably grew further away from the site. Although the sandy silt would have been laid down in an aquatic environment, there was no pollen evidence of any marine influence at this location. There was very little evidence for any human impact on the landscape at this time. A few microscopic charcoal particles noted during the pollen analysis may have come from some distance, having been blown or carried into the site by wind or water.

Evidence for an early influx of estuarine waters during the Mesolithic was noted in the overlying Lower Clay Silts examined in a number of sequences in the deeper Outer Basin. Brackish water diatoms were recorded from this unit in BH7. The pollen assemblages included many telmatic taxa which are found growing in the mud/shallow water of reedswamps: common reed (*Phragmites australis*), common club-rush (*Schoenoplectus lacustris*-type), grasses (Cyperaceae), sedges, iris, lesser bulrush/bur-reed (*Typha angustifolia*/*Sparganium*), bulrush (*Typha latifolia*), water-plantain (*Alisma*-type), and also floating aquatic taxa; pondweeds (*Potamogeton*), water starwort (*Callitriche*), water lilies (Nympheaceae), and the remains of freshwater green algae (*Botryococcus* and *Pediastrum*). Quite high pollen values of the goosefoot family (Chenopodiaceae), a taxon characteristic of salt marshes and including such genera as glassworts (*Salicornia*), sea-blites (*Sueda*) and saltworts (*Salsola*), suggest that the local environment was being influenced by salt water to some extent, and was probably reed swamp/upper salt marsh during this period. The arboreal pollen, averaging 70%, suggests that deciduous woodland with lime, elm, oak, hazel, ash (*Fraxinus excelsior*) and birch dominated the landscape on drier ground with alder and willow (*Salix*) on wetter soils. Values of microscopic charcoal particles were quite high, including pieces of charred grass, and are evidence for local, probably man-made, fires. Radiocarbon dates from BH7 suggest that deposition of the Lower Clay Silts at this location in the Outer Basin occurred during the late Mesolithic period 5480–4240 cal BC (WK-8801 6340±80 BP and NZA-28974, 5464±35 BP), between -6.3 and -4.95 m OD. This early marine transgression into the Ebbsfleet can be broadly correlated with Long's first phase of estuary expansion on the Thames floodplain (Long *et al* 2000) and Stage 3 of the Bates and Whittaker (2004) model.

The Lower Clay Silts were overlain by thick deposits of wood peat that began to accumulate from the late Mesolithic to early Neolithic period. In the Outer Basin the base of the wood peat in BH7, at -4.95 m OD, was dated to 4370–4240 cal BC (NZA-28974, 5464±35 BP). Further upstream, in the Inner Basin, the base of the wood peat lies at slightly higher elevations. In Trench 9 STDR4, *Table 60*) accumulation begins at –2.32 m OD, and is dated to the early Neolithic period at 3780–3640 cal BC (NZA-29080, 4926±35 BP). A similar date was produced in Area 4 (STDR401) at -2.1 m OD, dated to 3800–3650 cal BC (NZA-29247, 4945±35 BP). Although the difference in elevations may be to some extent the result of differential compaction and/or erosion, the unit does appear to be diachronous from the Outer to Inner Basins. In the Inner Basin, in a number of interventions excavated during the STDR4 investigations (STDR401; Areas 3 and 4 and STDR4; Trenches 8–9 and 11), substantial quantities of *in situ* early Neolithic worked flint were retrieved from the very base of the peat sequence. This activity may have occurred during the period when the area was still relatively dry ground and the wetland front was restricted to the low-lying ground around the Outer Basin. Pollen evidence from the main body of the wood peat indicates that locally freshwater alder carr environments predominated in the low lying areas of the valley during this period along with marsh/fen and an understorey of ferns and sedges. Analysis of the plant remains from Trench 9 (STDR4) included seeds of alder, stinging nettle (*Urtica dioica*), hemp agrimony (*Eupatorium cannabinum*) and wood club-rush (*Scirpus sylvaticus*). The only seeds from plants of open habitats were plants of wet mud, such as water pepper (*Polygonum hydropiper*) and shallow water, such as water parsnip (*Berula erecta*). Mollusc assemblages comprised freshwater aquatic species, including *Bithynia tentaculata*, which requires flowing water, suggesting episodes of flooding. Coleoptera included the alder leaf beetle (*Agelastica alni*), *Rhyncolus* sp., which bores into dead wood, and *Corylophus cassidoides*, which occurs in accumulations of dead vegetation in fens. *A. alni* is now extinct in Britain but is quite often found in Neolithic alder woodland deposits. Amongst the Coleoptera were small water beetles such as *Ochthebius* cf. *minimus* and *Hydraena testacea*, which probably occurred in pools of water. There is however, some indication of small clearances, possibly for domestic animals on areas of drier ground, with the occurrence of *Agrypnus murinus*, a grassland species, and a scarabaeoid dung beetle (*Onthophagus taurus*), which is now extinct in Britain but has been recorded from several Neolithic and Bronze Age sites.

In a number of sequences, particularly within the more marginal Inner Basin, deposits of micritic tufa were noted within the upper part of the peat profile, suggesting the presence of freshwater springs. The onset of tufa accumulation appears to have been relatively synchronous across the valley bottom, radiocarbon dated in BH7, Trench 9 and Area 4, to the early Neolithic period at 3640–2940 cal BC (BH7; NZA-28869, 4448±30 BP, Trench 9; NZA-29077, 4663±35 BP and Area 4; NZA-29082, 4725±35 BP). Rich assemblages of freshwater ostracods were preserved in the tufa from Trench 9 (STDR4), including the rare *Cypridopsis lusatica*, only the second record of this species from the British Isles. The ostracods are likely to have lived either in the spring/seepage itself, or in the vegetation that probably covered it. *Scottia pseudobrowniana* and *Nannocandona faba* are specialised semi-terrestrial species, which live in or burrow into this floating vegetation. Tree and shrub pollen continued to dominate the pollen assemblages with oak, lime, elm, ash and hazel values suggesting that the regional vegetation was deciduous woodland during the period of peat formation. However, a temporary decline in values of lime pollen noted in the lower part of the peat sequence from Trench 9, and commensurate with the first appearance of cereal pollen, may be related to human activity within the catchment.

Within the wider context the prehistoric peat in the Lower Ebbsfleet Valley generally occurs at similar elevations, stratigraphic position and date to Devoy's Tilbury III peat on the Thames floodplain (Devoy 1979). The dates are also consistant with Long's proposed phase of mid-Holocene estuary contraction (Long *et al* 2000), and Stage 4 of the Bates and Whittaker model (2004).

Tufa accumulation within the peat appears to cease sometime in the early Bronze Age at 2470–2020 cal BC (BH7; NZA-28971, 3836±50 BP and Trench 9; GU-16008, 3725±35 BP), and is probably related to the onset of a further phase of marine incursion into the valley which eventually caused the cessation of peat formation and the deposition of the Upper Clay Silts. Towards the top of the peat profile, there is evidence locally for an increase in marsh/sedge fen environments with abundant ferns, indicating increased wetness in the valley bottom. The change to minerogenic sedimentation is dated in the Outer Basin in BH7, at -2.38 m OD, to the (late) early Bronze Age 1940–1750 cal BC (NZA-28973, 3527±30 BP). Here, the Upper Clay Silts are rather homogenous, although some faint horizontal bedding was noted in BH7. Ostracod, foraminifera, diatom and pollen evidence suggests the presence of a tidal river with mudflats and fringing saltmarsh, fen and reed swamp environments. Further upstream, in the more marginal Inner Basin, the incursion occurs a little later. There is evidence from the pollen and diatoms of brackish water incursion within the top of the peat facies in Trench 9 during the late Bronze Age period; 2280–2020 cal BC, at -0.58 m OD (GU-16008, 3725±35 BP). The change to predominantly minerogenic sedimentation occurred at -0.03 m OD in the late Bronze Age or early Iron Age 840–590 cal BC (GU-16006, 2605±35 BP). However, the Upper Clay Silts at this location are more heterogeneous, characterised by intercalated beds of silt clays and more organic, sometimes peaty, deposits.

Accumulation of the Upper Clay Silts appears to have continued throughout the later prehistoric and into the historic period. An organic lens in Trench 9 (STDR4) at +0.33 m OD produced a mid–late Roman date of cal AD 220–410 (SUERC-16658, 1740±35 BP). Locally the pollen suggests that environments of middle and upper saltmarsh had developed by this period, evidenced by the record of pollen from the goosefoot family (Chenopodiaceae), sea plantain (*Plantago maritima*) and occasional grains of thrift/sea lavender (*Armeria*/*Limonium*).

This phase of marine transgression into the Ebbsfleet Valley in the later prehistoric and historic periods is mirrored at many sites previously investigated up and down the Lower Thames estuary. It can be broadly correlated with Long's second phase of estuary expansion on the Thames floodplain (Long *et al* 2000) and stage 5 of the Bates and Whittaker model (2004).

Towards the top of the Upper Clay Silt unit there is evidence, in both BH7 and Trench 9, that salt marsh was gradually being replaced by freshwater reed swamp once more, with some areas of open water. The Upper Clay Silts are generally overlain by a laterally extensive freshwater peat unit suggesting a further episode of marine regression. Radiocarbon dating suggests that peat accumulation commenced during the middle or late Saxon period. The base of this unit was dated in borehole 7, at +0.88 m OD, to cal AD 710–940 (NZA-28620, 1196±30 BP), and in Trench 9, at +0.72 m OD, to cal AD 650–810 (GU-16003, 1290±35 BP, see Vol 4). Pollen evidence suggests the presence of local freshwater marsh and sedge fen environments; there is little evidence for further marine incursion in this part of the Ebbsfleet Valley following the Saxon period. The Upper Peat in the valley bottom was invariably found to be sealed by varying thicknesses of relatively modern made ground or topsoil.

The regional pollen assemblages suggest that away from the valley bottom a much more open environment than had existed previously developed during the later prehistoric and historic periods. Woodland cover appears to decrease significantly at the beginning of the Bronze Age period (AP *c* 50%) as evidenced at the base of the Upper Clay Silts in BH7, and within the upper part of the peat profile in Trench 9. This is undoubtedly related to human activity in the catchment; and is consistent with the archaeological evidence for increased activity both at Springhead and Northfleet from the early Bronze Age period onwards. By the late Roman period arboreal pollen values were as little as 20–30%, as recorded in the sequence from Trench 9. The landscape is likely to have comprised open grassland with arable cultivation and some stands of oak and hazel woodland. Barley (*Hordeum* group) and oats/wheat (*Avena*/*Triticum*) were being cultivated from the Iron Age onwards, and rye (*Secale*) from the Saxon period.

Colluvial slope deposits

Colluvium has been mapped extensively across the higher ground and slopes of the Lower Valley and these episodes of colluviation have played an important role in modifying the landscape throughout the period of human activity in the valley. Within the HS1 land-take, Holocene colluvial deposits and their underlying Pleistocene equivalents were located predominantly on the western slopes of the valley. These deposits were recorded during the evaluation stages of the project; however, much of this area was not the subject of later, detailed excavation and sampling. Work associated with STDR4 indicated that substantial sequences of colluvium also underlie the eastern margins of the valley but these were even more poorly investigated.

Understanding the history of colluviation is complex as artefacts, and other evidence of human activity such as charcoal often reside in soils for long periods of time. In some cases episodes of erosion and redeposition through downslope processes may occur repeatedly and consequently pottery sherds, or other datable artefacts, may only provide a *terminus post quem* for the date of deposition. A more reliable indicator for the date of deposition can be provided where well-dated archaeological features are found stratified within colluvial deposits, as at the Springhead Sanctuary and the Ebbsfleet River Crossing (see above). In the Lower Ebbsfleet Valley, archaeological trenching identified only small mixed assemblages of worked flint and pottery sherds within these deposits, along with a small number of undated features. Assessment of samples identified occasional charcoal fragments. Mollusc shell was either absent or very poorly preserved. This, together with the limited scale of investigation and the localised nature of the Holocene colluvial processes, has proved problematic in terms of stratigraphic analysis.

The colluvial deposits in the Lower Ebbsfleet Valley often show a twofold division between material of Pleistocene date forming the lower part of the sequences, and later deposits of Holocene Age. Holocene deposits generally comprised reddish or yellowish brown sandy silts and clayey silts with varying quantities of chalk and flint clasts. Occasional zones of rooting suggest periods of slope stabilisation and soil formation. As opposed to climatically induced processes inferred from earlier sequences, the Holocene colluvial deposits are likely to have formed largely as a result of anthropogenic activities. These included episodes of forest clearance and cultivation which increase the susceptibility of soils to erosion through the breakdown of structure and loss of nutrients (see Bell and Boardman 1992).

Colluvial deposits of late Pleistocene and potentially early to mid-Holocene date, reaching up to 2 m in thickness, were identified on the north-west and western slopes of the valley adjacent to Area 6 and the Sportsground. Deposits were also found to be underlying the Northfleet villa complex on the gravel spur. These deposits were truncated by features of early Bronze Age and later date. The fine-grained textures of the deposits suggest deposition probably as sheet wash, reworking older (Pleistocene) deposits from further upslope. The sequence of deposits beneath the villa site was recorded in detail in section 18044 (*Table 61*).

On the eastern side of the valley colluvial deposits were identified during the evaluation, infilling a dry valley tributary of the Ebbsfleet at the south-eastern end of the STDR4 (STDR4, Trenches 13 to 17). Trenches 13 and 16 contained the deepest and most complete sequence of colluvial deposits and possible soil horizons. Soliflucted chalk with flint nodules (contexts 1322 and 1617), recorded at the base of the excavated sequence, was overlain by a series of sterile, eroded chalk silts (contexts 1321 to 1308, and 1613 to 1609). In Trench 16, two distinct horizons of reddish silt (context 1616 and 1614) within the chalk silts may represent early Holocene soil horizons. No artefactual material, however, was discovered from this lower colluvial sequence in either trench. Immediately overlying the lower chalk silts, a darker brown silty layer with flint nodule inclusions (contexts 1307 and 1608–1606) was recorded. A layer of burnt flint, 0.1 m thick, sealed 1307 across the full extent of the trench. This was investigated *in situ* but no worked flint or other artefacts were recovered from the layer. The absence of charcoal or evidence for *in situ* burning suggests that the material probably derived from a location upslope and had eroded into the dry valley. In contrast to the colluvial deposits examined on the western slopes of the valley, samples from the deposits in the STDR4 trenches contained moderate quantities of mollusc shell. In Trench 16 shells of woodland snails, particularly *Carychium* sp. and *Discus rotundatus*, predominated in parts of the lower colluvial sequence (1611, 1610, 1609 and 1608). They include the rare snail *Vertigo pusilla*,

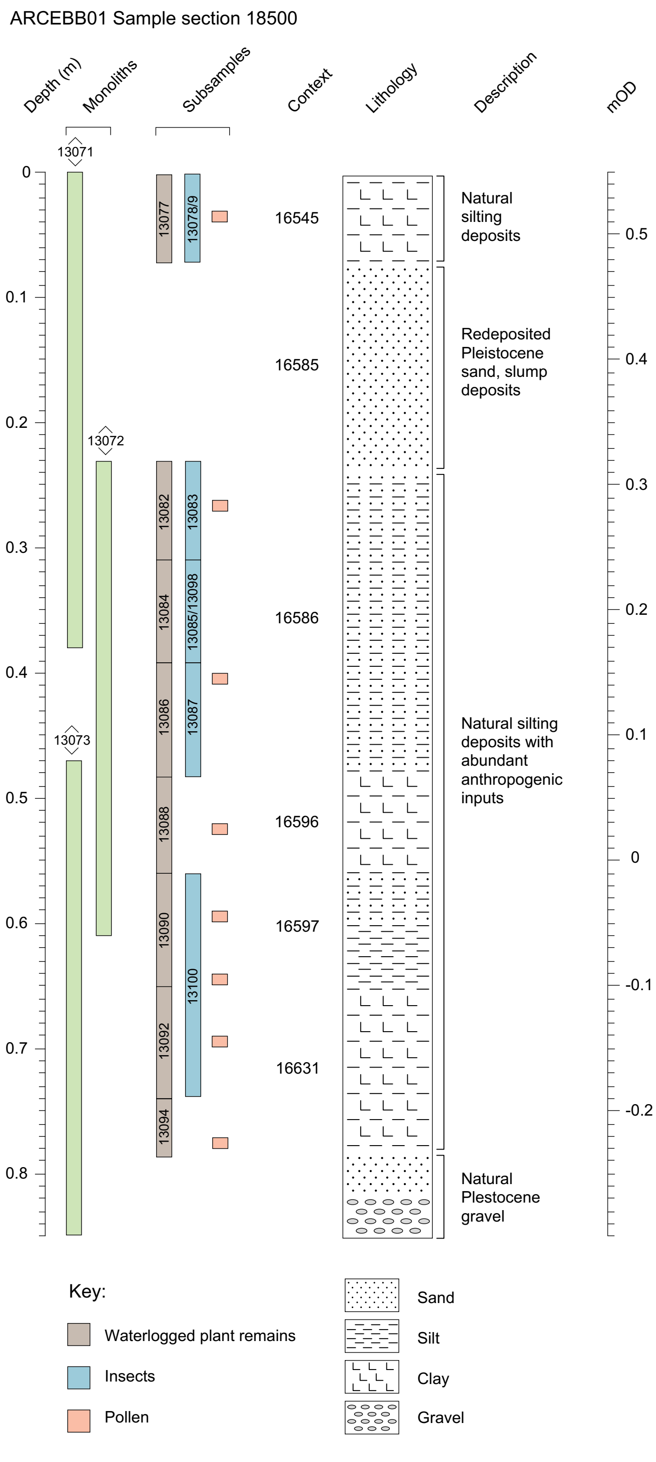


Figure 16 Section from Roman cistern at Northfleet

which no longer occurs in Kent. Open-country species were not entirely absent, but it is unclear whether they are residual from late glacial and early post-glacial deposits. The occurrence of many shells of *Pomatias elegans* in contexts 1609 and 1608 could be a reflection of clearance-related surface instability. A consistent sequence of more recent plough-derived colluvial soils sealed this early sequence, comprising 1.2–1.6 m of brownish grey silty loam. These deposits contained small coke-like inclusions and medieval or post-medieval tile.

Evidence for colluviation, securely dated to the later prehistoric and Roman periods, was sparser. At the foot of the north-western valley slope (north of the Sportsground excavation area), colluvial deposits examined during the evaluation stage ranged in thickness from 0.1 m to 1.7 m. Analysis of the elevation of the surface of the Pleistocene deposits in this area suggests that the deposits infilled a small valley feature. In trial trench 2018 (*Table 62*), excavated to 5.3 m, deposits were notably sandier than elsewhere and probably derive from the reworking of older, fluvial sediments or bedrock Tertiary Thanet Sand known to exist higher on the slope/up-valley. The lowermost unit, a chalky silt with angular flint and chalk clasts, probably represent Pleistocene solifluction deposits. Rooting was noted in places within the overlying silty sands, suggesting the possible presence of stable surfaces during accumulation. At 2.6 m to 2.8 m, a dark greyish brown sandy silt deposit contained frequent burnt flint fragments and occasional worked flint, along with late Bronze Age pottery and charcoal fragments. Late Iron Age or early Roman pottery was also recovered from a dark yellowish brown silty sand higher in the profile between 1.2 and 1.5 m. In the Sportsground excavation area features of early and middle Bronze Age date were sealed by a thin layer of relatively sterile yellowish brown sandy silt (20315, 20383, 20384) which was in turn cut by features associated with the Western Roman Complex. Unlike the Ebbsfleet River Crossing, no buried land surfaces or artefact spreads were found associated with the Bronze Age features, suggesting that erosion of the upper levels of the features had occurred. On the gravel spur the majority of the early and middle Bronze Age features were recorded at similar levels to those of the Roman archaeology, suggesting little sedimentation at this location during the later prehistoric period. Where the Holocene sequence remained untouched by previous excavations or truncated by modern disturbance, thick deposits of colluvium were identified sealing both the Roman and Saxon archaeological horizons throughout the excavation areas. By inference this build up is of medieval and post-medieval date, as in the STDR4 trenches. Along with sherds of medieval pottery much of this colluvium contained mixed residual assemblages of worked flint along with prehistoric, Roman and Saxon pottery, suggesting substantial erosion of earlier occupation horizons from up-slope locations.

The Feature-Related Soils and Sediments

Well 6731 Villa Phase (VP) 1–2 (AD 70–150/60)

Well 16731 was defined by a circular construction pit measuring 5.84 m wide at the top, narrowing to 3 m at the base, and, as excavated, was 3.2 m deep. A layer of chalk nodules (16728) was spread around the edge of the base to provide a surface for a square timber lining secured by stakes (16696) (see Vol 1, Fig 3.11). The lower four boxes of the lining survived with an internal width of 2.7 m. The feature itself was cut through sterile orangy brown silty sand (Pleistocene colluvium) with sandy fluvial gravel noted at the base. The base of the feature lay at -0.75 m OD, nearly a metre deeper than the other wells excavated at Northfleet, extending well below the water table. This together with the overall size of the feature indicates that its original function was to supply large amounts of freshwater to the villa complex. In the early phases this could well have been related to malting and brewing as well as other activities.

Five monoliths (M13071–73, M13039–42) from the lower waterlogged fills of the well were described (*Table 63*) and sub-sampled for pollen (see Scaife below). Larger bulk samples were also submitted for the analysis of macroscopic plant remains (see Stevens below) and insects (see D Smith below) (Fig 16). The basal silting layers date to the 1st century AD, but the feature continued in use through the later villa phases. The upper fills predominantly comprised deliberate backfill deposits and were not sampled.

The primary fill (16631) comprised a thin lens, 0.05 m thick, of waterlogged soft dark greyish brown slightly clayey silt with lenses of fine sand and granules of chalk. This was overlain by a series of well-bedded, occasionally laminated silts, sandy silts and clays with frequent organic detritus, 0.18 m thick (16597, 16596, 16586). The structure and fine grained texture of these deposits suggests initial accumulation by natural silting processes, though anthropogenic inputs were in evidence with occasional clasts of burnt flint, charcoal fragments and pottery. Sealing these silts was a very clean lens of light brownish grey sand (16585) interpreted as redeposited material deriving from the natural sands through which the feature was cut. This was overlain by a further deposit of dark greyish brown silty clay (16545), 0.07 m thick. Above context 16545 lay a series of layers interpreted as deliberate dump deposits (16524, 16526, 16525, 16380 and 16519) described from monoliths 13041 and 13042. The majority of these deposits were very mixed and comprised silty loam, often as intact soil clasts, clay silt and sandy silt with abundant charcoal, burnt clay and chalk fragments.

Well 16516 VP 2 (AD 120–150/60)

Well 16516 (see Vol 1, Fig 3.16, section 13223) was defined by a circular construction pit (16090) measuring 2 m wide at the top, narrowing to a square, 1.3 m wide, at the base. The base of the feature lay at +0.17 m OD. A square timber lining (16533) had been inserted tightly into the shaft and comprised three box frames, each made of four oak planks and secured by wooden stakes. The feature itself was cut through a recently filled pit or quarry 16428, and the upper part of the construction cut was partially backfilled with clay (16102–3) to narrow and line the upper shaft.

One monolith (M13026) retrieved from the lower fills of the well was described (*Table 64*). Bulk samples were also submitted for the analysis of macroscopic plant remains (see Stevens below) and insects (see D Smith below).

The lowermost fill (16388) comprised a brownish yellow slightly silty medium sand. This deposit was loose and structureless, mottled with iron mineralisation, and probably derives from redeposited Pleistocene sands. Overlying this was a series of finely laminated silt-clay and sandy silt deposits (16387). The structure of these deposits suggests initial rapid silting within the base of the well.

Well 15011 VP 5 (AD 200–250/60)

Well 15011 (Vol 1, Fig 3.21) was defined by construction cut measuring 2.5 m wide at the top, narrowing to 1.4 m wide, at the base. A stone lining set above a timber frame was assembled within the cut, and the gap between the lining and construction-cut walls backfilled with sandy silt. The feature itself was cut through Pleistocene sands. Three monoliths (M11258–60) retrieved from the lower fills of the well were described (*Table 65*). Bulk samples were also submitted for the analysis of macroscopic plant remains (see Stevens below) and insects (see D Smith below). The lowermost fills (15048 and 15047) comprised 0.24 m of dense brown sandy silt, overlain by 0.3 m of loose light yellowish brown silty sand with frequent clasts of chalk and flint. The structure of these deposits appeared to be quite mixed and they are interpreted as redeposited or dumped material possibly deriving from the Pleistocene deposits through which the feature was cut. Sealing these deposits was a layer of light yellowish brown sandy silt (15014) with fine horizontal micro-laminations, 0.61 m thick. This deposit was sterile apart from rare granule sized clasts of chalk and is likely to represent waterlain silts derived from the natural substrate and material blown/washed into the well. The well had been excavated previously by Steadman, and all of the fills overlying the deposits described had been redeposited after that earlier intervention.

Ditch 16723 VP 1 (AD 70–120)

Ditch 16723 extended at least 30 m between clay-lined tank (10712) and the channel of the River Ebbsfleet (see Vol 1, Fig 3.4). The slope and course of the feature suggested that it might have been dug to drain water from the tank. This ditch contained a complex series of fills that required further description and three monoliths (M11470–72) through the profile of cut 16032 were available for description (*Table 66*). The ditch at this location measured 2 m wide at the top and was 1.37 m deep with a steep V-shaped profile. The basal deposit (16034) comprised 0.11 m of fine dark greyish brown and very dark grey soft sandy silt with grey brown mottles. This deposit, which was well sorted and fairly sterile, is most likely waterlain, and consistent with the interpretation of this feature as a drainage ditch. In contrast the overlying fills comprised very mixed silty loams with much anthropogenic material, pottery fragments, mortar, chalk fragments and marine shell. These deposits are almost certainly associated with episodes of deliberate dumping of waste material.

Pollen

by Rob Scaife

Samples for environmental analysis were taken the field using metal monolith profiles, which were sub-sampled for pollen in the laboratories of Wessex Archaeology, Oxford Archaeology and the University of Southampton.

This project has presented a very diverse range of sediment types ranging from humic peat to soil and minerogenic sediments including alluvium, loam and colluvial deposits. Given this range of sediment types, often alkaline and oxidised, pollen preservation was extremely variable. Analysis was on the whole difficult. In many samples, pollen was totally absent and in some cases there were typical signs of severe differential preservation in favour of typically robust types (eg, fern spores and Lactucoideae). However, and fortuitously, a number of useful pollen profiles have been obtained.

Methodology

Because of the predominantly minerogenic character of most of the material analysed, samples of 3 ml volume were processed (2 ml for more humic/organic sediment). Standard extraction techniques were used to extract and concentrate any sub-fossil pollen and spores present (Moore and Webb 1978; Moore *et al* 1991). This procedure is outlined in the site archive.

Sub-fossil pollen and spores were identified and counted using an Olympus biological research microscope fitted with Leitz Fluotar objectives at x400 and x1000 and x10 wide-angle eyepieces. Phase contrast illumination was also available. A substantial modern comparative collection of British and European pollen types was available to assist any identification problems. A pollen sum of 500 grains of dry land taxa plus extant spores, wetland/marsh taxa and miscellaneous elements (eg, derived pre-Quaternary pollen, algal *Pediastrum* and intestinal parasites) was attempted for each sample. However, where pollen was very sparse this basic sum was not always achieved. Pollen sums are given on the pollen diagrams.

Pollen data obtained are presented in standard diagram form and, where appropriate, in tables. The former have been plotted using Tilia and TGView. Where percentages are given, these have been calculated as follows:

Sum =	% total dry land pollen (tdlp).
Marsh/aquatic =	% tdlp + sum of marsh/aquatics.
Spores =	% tdlp + sum of spores.
Misc =	% tdlp + sum of misc. taxa.

Taxonomy in general follows that of Moore and Webb (1978) modified according to Bennett *et al* (1994) for pollen types and Stace (1991) for plant descriptions.

Springhead

Ebbsfleet channel edge

The sediment archive of the River Ebbsfleet channel consists of a complex of humic peat/organics, alluvium and colluvium. Three monolith profiles have been examined from the southern end of the site (Trench 4) as described in Barnett *et al* (see *Sediments and soils*, above). The earliest dated deposit (context 546, monolith 161), of early Neolithic date (3370–3080 cal BC, NZA-28773, 4519±45 BP), is overlain and sealed by colluvium (545). Further lenses of organic deposits (493) and (494) occur at a higher level in monoliths 160–1 and 160–2 and are more recent, being of late Bronze Age/early Iron Age to mid-Saxon date. The relationship of the lower part of monolith 160–2 to 161 (546) was not clear in the excavated trench and it is now apparent that there is a substantial temporal hiatus between the profiles. However, examination of the two profiles has the potential to provide a useful record of the vegetation and environment of the Ebbsfleet at Springhead.

Pollen procedures are outlined above and pollen diagrams (Figs 17–18) have been plotted.

The earliest (early Neolithic) peat (context 546) (Tr 4), monolith 160–2

Pollen analysis of a basal calcareous alluvium (547) and overlying peat (546) has provided data on the on-site vegetation of early Neolithic date. A predominantly wooded habitat is suggested with minimal evidence for any human disturbances. A closer sampling interval was adopted for the upper part of this 'lower' peat horizon. Overall, there are only minor stratigraphical variations in the pollen spectra and no local pollen assemblage zones have been defined for this profile. The principal characteristics of the profile are described as follows:

Trees and Shrubs: Arboreal and shrub pollen are dominant (*c* 85–90%). *Tilia* (lime, well preserved and degraded) is abundant (to *c* 35% in total) with *Quercus* (oak, to 20%), *Alnus glutinosa* (alder) and *Corylus avellana* type (hazel, to 29%) also important. It is noted that *Quercus* and *Tilia* values are greater in the lower part of the profile (0.34–0.42 m) whilst *Alnus* expands higher up (0.3–0.33 m). There are small numbers of *Pinus* (pine) and *Ulmus* (elm) and occasional *Fagus sylvatica* (beech) and *Ilex aquifolium* (holly).

Herbs: Values are relatively small (to *c* 10% of the pollen sum). Poaceae (grasses) are most important (to *c* 10%) with small/sporadic occurrences of other taxa including *Plantago lanceolata* (ribwort plantain). Marsh/fen taxa are present in small numbers with Cyperaceae (sedges) and *Typha angustifolia* type (lesser bulrush). A single grain of large (>45u) Poaceae in the upper sample (0.3 m) may be of cereal type.

Spores: Monolete forms (*Dryopteris* type ferns) are most important with increasing percentages in the upper levels (to 45% sum +spores). *Pteridium aquilinum* (bracken, 15%) also becomes important. There are

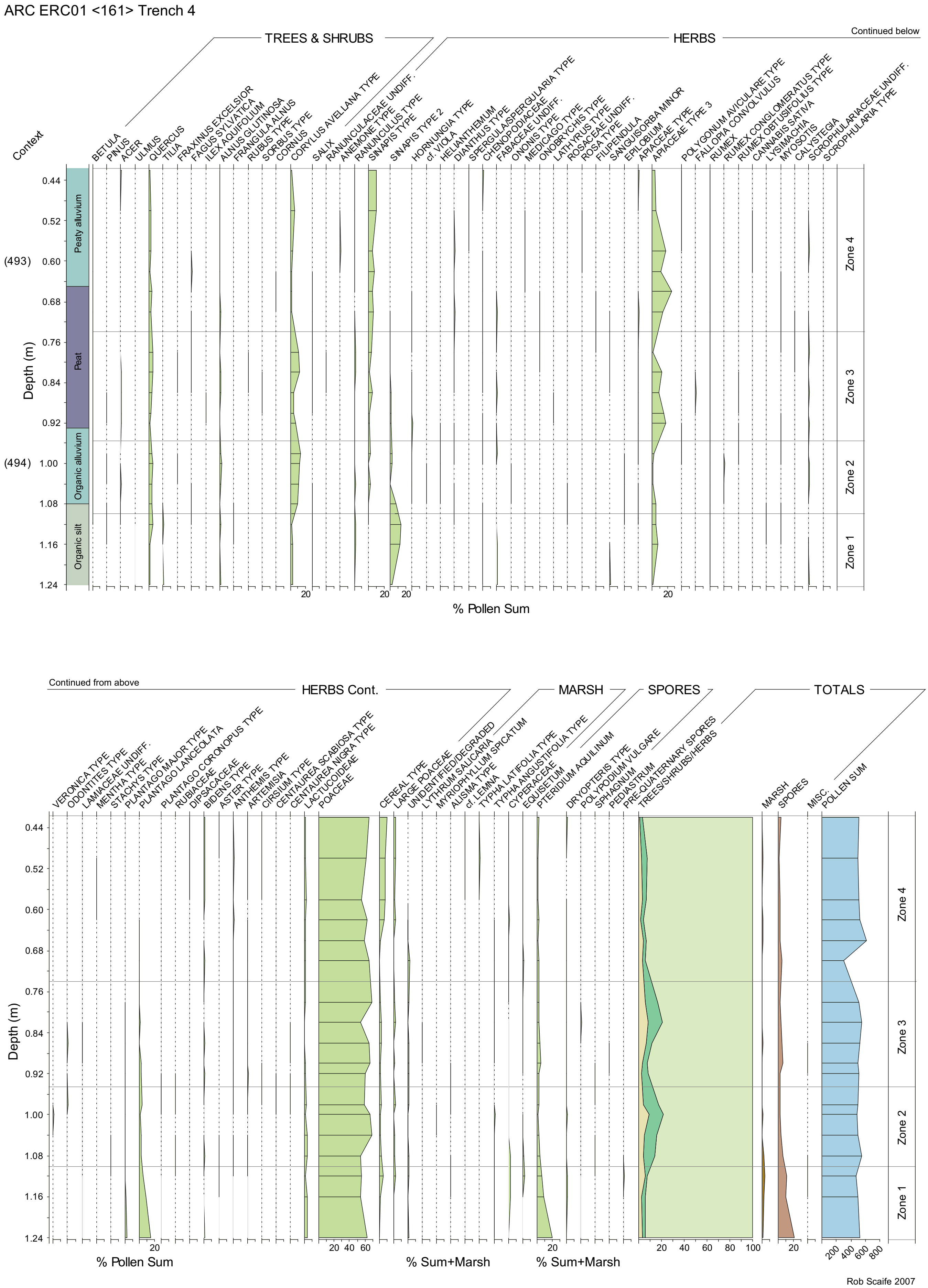


Figure 17 Pollen diagram: late prehistoric – Saxon sequence (Ebbsfleet river crossing – ARC ERC01)

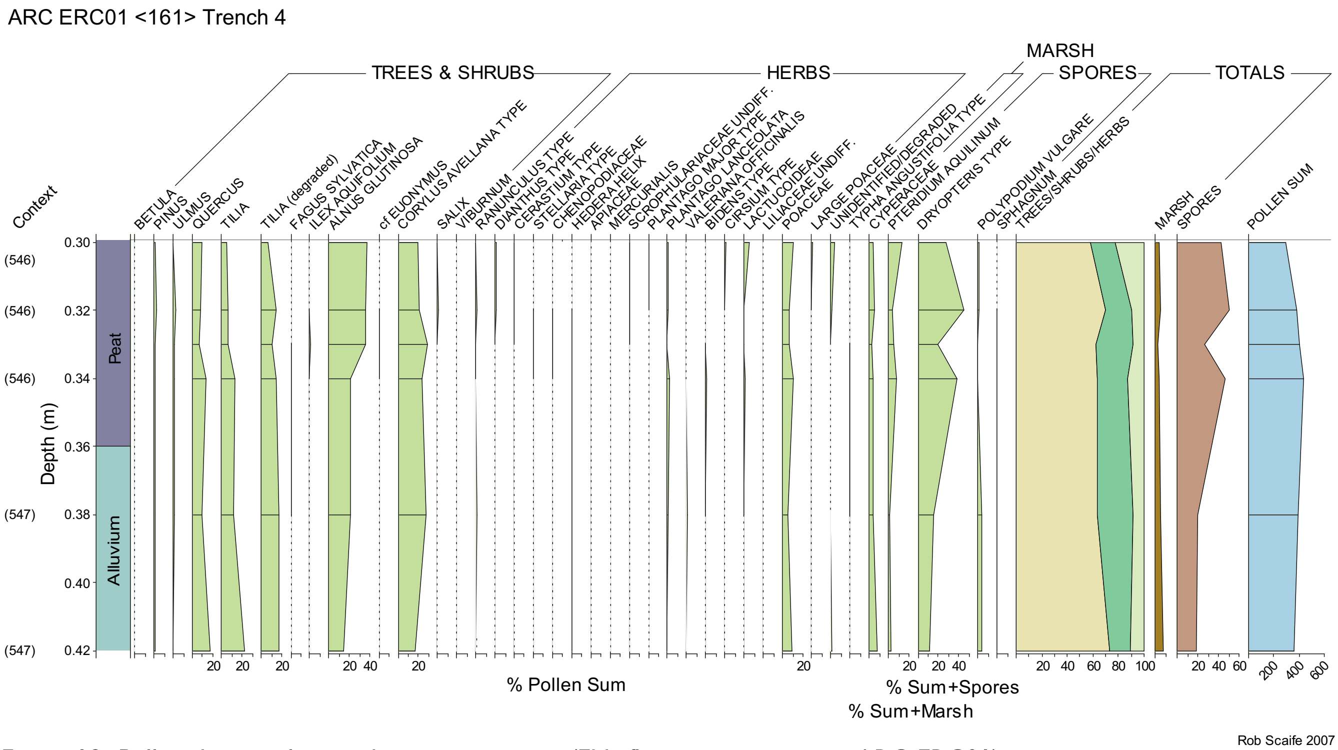


Figure 18 Pollen diagram: late prehistoric sequence (Ebbsfleet river crossing – ARC ERC01)

small numbers of *Polypodium vulgare* (polypody fern) and *Sphagnum* moss, especially in the lower part of the sequence.

The Early Neolithic vegetation and environment

The pollen assemblages throughout this soil profile suggest that woodland was dominant at this site, although with the possibility of some areas of grassland growing in clearings. In common with many pollen datasets from this period in southern England, lime (*Tilia cordata*) appears to have been the most important tree (Moore 1977; Greig 1982; Scaife 1980; 1987; 2000a; 2000b). Pollen representation of this taxon is, in general, regarded as being poor when compared with other (anemophilous) trees and shrubs (Andersen 1970; 1973). However, on- and near-site growth and the robustness of the lime pollen grains can result in over-representation in some poor pollen preserving environments. This appears, in part, to be the case here with substantial numbers of degraded grains in these sediments. Its importance is, however, still attested. Beech, holly and field maple (*Acer*) are similarly poorly represented in pollen spectra unless there is growth on, or very near site. These taxa are also present in this profile and may also have been growing in the vicinity.

Other trees and shrubs were also present (oak, elm and hazel), further indicating a predominantly wooded environment. Presence of alder implies some local wetland (also the few fen/marsh taxa) or growth along the banks or floodplain of the local river. The presence of a range of herbs including ribwort plantain, buttercups (*Ranunculus* type) and a small number of other herbs suggests that some areas of grassland (pasture) were present. It is possible that these largely pastoral taxa derive from localised clearances in the woodland or from more extensive deforested areas at some distance from the site. Unfortunately, it is not possible to define the pollen catchment more clearly. A single, possible cereal pollen grain was recorded in the upper sample of this profile at 0.3 m (546) and may indicate some arable activity. It is possible that subsequent clearance of the nearby interfluve woodland was responsible for the overlying colluvium that has sealed this peat context.

The channel and later peats (contexts 493 and 494) (Tr 4), monoliths 160–1 and 160–2

Monolith 160 lay to the west of 161 and, as noted above, the relationship between the base of this and 161 was unclear in the trench. Pollen analysis (Figs 17–18) and radiocarbon dating demonstrate that the peat in monolith 160 is not comparable with the peat examined in monolith 161 but post-dates it. In monolith 160, a lower peat (also designated (wrongly) as 546) has been dated to the late Bronze Age/early Iron Age at 830–770 cal BC (NZA-28795, 2625±30 BP) and the base of the upper peat to the mid-Saxon period at cal AD 650–730 (73.0%) and cal AD 740–770 (22.4%) (NZA-28866, 1318±25 BP).

Pollen was absent in the basal sample at 1.31–1.32 m. Four local pollen assemblage zones have been recognised in the *c* 1.2 m of sediments that span contexts 494 and 493. Throughout this profile herbs are dominant with only relatively small numbers of trees and shrubs, the latter occurring mostly in zones 2 and 3. The characteristics of these local pollen assemblage zones are characterised from the base of the profile upwards, as follows:

Zone 1: 1.24 m to 1.1 m (lower part of 494): This lower zone is characterised by greater numbers of spores of *Pteridium aquilinum* (bracken, declining from 22%), *Plantago lanceolata* (ribwort plantain, declining from 16%), and *Sinapis* type 2 (mustards, peak to 14%). Poaceae (grasses) are dominant (63% total pollen) remaining consistently important throughout the profile. Trees and shrubs include small numbers of *Quercus* (oak) and sporadic *Betula* (birch), *Tilia*, (lime), *Corylus avellana* type (hazel, 2–3%) and *Salix* (willow). Although taxa of grassland affinity are most important there are a small number of cereal types.

Zone 2: 1.1 m to 0.94 m (upper 494, lower 493): The change to zone 2 occurs with the transition to mineral/alluvial sediments. Palynologically this is delimited by an expansion of trees and shrubs and a reduction in some herb types (*Plantago lanceolata* and *Sinapis* type 2). *Corylus avellana* type (18%) and *Quercus* (to 8%) are most important with occasional occurrences of *Acer* (field maple) and *Fagus sylvatica* (beech) also occurring in this zone. Herbs remain dominant with Poaceae (to 70%). There are reductions in *Sinapis* type (2) whilst *Sinapis* type expands. The former is thought to be an autochthonous Brassicaceae. Cereal pollen remains consistent at low levels (to 3%).

Zone 3: 0.94 m to 0.72 m (493): A return to peat accumulation is reflected by a sharp expansion of members of the Apiaceae family (type 3). This is suspected as an on-site component (*cf Oenanthe*, water-dropwort). Arboreal and shrub values remain small with *Quercus* the principal element (to 8%). After an initial decline from zone 2, *Corylus avellana* type expands again to previous values (*c* 16–18%). Herbs remain dominated by Poaceae (*c* 65%). Cereal type and *Plantago lanceolata* remain constant but with small values. The former has a minor peak at the base of the zone.

Zone 4: 0.72 m to 0.42 m. (493): There is a reduction in *Corylus avellana* type (to 5%). Herbs remain dominant with Poaceae abundant (to 65%). Cereal type (10%) and *Sinapis* type (max. values of 26%) become more important. Apiaceae (type 3) peaks to highest values at 0.65 m. *Cannabis sativa* type (hop or hemp) is present sporadically. There are small numbers of marsh taxa that include Cyperaceae and *Typha latifolia* (bulrush).

The late prehistoric to Saxon vegetation and environment

The low numbers of arboreal pollen and particularly the absence of elm and lime support the much later date indicated by the radiocarbon dating for this profile. It is most probable that the region was cleared of woodland during the (late) Neolithic and/or Bronze Age periods resulting in an open herbaceous habitat. As noted above, such clearance may also have been responsible for the colluvial sediments (545) that overlie the lowest peat (546) of monolith 161.

There is evidence of an initial phase of pasture in zone 1 (base of 494) as indicated by grass pollen, ribwort plantain and Asteraceae types (esp. Lactucoideae; dandelion types). During this period there were also areas of bracken. Grassland did, however, remain during the subsequent expansion of the hazel scrub. The reductions in ribwort plantain and bracken values suggest that hazel scrub may have colonised these open areas. Throughout this period, there is also some evidence for cereal cultivation, although this appears not to have been of any great local significance at this time, at least in proximity to the sample site.

The pollen data show that a largely open environment existed with the small amounts of tree and shrub pollen probably coming from regional sources or from occasional local growth. This would be the case especially for beech, ash (*Fraxinus excelsior*) and holly, which are markedly under represented in pollen spectra. Only in zones 2 (493) and 3 (494) of this profile is there any indication of woodland or scrub regeneration. Hazel pollen values increase suggesting that hazel scrub regeneration (or even encouragement, see Barnett, Charcoal reports, Chap 4) may have occurred on the especially suitable calcareous soils of the interfluves. However, it should also be noted that the changes to alluvium from peat indicate that there may also have been changes in the taphonomy of the pollen. Consequently, it is possible that the pollen catchment may have been enlarged by fluvial transport. If hazel occurred locally, this phase of regeneration occurred after a period in which grassland, probably pasture, was important in zone 1 (base of 494).

In the uppermost, pollen zone 4 (493), dated to the mid-Saxon period, there is a clear expansion of cereal pollen with associated arable weeds (eg, *Sinapis* type, *Polygonum* spp.), some reduction in the elements of pasture, and also a further reduction in the extent of hazel scrub noted in previous zones. This suggests changes in local land use to arable cultivation. This may also have been responsible for the later valley side colluviation at this site (eg, contexts 485–488). During this arable phase a single record of hemp/hop (*Cannabis* type) was recorded. It is possible that this derives from Saxon hemp cultivation (see Dark 2000); however, pollen morphology does not allow conclusive separation to hop or hemp and the former may be represented.

The depositional habitat throughout most of the period represented by monolith 160 was one of damp fen evidenced by the presence of sedges, greater reed mace and/or bur reed (*Typha angustifolia* type and *Sparganium*), water plantain (*Alisma plantago-aquatica*) and loosestrife (*Lythrum salicaria*). This habitat was also subject to some alluviation and occasional aquatics are noted with water-milfoil (*Myriophyllum*) and duckweed (*Lemna*). These imply that there were some areas of standing water. Within the pollen assemblages, there are also substantial peaks of *Sinapis* pollen (type 2 Brassicaceae) in zone 1 and Apiaceae (type 3) in zones 3 and 4. The former occurs within the lower peat (lower 493) whilst the latter expands in the upper peat (493). It is suspected that this pollen derives from on or near site communities. The Apiaceae noted may derive from one of the water dropworts (*Oenanthe* spp.) whilst Brassicaceae might include watercress (*Rorippa nasturtium-aquaticum*). The latter is especially important given that the Ebbsfleet valley was renowned for its watercress beds prior to the Second World War. Lowering of the groundwater table through chalk extraction destroyed this activity along the Ebsfleet Valley.

Summary and Conclusions
The two separate pollen sequences obtained from this part of the River Ebbsfleet valley margin have provided information on the late prehistoric and historic environments of this area. The earliest sediments of context 494 are of Neolithic date and show a predominantly wooded habitat. This was dominated by lime, oak and hazel on drier areas with alder carr along the fringes of the Ebbsfleet valley. There is also some evidence for open areas, probably localised woodland clearances. These were of a pastoral/grassland nature, although it is possible that arable components are not fully represented in the pollen assemblages. The valley bottom at this time (prehistoric) was fen with alder and an understorey of reed–swamp taxa. A phase of colluviation (545) occurred, probably as a result of woodland clearance and destabilisation of the soils. This effectively sealed the lowest peat accumulation (546).

The later peat and sediment of contexts upper 494 and 493 are of historic (late Iron Age to mid-Saxon) date and have a completely contrasting pollen flora showing a largely open, deforested, environment. A phase of predominantly grassland/pasture is evidenced for the later prehistoric period (pollen zone 1) at the base of monolith 160–2. Occasional cereal pollen is present suggesting localised arable activity. An expansion of hazel scrub occurs (pollen zones 2 (494) and 3 (lower 494)) which may be a taphonomic phenomenon caused by changing sediment regime, but is more probably due to colonisation of areas of grassland and bracken. Grassland (with some evidence for arable activity) remained.

The uppermost pollen zone 4 (493) has clear evidence for an increase of arable activity in the local region during the mid-Saxon period. The only other possible cultigen apart from cereals is a single and inconclusive record of hop or hemp. Contrasting with the alder herb fen environment of the earlier prehistoric period, the Ebbsfleet valley at this point became one of much more open, fen herb character. Grasses, sedges and a range of other taxa are indicated.

Springhead Sanctuary
Monoliths 8025, 8374–5 and 8450: prehistoric contexts
Pollen samples were examined from monolith 8025, the infill of a late Iron Age 'Viewing platform'/terrace (400011) comprising layers of turf; monolith 8374, a middle Bronze Age soil; and monolith 8450, soils under a middle Bronze Age burnt mound. In all of these samples, pollen was extremely poorly preserved or totally absent (in monoliths 8025 and 8450). This is attributed to the oxidised and largely calcareous nature of the soils. Where pollen and spores are present there is a strong differential preservation in favour of the most robust grains. Only the basal levels of the middle Bronze Age soil in monolith 8374 (context 5102) had countable numbers of pollen, albeit heavily degraded, differentially preserved and of little use in any palaeoenvironmental interpretation.

Twelve samples were examined from monolith 8374–5(contexts 5102 and 5103). Sub-fossil pollen and spores were recovered only from 0.16 m and 0.2 m (5102). These consist largely of Lactucoideae pollen and spores of *Pteridium aquilinum* (bracken). At 0.17 m a pollen sum of only 52 grains comprised 90% Lactucoideae (dandelion types, poorly preserved) and 8% Poaceae (grasses). *Pteridium aquilinum* (bracken) was also relatively abundant (37% of the pollen sum + spores). These are indicators of extremely poor pollen preserving conditions and differential preservation of the most robust of pollen and spores. With such poor preserving conditions and extreme differential preservation, no useful palaeoenvironmental data were obtainable from these contexts.

Monolith 8500: prehistoric spring deposits
A series of twelve samples was prepared from monolith 8500 (contexts 5876, 5875, 5873, 5871, 5631 and 5638). Pollen and spores were, however, absent in countable numbers in this series. Microscope slides were scanned in total and only very occasional Asteraceae types were noted. These were of Asteraceae, Lactucoideae (Liguliflorae) which have a robust exine and are usually the last vestiges of pollen in poor pollen preserving conditions. The sampled deposits were largely mineral sediments, although it was noted that the uppermost sample at 0.02–0.03 m (5638) contained a residue of highly humified organic detritus. This may have been a stabilisation horizon.

Monolith 14252: Roman waterfront (contexts 17439, 17442, 17445)
Pollen analysis was carried out on four samples from the edge of the Roman waterfront on the west side of the River Ebbsfleet. These comprise material from a basal alluvium, which was overlain by layers rich in occupation debris, and a humic silt loam. The data are presented in pollen diagram Figure 19.

It is immediately clear from examination of the pollen diagram of this sequence, spanning 1.16 m to 0.92 m, that there is a significant difference between the upper two samples at 0.92 m and 1 m (contexts 17439 and 17442), and the lower samples at 1.08 and 1.16 m (context 17445). Two local pollen assemblage zones have been recognised. The uppermost, zone 2, from 1.04 m to 0.92 m contexts (17439 and 17442) is dominated by very substantial numbers of Lactucoideae (dandelion types: to 92% of total pollen) with smaller and declining numbers of Poaceae (grasses). There is also a much less diverse range of taxa than in the lower zone 1. The only other taxon of note in this upper part of the sequence is *Pteridium aquilinum* (bracken; to 16%). Poor pollen preservation and small absolute pollen frequencies negated obtaining full pollen counts for these contexts. This is clearly linked to a stratigraphic change from the

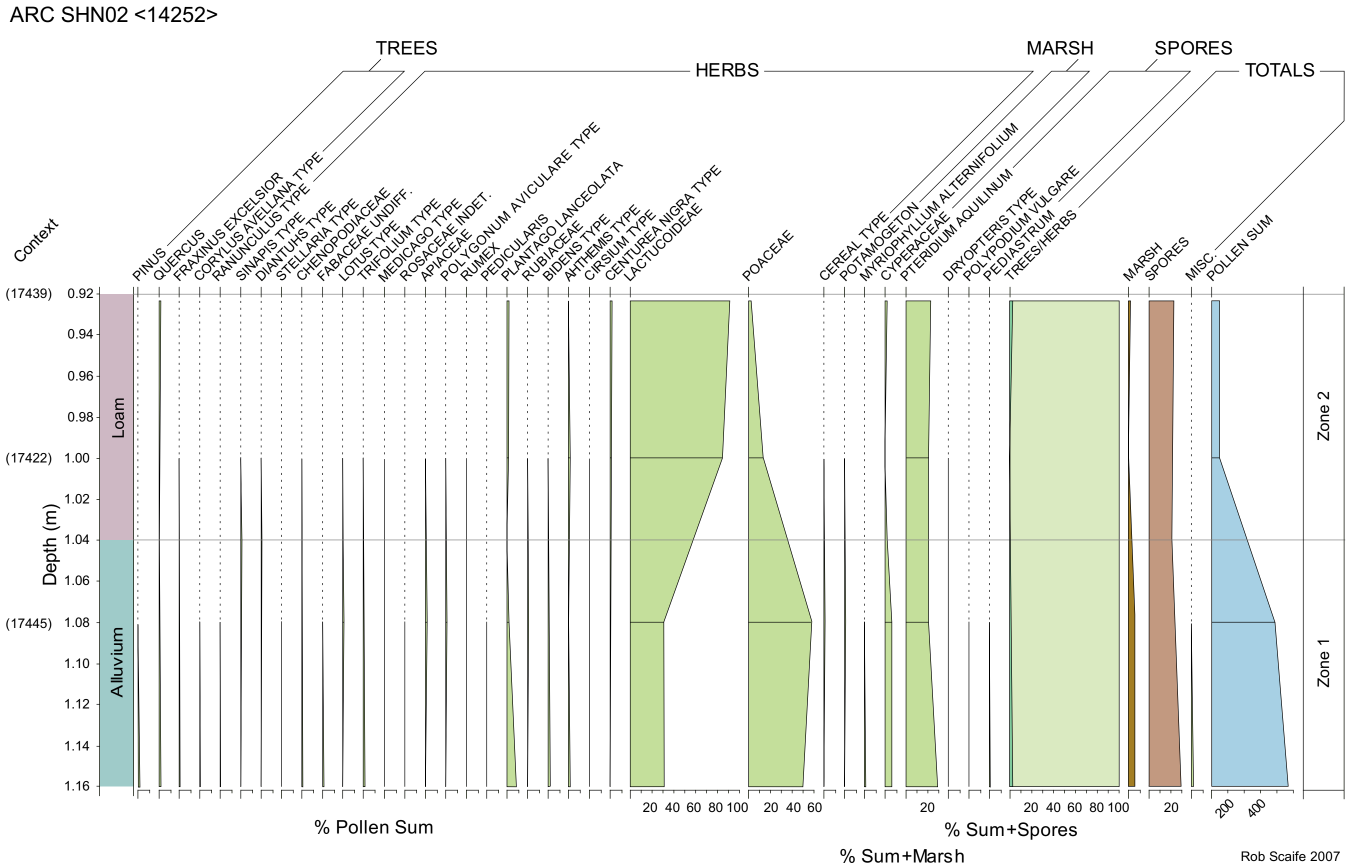


Figure 19 Pollen diagram: Roman waterfront sequence (Springhead Roadside Settlement – ARC SHN02)

lower alluvium to a loam. Alkalinity, probably associated with fluctuating groundwater and oxidation (gleying?), are responsible for the very marked differential preservation of the most robust pollen and spore types at the expense of thinner walled grains. The dominance of Lactucoideae is especially diagnostic of this (Dimbleby 1988). Thus, little useful palaeoenvironmental information can be gained from these upper levels.

In contrast to the above, pollen assemblage zone 1 (1.16 m to 1.04 m, context 17445) contains relatively well preserved pollen in sufficient quantity and diversity to obtain counts of up to 500 grains per level. Thus, the pollen spectra provide useful information on the local environment at the time of deposition.

The two samples of zone 1 (1.16 m to 1.04 m, context 17445) are herb dominated with little tree and shrub pollen. The latter comprises occasional occurrences of *Pinus*, *Quercus*, *Fraxinus excelsior* and *Corylus avellana* type. Herbs are dominant with Poaceae (*c* 55%) and Lactucoideae (*c* 30%) being most abundant. Other taxa include *Plantago lanceolata* (7% at base of zone), *Ranunculus* type, Chenopodiaceae, *Trifolium* type, *Medicago* type, *Rumex* and Asteraceae types, that is, taxa mostly of grassland/pastoral affinity. There is, however, a small and negligible trace of cereal pollen. Aquatic and marsh taxa are present including Cyperaceae (5–6%), *Myriophyllum*, *Potamogeton* type and algal *Pediastrum*. Spores are dominated by *Pteridium aquilinum* (30%).

The vegetation and environment of the Roman waterfront

As noted above, the upper levels of this sequence display the effects of extreme differential preservation in favour of those taxa with robust exines (Lactucoideae and *Pteridium*) whilst thinner walled types have been destroyed due to oxidation. Thus, little useful information can be gained from these samples. However, the lower levels with better pollen preserving conditions provide a clearer indication of the on-, and near-site habitats. Overall, the pollen data suggest an open, grassland (probably pasture) environment during creation/use of the waterfront, as indicated by the dominance of grass pollen with small numbers of other associated taxa (ribwort plantain, buttercups, medicks, clovers etc). There is a notable paucity of trees and shrubs with only occasional pollen of pine, oak, ash and hazel, which may have been transported from some distance. Poaceae values decline upwards through differential destruction of these thin-walled grains whilst robust Lactucoideae type, other Asteraceae types and ribwort plantain increase or remain constant. These are predominantly taxa of grassland/pasture and despite the extremely poor pollen preservation noted, the pollen in zone 2 reflects a continuation of this pastoral habitat.

There is some evidence of fen marsh and aquatic habitats with pondweed (or possibly marsh arrowgrass), water-milfoil (*Myriophyllum alternifolium*), sedges (Cyperaceae) and algal *Pediastrum*. Numbers of these pollen taxa are small and it is not possible to conclude whether this wetland was on-site or nearby, or to establish its spatial extent.

Summary and Conclusions

Pollen data from this site indicate an open, herbaceous, treeless environment, at least in proximity to the waterfront. This habitat was predominantly grassland/pasture, although there are also traces of cereal pollen and associated taxa. There is also some evidence for fen marsh on or near the site. Only the basal levels of this profile provide useful information, where oxidation has been less. The upper levels contrast with the lower, with strongly skewed preservation in favour of robust pollen grains (Lactucoideae), although these possibly indicate a continuation of the grassland habitat.

Northfleet

Pollen analysis was undertaken on the fills of the preserved 1st century well. The sediments, comprising basal, predominantly gleyed silts, accumulated from the time of its construction until the 3rd century AD. Pollen was generally well preserved and abundant. Overall, the pollen assemblages have few trees and shrubs and a marked dominance of herbs, both in diversity and numbers of grains. Being a well, the taphonomy of the sub-fossil pollen and spores is complex and may not be fully representative of the vegetation and environment.

The pollen data and zonation

Pollen procedures are given in the site archive and pollen diagram (Fig 20). Sub-fossil pollen was relatively abundant and well preserved which allowed counts of 500 grains per level to be made. The pollen spectra are largely homogeneous over the 0.7 m (8 samples) of sediment examined. However, the profile can be divided into two pollen assemblage zones. A lower (zone 1: 0.76 to 0.46 m) has significantly greater numbers of cereal pollen and associated weeds of arable ground. The upper (zone 2: 0.46 to 4 m) is delimited by greater numbers of Lactucoideae (dandelion types). The overall vegetative characteristics of the sequence are described as follows.

Tree and shrubs

There is a marked paucity of tree and shrub pollen (to a maximum 1–2%). Where these do occur they are sporadic, largely individual records throughout the sequence. Trees include *Betula* (birch), *Quercus* (oak), *Fraxinus excelsior* (ash) and *Alnus glutinosa* (alder) whilst shrubs consist of *Corylus avellana* type (hazel).

Herbs

Poaceae are dominant throughout (to 60–65%). As noted, two local pollen assemblage zones have been defined. Zone 1 is characterised by Cereal type (to 26%) with greater numbers of Chenopodiaceae, *Polygonum aviculare* type, *Anthemis* type and *Plantago lanceolata*. Zone 2 shows a change to Lactucoideae (dandelion types: to 29%). In addition to these dominants, there is a diverse range of taxa that are attributed to a range of habitats including pasture, arable and marsh/ aquatic types.

Marsh/Aquatic types

These comprise occasional presence of *Callitriche* (water starwort), *Lemna* (duckweed), *Potamogeton* type (pondweed), *Typha angustifolia* type (bur reed and reed mace) and Cyperaceae (sedges). These occur predominantly in zone 2.

Spores of ferns and miscellaneous taxa: there are only small numbers of spores with the exception of an isolated peak of *Pteridium aquilinum* at 0.26 m (to 20%). Other taxa include small numbers of monolete forms (*Dryopteris* type), *Polypodium* (polypody fern) and *Sphagnum* (bog moss). Also present are the cysts of the intestinal parasites *Trichuris* (whipworm) and *Ascaris* (round/maw) worm.

The vegetation and environment

There are complex taphonomic problems associated with the study of such features and as a consequence there have been relatively few pollen studies of the sediment fills of wells. However, in some circumstances useful palaeo-habitat information can be obtained, especially when forming part of an interdisciplinary study carried out in conjunction with examination of insect remains and plant macrofossils. It is generally accepted that the pollen catchment of small features such as wells is probably limited to the very local area around the feature and to secondary, derived pollen coming from refuse/debris dumped into the well. Pollen in the latter may mask pollen from the near local and regional sources. A consequence of this is the paucity of trees and shrub pollen in most well assemblages. This, therefore, does not, however, necessarily preclude the existence of areas of woodland in the region. The pollen spectrum obtained from this well is typical in that it contains a diverse range of weeds which are typical of waste and disturbed ground commensurate with areas of occupational disturbance and from secondary sources.

In zone 1, there are substantial numbers of cereal pollen (wheat and barley type) that, along with 'wild' grasses, are the dominant pollen taxa. The cereal pollen is most probably from secondary sources dumped into the well. Such sources might include waste farinaceous food products, debris from crop production or faecal material. With regard to the 'wild' grasses, pollen readily passes through human and animals and the latter source is most likely. This is also evidenced by the presence of the intestinal round worm (*Ascaris*) and whipworm (*Trichuris*). Cereal pollen in well contexts is also known from other sites (Barber 1967; Greig 1981). Part of the diverse herb flora may also derive from this source as well as from disturbed and waste ground habitats in proximity to the well site. These for example, may include *Polygonum aviculare* (knotweed), *Fallopia*

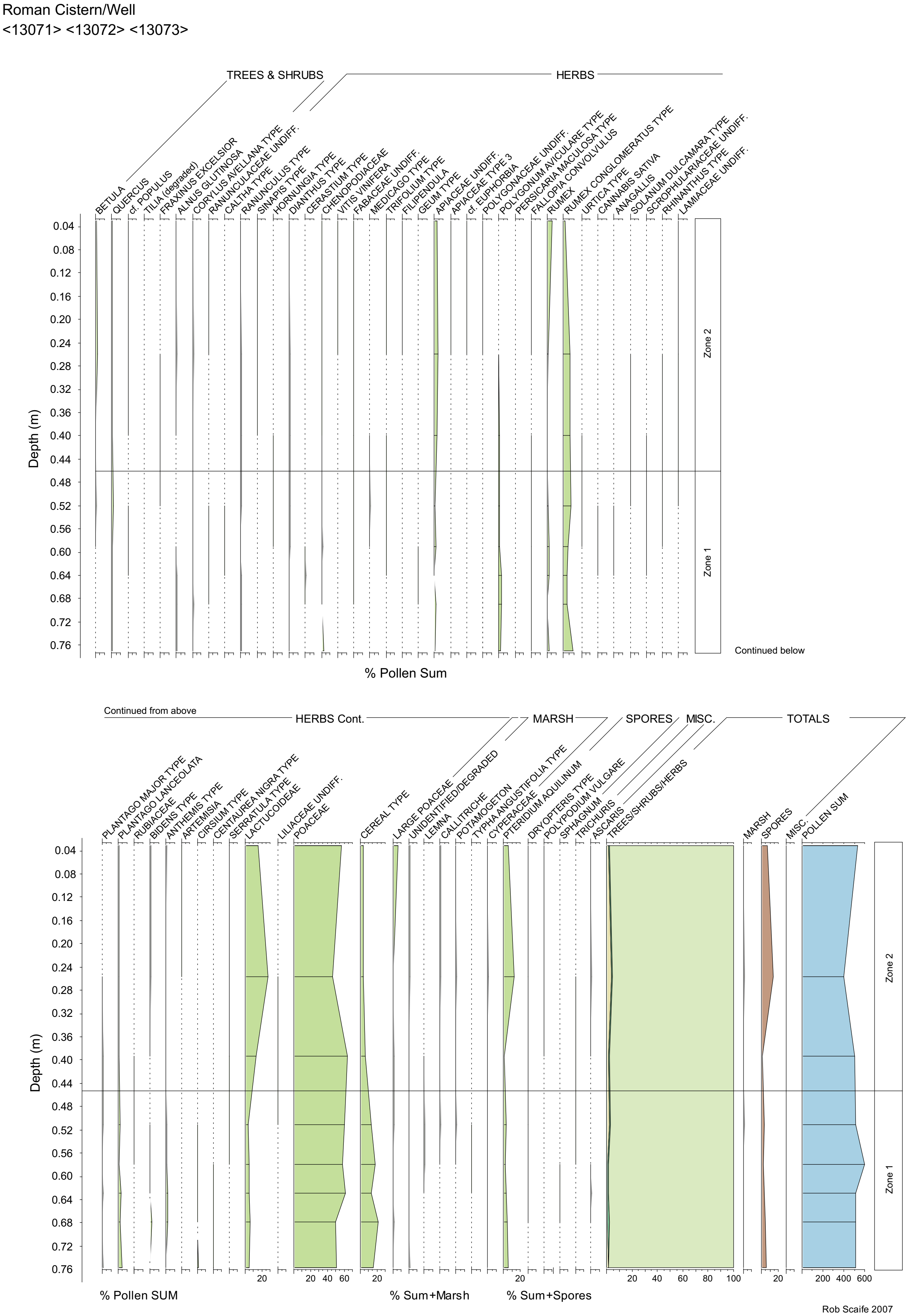


Figure 20 Pollen diagram: Northfleet

convolvulus (black-bindweed), (goosefoots and oraches), possibly Asteraceae types (daisy family) and Chenopodiaceae. The latter may also be associated with more nitrogenous soils.

In addition to the arable component there is also a strong representation of plants of grassland (probably pasture). These taxa tend to produce larger numbers of pollen that are more widely disseminated. Thus, it is not possible to state clearly whether the sources of this pollen are natural transport and deposition, dumped waste material such as floor sweepings, or a by-product of the arable weed component.

As noted, the preponderance of local and introduced pollen has a 'swamping' effect on the relative pollen numbers from more regional sources. This certainly applies to the tree and shrub component which occur only sporadically in this profile. Only at Thurnham Roman Villa (Scaife 2006) were substantial numbers found coming from ash trees overhanging the abandoned well. The more continuous tree and shrub pollen records at Springhead are from anemophilous types, which include birch, oak, alder and hazel (see above). These are, however, in small numbers and probably come from regional sources. Sporadic/ individual records of ash (*Fraxinus excelsior*) and lime/linden (*Tilia*) are from poorer pollen producers and more likely to derive from the local site.

Apart from the substantial cereal/arable component noted, two other cultigens are of interest, although pollen numbers are small. *Cannabis sativa* type is present at 0.6 m. This taxon may, however, come from hop (*Humulus lupulus*) or hemp (*Cannabis sativa*). Unfortunately, their almost identical pollen morphology does not allow determination in most pollen preserving conditions. It has not been possible to differentiate between them here although it is probable that hemp is the source because wild hop is ecologically more suited to floodplain carr woodland which is not in evidence here.

A single pollen grain of grape (*Vitis vinifera*) is one of an increasing number of records. Whether this comes from local viticulture or from secondary sources such as wine or dried fruit is unclear. That latter is, perhaps, more likely.

Summary and Conclusions

Pollen extracted from the sediment fills of wells has a complex taphonomy with inputs from both natural and secondary sources. This appears to be the case in this cistern/well feature. Substantial representation of cereal pollen and associated weeds is suggested as coming from human or animal faecal material since there are also intestinal parasites present. In addition to this component is a diverse range of other herbs that are dominated by grasses with other grassland/pasture plants. This element probably comes from secondary, dumped domestic material as well as from the local region. A minimal number of trees and shrubs are present and although percentage values will have been swamped by the secondary and local component, background woodland of oak and hazel is evidenced. Occasional grains of ash and lime may be from growth local to the villa. *Cannabis sativa* type has been recorded and may come from hop or hemp, although for ecological reasons the latter is suggested (grown for fibre). Pollen of grape (*Vitis vinifera*) is an interesting record and may come from local viticulture or more probably from wine or dried fruit in the faecal component.

Diatoms from Springhead

by Nigel Cameron

A total of 14 samples were prepared from three sites: Ebbsfleet river crossing, Sanctuary site and Roadside Settlement. These samples were evaluated and, where possible, analysed for diatoms. The aim of rapid diatom assessment was to determine if diatoms were present and the potential for percentage analysis of the diatom assemblages. Where diatom analysis was possible, the purpose was to reconstruct past water quality characteristics such as variation in salinity and nutrient concentrations that were relevant to the archaeological investigation.

Methods

Diatom preparation followed standard techniques: the oxidation of organic sediment, removal of carbonate and clay, concentration of diatom valves and washing with distilled water (Battarbee 1986). Two coverslips, each of a different concentration of the cleaned solution, were prepared from each sample and fixed in a mounting medium of a suitable refractive index for diatom microscopy (Naphrax). Slides were scanned at magnifications of x400 and x1000 under phase contrast illumination.

Diatom floras and taxonomic publications were consulted to assist with diatom identification; these include Hartley *et al* (1996) and Krammer and Lange-Bertalot (1986–1991). Diatom species' salinity preferences are discussed using the classification data in Denys (1992) and the halobian groups of Hustedt (1953; 1957, 199).These salinity groups are summarised as follows:

1. Oligohalobian – Halophilous: optimum in slightly brackish water
2. Oligohalobian – Indifferent: optimum in freshwater but tolerant of slightly brackish water
3. Halophobous: exclusively freshwater
4. Unknown: taxa of unknown salinity preference

Diatom data were plotted using the 'C2' program (Juggins 2003).

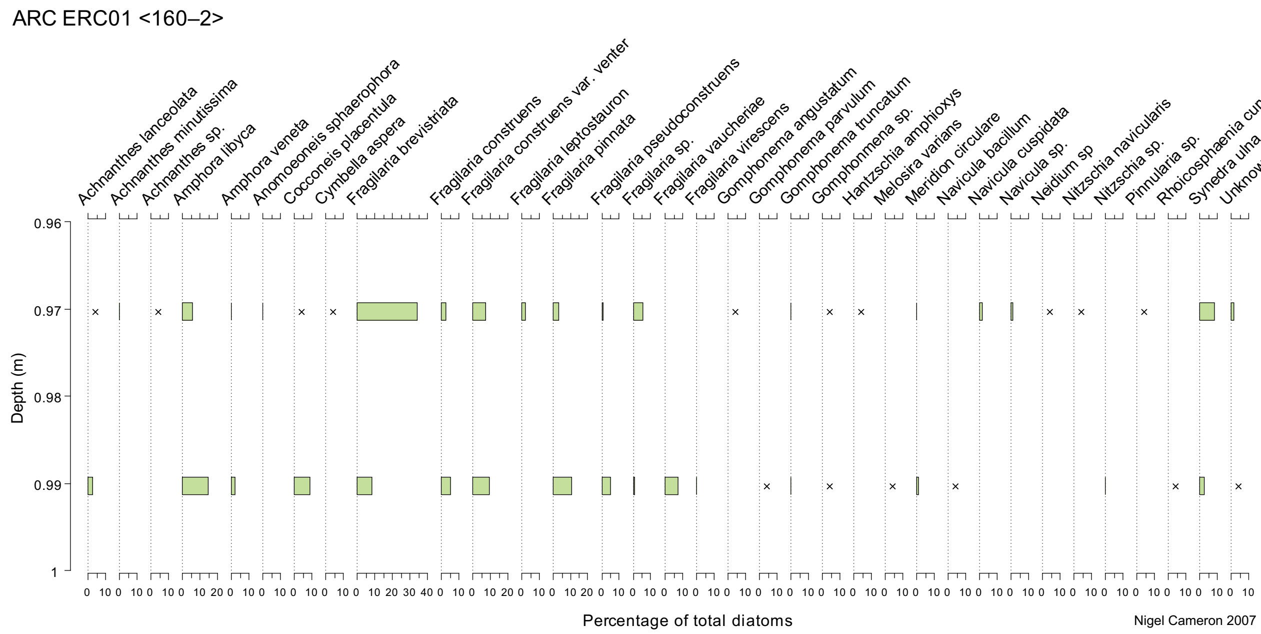


Figure 21 Diatom data from Ebbsfleet River Crossing (ARC ERC01)

Results and Discussion

The results of the diatom assessment are summarised in *Table 67* and a percentage diatom diagram is shown in Figure 21.

Diatoms are absent from 12 of the 14 samples assessed, with none from the spring area at Springhead Roman Town or the waterfront on the Roadside Settlement. Only in two samples from Ebbsfleet River Crossing, monolith 160–2, at depths of 0.99 m and 0.97 m, are diatoms present. These were from the humic alluvium (context 493) underlying the mid-Saxon upper peat in the Ebbsfleet channel edge sequence (exposed in Tr 4, sections 1012–1013). In these two samples the concentration of diatom valves, the quality of preservation (degree of diatom valve breakage and silica dissolution) and the diversity of taxa is relatively poor. However, it was possible to make percentage diatom counts from these two samples. The absence of diatoms from 12 samples is probably the result of valve breakage and silica dissolution affecting the diatom assemblage (Flower 1993; Ryves *et al* 2001).

The diatom composition of the two diatomaceous samples is similar. The dominant components of these diatom assemblages are freshwater, non-planktonic, shallow water diatoms. These diatoms grow attached to submerged surfaces including aquatic macrophytes (epiphyton) and in benthic, mud-surface habitats (epipelon). The dominance of these diatom habitat groups and the absence of plankton reflect a shallow water environment in which the diatoms remain in the photic zone whilst living on the bottom. In particular there are a range of *Fragilaria* species (eg, *F. brevistriata*, *F. construens*, *F. construens* var. *venter*, *F. leptostauron*, *F. pinnata*, *F. pseudoconstruens*) that are considered to be pioneer species with the ability to tolerate drying out of sediments for short periods and with relatively wide tolerance ranges for different water quality (eg, pH, salinity, nutrients). However, aerophilous diatoms and chrysophyte stomatocysts associated with soils, and the erosion of soil from catchments, such as *Hantzschia amphioxys* and aerophilous *Pinnularia* spp. are uncommon here. With the exception of a single fragment of the estuarine, benthic diatom *Nitzschia navicularis*, polyhalobous (marine) and mesohalobous (brackish) diatoms are not present in these samples.

Common epiphytic diatoms at 0.99 m and 0.97 m include *Cocconeis placentula*, *Gomphonema angustatum*, *Gomphonema parvulum*, and *G. truncatum*. Species such as *Navicula bacillum*, *Navicula cuspidata* and *Anomoeoneis sphaerophora* grow in the benthic, mud-surface, habitat.

None of the diatom assemblages reflect nutrient enrichment (eutrophication) that is associated with the input of large amounts of organic waste from intensive human settlement and livestock grazing within the catchment. The qualitative evaluation here of the diatom assemblages shows that nutrient levels were only moderately high. Halophilous diatoms such as *Rhoicosphaenia curvata* and *Melosira varians* are rare in the two diatomaceous samples. *Meridion circulare*, present at both 0.99 m and 0.97 m in monolith 160–2, is an attached, freshwater diatom associated with flowing water.

Molluscs

Springhead

by Sarah F Wyles and Catherine Barnett

Mollusc assemblages were analysed from four sections and two spot samples from Ebbsfleet River Crossing and Sanctuary site in order to assist in ascertaining a landscape history of the site.

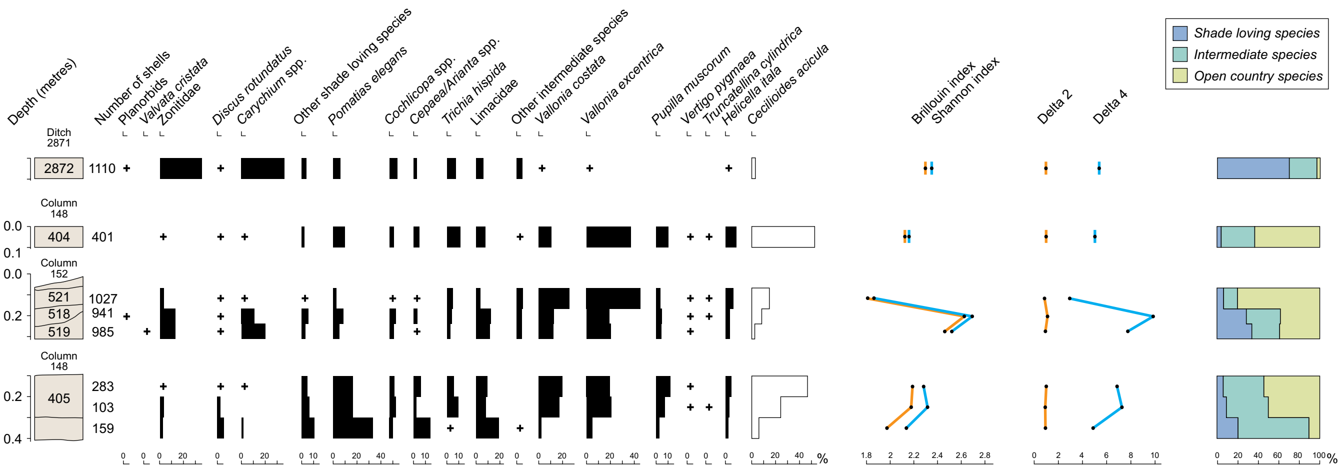


Figure 22 Mollusc data from Ebbsfleet River Crossing (ARC ERC01; columns 148 and 152)

Methods

Standard analytical methods were employed, namely the identification of apical and diagnostic mollusc fragments using a x10–x40 stereo-binocular microscope and following the nomenclature of Kerney (1999). The results were tabulated and histograms produced. The following species diversity indices were calculated: Shannon, Brillouin, Delta 2 and Delta 4. Numbers of *Cecilioides acicula*, a burrowing (and therefore potentially intrusive) species, were tabulated and the frequency calculated independently as a percentage of the other molluscs in the histograms.

Results

River edge sequence, mollusc columns 148 and 152, (Tr 1), sections 7417 and 7431, and ditch 300248

Seven samples from the north end of the site through a ?middle Bronze Age buried soil (405), a Roman ditch (520 / 300248) and post-Roman colluvium (404), as well as a single sample from the primary fill of the same Roman ditch about 100 m to the north, were analysed and the results combined to produce a chronological sequence. The results are recorded in *Table 68* and Figure 22. The changes in the snail assemblages were such that five zones could be differentiated.

Zone 1: 'natural', ?pre-middle Bronze Age

The sample taken from the 'natural', a clay silt colluvium with chalk inclusions, produced an assemblage dominated by intermediate species, in particular *Pomatias elegans*, *Cepaea/Arianta* and Limacidae. The shady element of the assemblage is represented by *Clausilia bidentata*, *Cochlodina laminata* and *Discus rotundatus* as well as a few Zonatids. *Pomatias elegans* is fond of broken ground and is therefore sometimes used as an indicator of interference with the soil such as the onset of clearance (Evans 1972). The presence of Clausiliidae and *Discus rotundatus* is indicative of the presence of woodland or scrub nearby. The clearance is likely to have been secondary rather than primary, given that no taxa indicative of full undisturbed cover were present.

Zone: 2 context 405, ?middle Bronze Age buried soil

This zone is characterised by an increase in open country species and a decline in shady loving species. The sample is dominated by *Vallonia costata* and *Vallonia excentrica* with continuing significant numbers of *Pomatias elegans*, although these have decreased from zone 1. *Pupilla muscorum* also increased during the zone and there is an occurrence of the rarely found *Truncatellina cylindrica*, an obligatory xerophile (lover of extremely dry conditions) that favours short dry calcareous grassland. *Pupilla muscorum* also thrives in short turfed grassland, especially in earth bare of vegetation, as do the Valloniidae, with *V. excentrica* also being common in arable land.

Zone 3: contexts 519 and 518, Roman ditch 517/300248

The samples from the colluvial ditch fill and subsequent inwash of colluvial material form a zone characterised by a significant increase in shade-loving species from zone 2, although this decreases within the zone. The shady element of the assemblages is predominately formed by the Zonatids *Aegopinella pura* and *Aegopinella nitidula* and *Carychium*. The main intermediate species are *Pomatias elegans* and Limacidae and open-country species the Valloniidae, with *V. excentrica* predominating over *V. costata*. There is also a very small fresh water element to the assemblages with the presence of *Valvata cristata* and *Gyraulus albus*. The shady element of the assemblage is likely to be indicative of long unkempt grassland.

Zone 4: contexts 521 and 404, Roman and post-Roman colluvium

This zone is characterised by the dominance of open-country species, although these decrease a little within the zone. The majority of the open country shells are Valloniidae, with *V. excentrica* being predominant. The intermediate species increase within the zone, in particular *Pomatias elegans*, *Trichia hispida* and Limacidae. Although *Vallonia excentrica* is predominant over *Vallonia costata*, the presence of *Pupilla muscorum*, *Helicella itala*, *Vertigo pygmaea* and *Truncatellina cylindrica* suggests very open, probably short turfed, grazed downland or areas of trampling, rather than arable agriculture in the immediate vicinity.

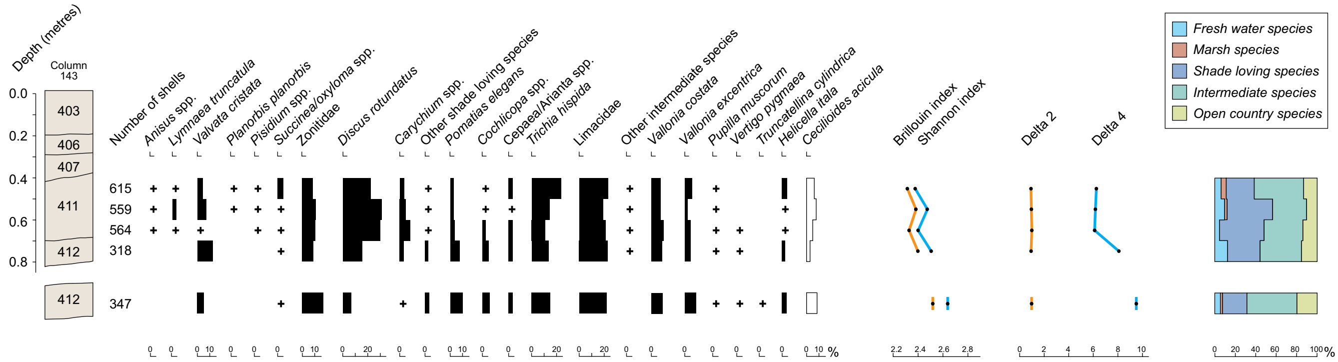


Figure 23 Mollusc data from Ebbsfleet River Crossing (ARC ERC01; column 143)

Zone 5: context 2872, Roman ditch 2871/300248

This zone is characterised by very high levels of shade-loving species, dominated by Zonitidae and *Carychium*. The intermediate species together represent 26% of the assemblage and there are only very low numbers of open-country species. As the snail assemblage was recovered from the primary fill of the ditch, it indicates that the ditch is likely to have lain within an area of mainly long unkempt grassland rather than that the shady environment only existed within the ditch itself.

Roman and post-Roman river channel fills, mollusc column 143, section 1008

Five samples were analysed from these channel fills which comprised silt and sandy silt alluvium that overlay the consolidated Roman riverbed (ARC ERC01). The results are recorded in *Table 68* and Figure 23. The assemblages allow the definition of two zones.

Zone 1: contexts 412 and part of 411 (0.6–0.7 m)

The zone is characterised by an increase of shade-loving species (from 25 to 44%) and of fresh-water species and a decrease in both intermediate and open country species. The shade-loving element is mainly formed by numbers of *Discus rotundatus* and *Carychium* (dominated by *C. tridentatum*), which increase, and Zonitidae, which decline. The significant intermediate species recorded are *Trichia hispida*, Limacidae and *Pomatias elegans*. Both *Vallonia costata* and *V. excentrica* decline and *Vertigo pygmaea* and *Truncatellina cylindrica* are also present. The freshwater species are dominated by *Valvata cristata*, which is restricted to well-oxygenated, slowly flowing or still water, with a strong preference for richly vegetated places on muddy substrates. The assemblages appear to reflect an environment of open areas with the shade-loving species exploiting areas of open woodland or scrub with long grass along the edge of the river.

Zone 2: context 411 (0.4–0.6 m)

This zone is characterised by a decrease in shade-loving species, particularly *Discus rotundatus* and *Carychium*, and a rise in intermediate species, especially *Trichia hispida* and Limacidae. *Vallonia costata*, *V. excentrica* and *Helicella itala* all increase slightly. The freshwater species decrease, while the marsh type *Succinea*/*Oxyloma* increase. This zone is indicative of an open area with less open woodland or scrub but increased long grass edging the river. There seems to be a larger marshy environment by the river channel, as indicated by the increase in *Succinea*/*Oxyloma* and *Lymnaea truncatula*. It is of note that the sediments above this layer show a change to peat accumulation under encroaching marshy conditions.

Pre-middle Bronze Age to Roman spring-side sequence (ARC SPH00), mollusc columns 8397, 8398 and 8420, sections 7486, 7487 and 7630

A series of 22 samples from these three mollusc columns from the spring-side sequence and a single sample from beneath the middle Bronze Age barrow was analysed. It should be noted that the majority of samples predate the late Iron Age. The results are recorded in *Table 69* and Figure 24. Changes in the assemblages allow the definition of seven zones.

Zone 1: context 5877, pre-middle Bronze Age/ pre-barrow layer

The assemblage produced by the sample from the layer of calcareous sandy silt colluvium (5877) beneath the barrow had significant open country and shade-loving components. The assemblage is dominated by *Vallonia costata* with some *Pupilla muscorum* which is indicative of open grass land, while the significant shade-loving species *Discus rotundatus*, *Carychium tridentatum* and Zonitidae favour areas of woodland or scrub.

Zone 2: stasis over chalk, ?pre-middle Bronze Age

The snail numbers from the three samples from this context are too low to assist in any interpretation of the environment. This is probably due to preservation problems in this layer. This context is a weakly developed stasis horizon over soliflucted or periglacially moved chalk.

Zone 3: context 5102, ?pre-middle Bronze Age

This zone represents the B horizon of a thin ?middle Bronze Age soil and is characterised by an increase in shade-loving species mirrored by a decrease in open country species. The dominant shade-loving species are Zonitidae, *Discus rotundatus* and *Carychium tridentatum*, while the predominant open country species are *Vallonia costata*, *Vallonia excentrica* and *Pupilla muscorum*. *Truncatellina cylindrica* also occurred. The zone appears to represent an area of short-turfed grassland which became more overgrown with areas of long grassland and scrub.

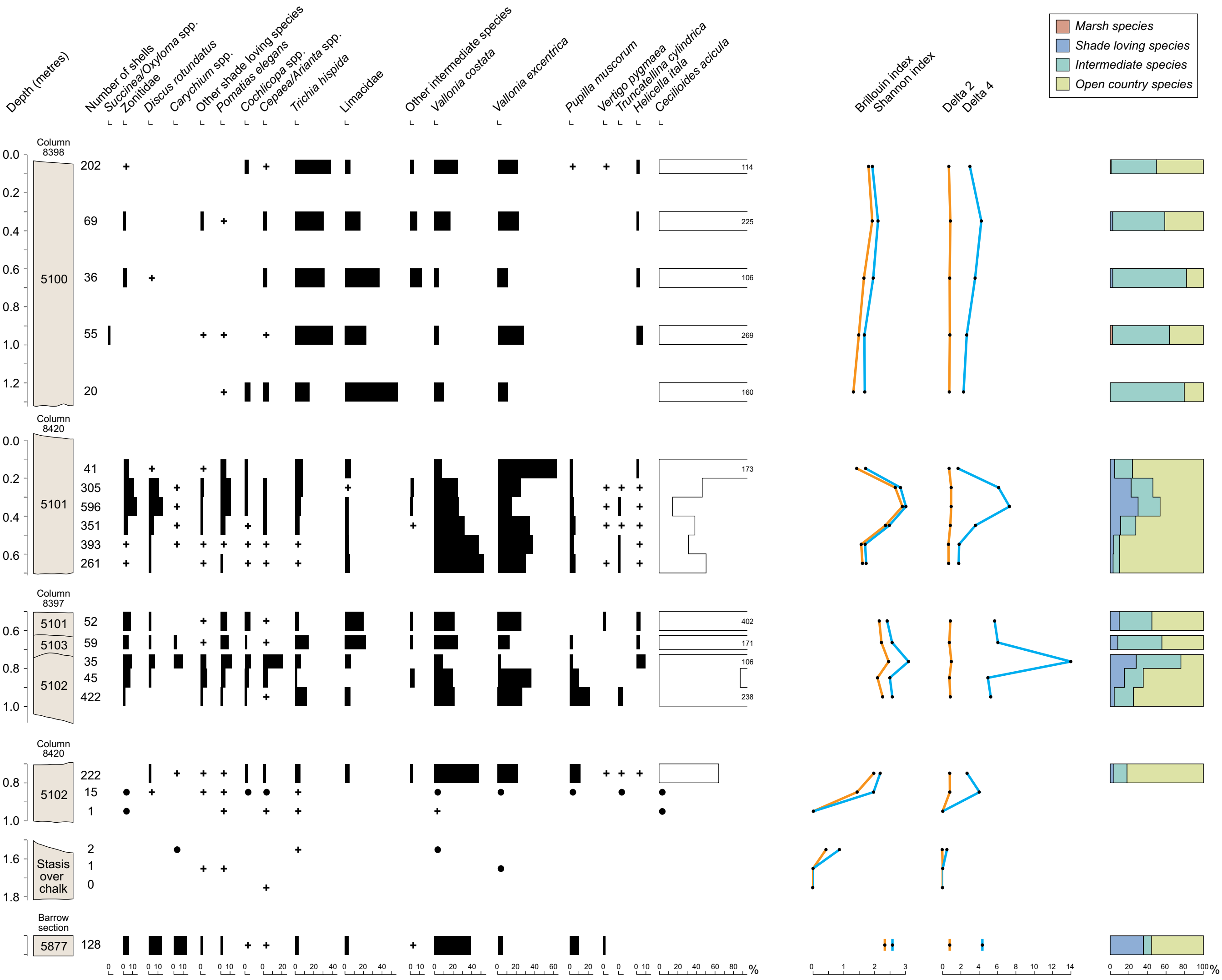


Figure 24 Mollusc data from spring section (ARC SPH00; columns 8397, 8398 and 8420)

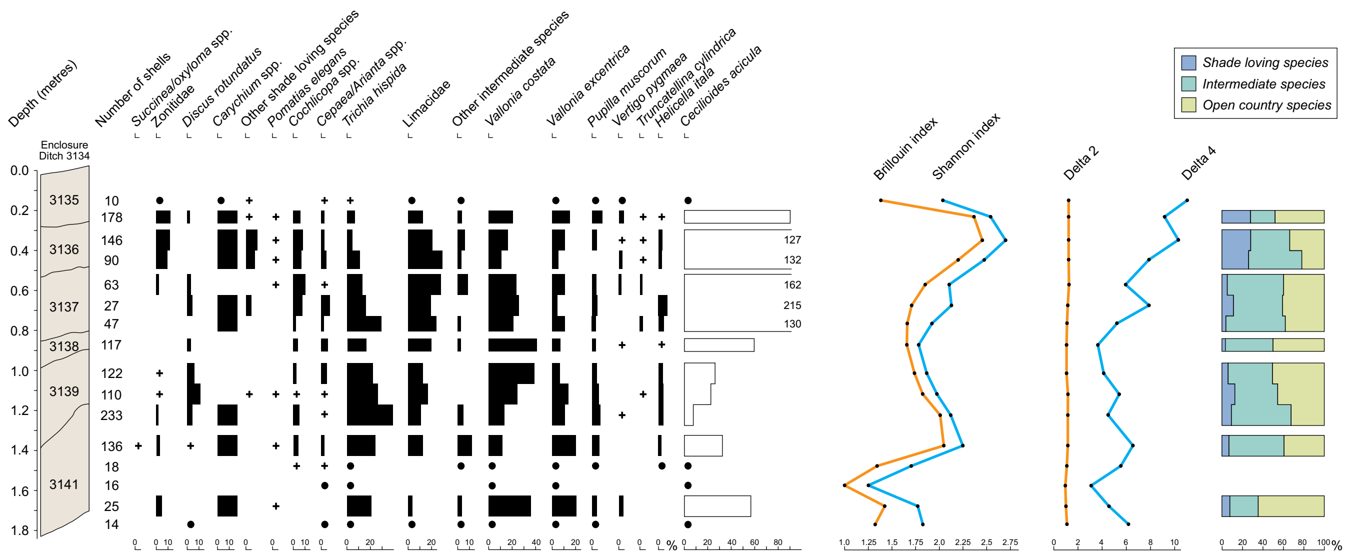


Figure 25 Mollusc data from enclosing ditch 400017 (300046, segment 3134), Sanctuary site (ARC SPH00; column 8065)

Zone 4: context 5103, ?middle Bronze Age; and 5101, 0.5–0.6 m column 8397, late Bronze Age/early Iron Age
This zone covers 5103, the A horizon of the thin ?middle Bronze Age soil formed in colluvium which included a spread of material from a burnt mound, and 5101 where it overlies 5103 in column 8397, a slowly accumulated layer of colluvium. It is characterised by a drop in numbers of shade-loving species and an increase in the open country species. The significant species are *Trichia hispida*, Limacidae, *Vallonia costata* and *Vallonia excentrica*. This is indicative of open areas of grassland with less shade than zone 3.

Zone 5: context 5101, 0.4–0.7 m column 8420, late Bronze Age/early Iron Age
This zone is characterised by a predominance of the open country species, although these decline from 90% to 73% within the zone. The zone covers a colluvial deposit and there may be a hiatus at the base. Snail numbers are indicative of a slow rate of sedimentation. *Vallonia costata*, although it decreases, is the dominant species, while *Vallonia excentrica* is constant. *Truncatellina cylindrica* also occurred. This zone is indicative of open areas of short grazed grassland with a small amount of long grass or scrub.

Zone 6: context 5101, 0.1–0.4 m column 8420, late Bronze Age/early Iron Age
There is a drop in open country species to 46%, mirrored by an increase in both shade-loving and intermediate species from the previous zone. This may be indicative of a stasis within the colluvium, and the open country species increase and the shade-loving species decline within the zone. Again, snail numbers are indicative of a slow rate of sedimentation. The open country species are dominated by the Vallonias; *Vallonia excentrica* increases while *Vallonia costata* decreases. *Truncatellina cylindrica* is present. *Discus rotundatus* and Zonitidae are the significant shade-loving species, while the intermediate species are mainly represented by *Pomatias elegans* and *Trichia hispida*. This may reflect an area of open grassland with patches of scrub and long grassland, which decrease through the zone.

Zone 7: context 5100, column 8398, Roman
This zone through colluvium is characterised by a dominance of intermediate species and a virtual absence of shade-loving species. Snail numbers are much lower than in the previous two zones. The intermediate species are mainly represented by *Trichia hispida* and Limacidae, and the open-country species by *Vallonia costata* and *V. excentrica*, with excentrica generally being predominant. A single specimen of the marsh species *Oxyloma* cf. *pfeifferi* was retrieved. This zone shows indications of open areas in the vicinity, probably under some arable cultivation, with the return to short turfed grassland at the top of the zone. Any cultivation taking place would have been a little distance away, as the steepness of slope has resulted in movement of material over some distance.

Sanctuary enclosing ditch 3134/300046 (ARC SPH00), mollusc column 8065
Sixteen samples were analysed from Sanctuary enclosing ditch segment 3134. The results are recorded in *Table 70* and Figure 25. Although the sequence shows the environment was generally open, there was an increase in levels of shade towards the top, and the snail assemblages could be divided into four zones:

Zone 1: context 3141, early/middle Roman
This zone is characterised by the predominance of mainly open country species, although these decline through the zone. This pattern is reflected in the numbers of *Vallonia costata*. There are also significant quantities of *Vallonia excentrica* and *Trichia hispida*, which increase. Limacidae and other intermediate species also increase. The small shade element is represented by *Carychium* and Zonatidae. There is also a single occurrence of *Succinea/Oxyloma*. This is indicative of an open environment, probably short grassland, with some areas of longer grass.

Zone 2: contexts 3139 and 3138, middle Roman
This zone is characterised by a gradual increase in open country species and a slight decrease in the shade-loving species. The decrease in *Trichia hispida*, *Vallonia excentrica* and *Pupilla muscorum* is mirrored by an increase in *Vallonia costata* and Limacidae. There is a steady presence of *Helicella itala* and an occurrence of *Truncatellina cylindrica*. The shady element of the assemblages is mainly represented by *Discus rotundatus*. There is a slight variation in the assemblage at 1.1–1.2 m (sample 8076), namely an increase in *Discus rotundatus*, Limacidae and *Vallonia excentrica*. The disappearance of *Carychium* is a useful indicator of the onset of cultivation or heavy grazing. This zone appears to indicate an environment of increasingly short-turfed grazed grassland with some possible scrub.

Zone 3: context 3137, middle Roman
This zone is characterised by a slight decrease in open country species and a dominance of Limacidae and *Vallonia costata*. The increase in *Cochlicopa*, *Cepaea/Arianta* and Limacidae is matched by a decrease in *Trichia hispida*. Although there is a decrease in *Vallonia costata* from Zone 2, it is still predominant over *Vallonia excentrica*. *Truncatellina cylindrica* is also present. The small variation in assemblage composition at 0.62–0.72 m (sample 8072) is a result of decreasing numbers of Limacidae and *Vallonia excentrica* and increasing numbers of *Vallonia costata*. This may be indicative of an open environment of short grassland with some areas of longer grass and possible scrub.

Zone 4: contexts 3136 and 3135, middle Roman
This zone is characterised by a marked increase in the shady element of the assemblages. This increase in shady species is reflected in an increase in numbers of Zonatidae, *Carychium tridentatum* and other shade-loving species. There is a decrease in Limacidae and *Trichia hispida*. Although there is a decrease in open country species from Zone 3, numbers of *Vallonia costata*, *Vallonia excentrica*, *Pupilla muscorum* and *Vertigo pygmaea* increase through Zone 4. This may be indicative of an open environment of short-turfed grassland with shade being provided by long grass within the ditch.

Discussion

The probable changes in the local environment and likely landscape use as reflected by the mollusc assemblages are as follows:

Ebbsfleet River Crossing (north end), River edge sequence, sections 7417 and 7431, and ditch 300248

Zone	*Date*	*Context*	*Feature*	*Description*
1	?pre-MBA	'natural'	colluvium	evidence of clearance & limited woodland or scrub in area
2	?MBA	405	buried soil	open environment of short-turfed grassland with areas of bare earth
3	RB	519+518	ditch 520	open environment of short-turfed grassland with areas of long unkempt grass, poss along edge of ditch
4	RB + post-RB	521+404	colluvium	v open environment of short-turfed grazed grassland or areas of trampling & poss human activity
5	RB	2872	ditch 2871	ditch cut into an area of long, unkempt grassland

Ebbsfleet River Crossing Roman river channel fills, section 1008

Zone	*Date*	*Context*	*Feature*	*Description*
1	RB/ post-RB	412 +411 (0.6–0.7 m)	river Channel	open areas with open woodland or scrub, long grass along edge of river
2	RB/ post-RB	411 (0.4–0.6 m)	river Channel	open areas with less open woodland or scrub & increased amount long grass along river edge, with greater marshy area than in zone 1

Pre-Middle Bronze Age–Roman springside sequence (ARC SPH00), sections 7486, 7487 and 7630

Zone	*Date*	*Context*	*Feature*	*Description*
1	Pre-MBA	5877	pre-barrow layer	open, short-turfed grassland with areas of open woodland or scrub
2	Pre-MBA		stasis over chalk	snail numbers too low for interpretation
3	Pre-MBA	5102	spring section	open, short grassland becoming more overgrown with areas of long grass and scrub
4	?MBA +LBA/EIA	5103+5101 (0.5–0.6 m col 8397)	spring section	open grassland areas with less shade
5	LBA/EIA	5101 (0.4–0.7 m col 8420)	spring section	open areas of short, grazed grassland with a small amount of long grass or scrub
6	LBA/EIA	5101 (0.1–0.4 m col 8420)	spring section	open grass land with areas of scrub and long grassland, which decrease through the zone
7	RB	5100 (col 8398)	spring section	open areas in the vicinity, probably under arable cultivation with the return to short-turfed grassland at the top of the zone

Sanctuary Enclosing Ditch 3134/300046

Zone	*Date*	*Context*	*Description*
1	E/MRB	3141	open, short grassland with some areas of longer grass
2	MRB	3139+3138	open, short-grazed grassland with some poss scrub
3	MRB	3137	open, short grassland with some areas of longer grass & poss scrub
4	MRB	3136+3135	open, short-turfed grassland with long, unkempt grass within ditch & in areas nearby poss reflecting disuse

The environmental and landscape histories reflected in these assemblages fall into the broad zones e and f described at Wateringbury (Kerney *et al* 1980) and Holywell Coombe (Preece and Bridgland 1998; 1999), both in Kent. There, zone e is characterised by open-ground fauna, decline of shade-demanding species and re-expansion of *Vallonia*. Zone f is characterised by open-ground fauna, as zone e but with the appearance of *Helix aspersa* indicating a Roman date. Mollusc assemblages from colluvial valley sediments have been studied elsewhere, for example at Kiln Combe and Itford Bottom (Bell 1983) in Sussex, in an attempt to provide evidence of land-use patterns. At both these sites there were generally higher numbers of *Vallonia excentrica* recovered in relation to numbers of *Vallonia costata* than at Springhead. In the studies of the South Down valleys the fauna from the colluvium is of open country ecological preferences, chiefly *Vallonia costata*, *Vallonia excentrica*, *Trichia hispida* and Limacidae, and is restricted both in terms of the numbers of individuals and the range of species present, being most indicative of an arable environment (Bell 1982). The assemblages recovered from Springhead, although mainly dominated by open country species, are generally not so restricted in either species diversity or numbers. The only possible indication of arable cultivation is seen in zone 7 of the spring-side section at ARC SPH00 (Sanctuary site). The mollusc assemblages analysed from hillwash at Cwm Nash (Evans *et al* 1978) in Wales were not characterised by vast numbers of open country species, and it is suggested that the formation of the hillwash was brought about by animals browsing in a scrub or open-forest environment on the steep valley sides, rather than by tillage. This could also have been the case at Springhead.

The snail assemblages for much of the chronological sequence indicate a generally open environment across the site, mainly of short grassland, with local variations in the levels of open woodland, scrub and long grass. There is possible evidence for limited secondary clearance and woodland at the north end of the site, on the Ebbsfleet River Crossing, before the middle Bronze Age. In the pre-middle Bronze Age further to the south, around the springs, the area appears to have been open, short grassland with some open woodland or scrub and long grass; by the middle Bronze Age this seems to be an area of open grassland. During the late Bronze Age/early Iron Age period the snails indicate open, short grazed grassland with some areas of scrub and long grass. There is a variety of environments and land-uses indicated by the assemblages during the Roman period. There are areas of short-turfed grassland, long unkempt grassland, some open woodland and scrub, particularly along the edge of the river, together with areas of marsh, and also some areas under cultivation.

Northfleet

by Elizabeth Stafford

Thirty-eight samples were assessed for the preservation of Mollusca across the villa. The samples derived from a series of well-dated ditches and gullies associated with various phases of occupation dating from the early to late Roman period (Villa Phases 1–4 and 6). Twenty-three samples, from ditches 15756, 15751, 16803 and 15755, were taken specifically for Mollusca as incremental columns at 10 cm intervals, with each increment weighing between 0.86 kg and 1.49 kg of sediment. The remaining samples were from much larger volumes of sediment (10–40 litres), initially floated for the retrieval of charred plant remains. In addition to the villa site, a number of samples from features of Roman date were examined from the Sportsground area but were found to be entirely barren and are not discussed further.

Samples retrieved specifically for Mollusca were weighed and floated onto a 0.5 mm mesh and air-dried. The flots were scanned under a binocular microscope at x10 and x20 magnifications and abundance of identifiable shell fragments were noted. Nomenclature follows Kerney (1999) and habitat information follows Evans (1972) and Kerney (1999; Kerney and Cameron 1979). *Table 71* is a summary of the features examined from the villa area along with the general level of preservation encountered. Due to the poor preservation recorded during the assessment the samples from Northfleet were not analysed in detail. Only nine samples from three ditch sections at the villa site contained identifiable shells (*Table 72*). Only one sample from feature 15755 produced useful quantities of shells with a minimum of 122 individuals, although this sample was retrieved from the upper levels of the ditch and therefore relates to the final stages of infilling. The remaining eight samples averaged less than five individuals.

On this basis the assemblages provide only very limited environmental information for the Roman period. The assemblages were generally of low diversity with the fauna restricted to a few species. Open country species were notably absent, apart from *Vallonia costata* in ditch 15751. The species represented generally consist of either intermediate (*Trichia* sp., *Cochlicopa* sp.) or shade-loving species (*Discus rotundatus*), which suggests a local environment, within or adjacent to the features, comprising some shade, perhaps scrub and disturbed ground with patches of long grass as may be expected in the immediate vicinity of the villa complex. A single apice of *Acicula fusca*, which is considered to be a species indicative of some form of scrub or woodland, was present in ditch 15474. Apart from a single shell of *Planorbis planorbis* from ditch 14755, the absence of freshwater species within these features indicates relatively dry conditions during infilling. This perhaps argues against a drainage function, although this cannot be certain given the poor preservation of shell.

Waterlogged Plant Remains

by Chris J Stevens

Unlike charred plant remains, which often relate to the agricultural economy and the use of woodland resources for fuel (see below), waterlogged plant remains more commonly provide information on the immediate environment surrounding the feature or context in which they are found. As such, the greatest potential is in revealing the nature of the vegetation that grew within the general area of the site during the Roman period.

It was hoped the waterlogged samples could address some of the major project aims including elucidating the development of the Northfleet villa in relation to the wider landscape, as well as the relationship of the villa to the river resources and the riverine environment. Additionally it was hoped that such information could shed light on the changing nature of the local environment, including the extent of saltmarsh, local water levels and sea-level changes.

Of the 11 samples chosen for analysis from Northfleet villa, one came from a Roman well and four from a cistern. The remainder of the samples come from Saxon deposits taken from sequences in the vicinity of the Saxon mill (see Vol 4).

Only three samples were found to be waterlogged from the Roadside Settlement (ARC SHN02) at Springhead, all from the Ebbsfleet channel edge alluvium/colluvium, in property 3, with just one from the spring area at the Sanctuary site (ARC SPH00).

Methods

All of the waterlogged samples were of 1 litre of sediment taken from the larger bulk samples. The samples were processed by laboratory flotation. The resultant flot was decanted onto a 250µm mesh sieve and the residues fractionated to 0.5 mm. Prior to analysis, the flots were sieved in order to facilitate sorting and identification of the plant remains. This was carried out using a stack of granulometric sieves; 2 mm, 1 mm, 0.5 mm and 0.25 mm. Recovery and identification was by the use of a low power stereo-binocular microscope with magnifications between x6.4–x40. Identification of more unusual taxa was made with reference to the Seed Atlas (Cappers *et al* 2006) and modern reference material at the Institute of Archaeology, University College, London. The results of the analyses of Roman material are divided into two tables; those from features at Springhead (Table 73) and those from the cistern and well at Northfleet (Table 74). Nomenclature follows that of Stace (1997). Ecological information comes from Stace (1997), Clapham *et al* (1987), Rodwell (1991a; 1991b; 1992; 1995; 2000) and Horwood (1919).

In most cases individual seeds were counted, however, where seeds or items were particularly numerous the following relative abundance system was used:

+	present 1(–10)
++	10–50
+++	50–100
++++	100+

Results

Springhead

The Springhead sites produced few contexts with preservation of plant remains by waterlogging, a result of de-watering of the nearby chalk quarries, beginning in the 1930s, which lowered the water table and caused the springs to dry up. The waterlogged material from the four contexts that could be analysed was poorly preserved and, in comparison with the large amount of charred remains, was poorly represented (Table 73). The richest sample from the Roadside Settlement came from the Ebbsfleet channel edge alluvium/colluvium (context 17864) in property 3. This contained seeds of around 30 different species. Most of the seeds were of scrub/hedgerow species, elder (*Sambucus nigra*) and bramble (*Rubus* sp.). Other species can also be attributed to waysides, hedges and scrub, such as fool's parsley (*Aethusa cynapium*), curled-leaved dock (*Rumex crispus*), campion (*Silene* sp.), common nettle (*Urtica dioica*) and hemlock (*Conium maculatum*), the latter often found on damp ground near water.

A number of species are characteristic of disturbed soils, perhaps associated with trampling or even arable activities, including poppy, (*Papaver* sp.), fumitory (*Fumaria* sp.) and pimpernel (*Anagallis* sp.). Associated in general with human habitation, disturbed nitrogen-rich soils, manure heaps and middens were seeds of many-seeded goosefoot (*Chenopodium polyspermum*), mouse-ear chickweed (*Cerastium* sp.) and henbane (*Hyoscyamus niger*). A few species in this sample may be more directly related to anthropogenic activity, including the seeds of elder, which may relate to deliberate collection for food, a pip of apple (*Malus sylvestris/ domestica*), a seed of flax (*Linum usitatissimum*) and a possible seed of fig (*Ficus carica*).

As might be expected, several of the seeds were of wetland species, including marsh marigold (*Caltha palustris*), hairy-buttercup (*Ranunculus sardous*), water-crowfoot (*Ranunculus* subgroup. Batrachium), spikerush (*Eleocharis palustris*), common/grey club-rush (*Schoenoplectus lacustris/tabernaemontani*), starwort (*Callitriche* sp.), sedge (*Carex* sp.), blinks (*Montia fontana* subsp. *chondrosperma*) and sweet grass (*Glyceria* sp.). Grassland species were also represented, such as cat's tails (*Phleum* sp.), cinquefoil (*Potentilla* sp.) and buttercup (*Ranunculus acris/repens/bulbosus*).

Interestingly, this sample contained some cone bracts of birch (*Betula* sp.), but this was the only tree species represented in the sample. It might be noted this species was also recovered from Saxon samples at Northfleet (see Stevens, Vol 4).

Table 73 Waterlogged plant remains from Roman Springhead

			ARC SHN02	*ARC SHN02*	*ARC SHN02*	*ARC SPH00*
		Feature type	*Slot*	*Pit*	*Layer*	*Spring/pond*
		Feature	–	*19217*	*19386*	–
		Context	*17864*	*19216*	*19384*	*5082*
		Sample	*14280*	*14305*	*14315*	*8327*
Species	*Common name*					
Caltha palustris	marsh marigold		+	–	–	–
Ranunculus subg. Ranunculus arb	buttercup		+	–	–	–
Ranunculus sardous	hairy buttercup		1	–	–	–
Ranunculus subg. Batrachium	water-crowfoot		1	–	–	–
Papaver sp.	poppy		+	+	–	+
Fumaria sp.	fumitory		1	+	–	–
Ficus carica	fig		cf.1	–	–	–
Urtica dioica	common nettle		+	+	–	++
Betula sp. (bracts)	birch		+	–	–	–
Chenopodium polyspermum	many seeded goosefoot		+	–	–	–
Chenopodium album	fat-hen		–	–	–	+
Atriplex sp.	orache		–	++	–	–
Montia fontana subsp. *chondrosperma*	blinks		+	–	–	–
Cerastium sp.	mouse-ear chickweed		+	–	–	–
Silene vulgaris	bladder campion		1	+	–	–
Rumex sp.	dock		+	+	–	–
Brassica oleracea/nigra	wild cabbage/black mustard		–	cf.+	–	–
Reseda sp.	weld/mignonette		–	+	–	–
Anagallis sp.	pimpernel		+	–	–	–
Malus sylvestris/domestica	apple		1	–	–	–
Rubus sp.	bramble		++	+	–	++
Potentilla sp.	cinquefoil		+	–	–	–
Linum usitatissimum	flax		cf.1	–	–	–
Aethusa cynapium	fool's parsley		1	–	–	–
Conium maculatum	hemlock		1	+	–	–
Apium cf. *graveolens*	wild celery		+	–	–	–
Hyoscyamus niger	henbane		+	–	–	+++
Lamium sp.	dead-nettle		–	–	–	++
Odontites vernus	red bartsia		–	+	–	–
Sambucus nigra	elder		++	+	+++	++
Eleocharis palustris	spikerush		+	+	–	–
Schoenoplectus lacustris/tabernaemontani	common/grey club-rush		+	–	+	–
Carex sp.	sedge		1	–	–	–
Phleum sp.	catstail		+	cf.+	–	–
Glyceria sp.	sweet grass		+	–	–	–
Indet. *Euphorbia stricta/Torilis nodosa?*	indet.		–	–	1	–

The sample from a pit (19217), 10 m or so from the water's edge, was also quite rich containing many of the species indicative of rough grassland, marshland, wooded scrub and hedgerows described above. Represented in this sample also were seeds of orache (*Atriplex* sp.), weld or mignonette (*Reseda* sp.), and possibly black mustard/wild cabbage (*Brassica oleracea/nigra*). It might be noted that both orache and mignonette have species that are more common in estuaries and salt-marshes, while black mustard or wild cabbage are also commoner in coastal environments. The only other species seen in this sample, but absent from the others, was red-bartsia (*Odontites vernus*) which can be found in waste-ground, arable fields and rough grassland.

Humic layer 19386, also at the edge of the Ebbsfleet, contained many seeds of elder and a single seed of bulrush, possibly reflecting that the material was generally poorly preserved, given that elder seeds appear to survive prolonged periods of drying better than seeds of many other species.

The single sample from the Sanctuary site (context 5082) was from a spring infill deposit. Again, as might be expected given the environment, the sample was dominated by seeds of nitrogen-rich disturbed soils including common nettle (*Urtica dioica*), henbane (*Hyoscyamus niger*) and fat-hen (*Chenopodium album*), and those of disturbed waste ground in general such as deadnettle (*Lamium* sp.) and poppy (*Papaver* sp.). Seeds of both elder (*Sambucus nigra*) and bramble (*Rubus* sp.) relating to patches of overgrown scrub or hedgerows were also common.

Northfleet Villa Cistern 16696 and Well 16516

Most of the samples examined from the cistern and the well were rich in charred plant material, predominately the glumes, grains and spikelets of spelt wheat (see W Smith, below). They were also generally rich in waterlogged plant remains (Table 74) and similar in species composition, being dominated by seeds of common nettle (*Urtica dioica*), while other species associated with wasteland and human occupation were

Table 74 Waterlogged plant remains from Northfleet Roman villa

	Phase		*Roman*			
	Feature type	*Well*		*Cistern*		
	Group/Section	*16516*	*16696*	*16696*	*16696*	*16696*
	Feature	*16090*	*16170*	*16170*	*16170*	*16170*
	Context	*16387*	*16524*	*16545*	*16596*	*16597*
	Sample	*13033*	*13049*	*13076*	*13088*	*13092*
	Size (l)	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
	Waterlogged flot	*70*	*80*	*130*	*40*	*80*
Charred	*Common name*					
Triticum spelta (glumes, grain, spikelets)	spelt wheat rachis	+	++	+	+	++
Waterlogged species	*Common name*					
Ranunculus subg. Ranunculus arb	buttercup	4	2	2	2	3
Ranunculus sardous	hairy buttercup	–	–	–	–	5
Ranunculus subg. Batrachium	water-crowfoot	1	–	2	–	2
Papaver sp.	poppy	–	6	–	2	2
Fumaria sp.	fumitory	1	–	–	1	1
Urtica dioica	common nettle	10	200+	200+	200+	200+
Urtica urens	small nettle	1	–	–	1	1
Chenopodium polyspermum	many-seeded goosefoot	1	1	–	1	–
Chenopodium album/vulvaria	fat-hen/stinking goosefoot	4	–	–	3	–
Atriplex sp.	orache	18	2	–	6	8
Atriplex cf. *prostrata/portulacoides* (fruit)	spear-leaved orache	1	–	–	–	–
Atriplex littoralis	grass-leaved goosefoot	1	–	–	–	–
Montia fontana subsp. *chondrosperma*	blinks	–	2	–	–	–
Stellaria media	common chickweed	–	–	–	1	1
Stellaria graminea/palustris	lesser/marsh stitchwort	–	–	–	1	–
Silene vulgaris	bladder campion	4	2	–	1	–
Persicaria minor	small water-pepper	–	–	–	3	3
Polygonum aviculare	knotgrass	1	5	–	7	2
Rumex sp.	dock	9	4	–	23	45
Rumex sp. fruiting tepals/tubercles	dock	–	–	–	–	6c.
Rumex conglomeratus	clustered dock	–	–	1	3	cf.2
Hypericum sp.	St John's wort	–	–	–	–	2
Rubus sp.	bramble	1	–	–	–	2
Potentilla sp.	cinquefoil	1	3	–	–	–
Potentilla cf. *reptans*	creeping cinquefoil	1	–	–	–	1
Prunus cf. *avium*	wild cherry	–	1	–	–	–
Linum usitatissimum (capsule frag.)	flax	–	–	–	–	1
Conium maculatum	hemlock	7	15	257	32	6
Heracleum sphondylium	hogweeds	–	–	1	–	–
Hyoscyamus niger	henbane	–	1	–	4	1
Sambucus nigra	elder	–	1	–	3	–
Arctium lappa/minus	greater/lesser burdocks	–	–	–	2	4
Cirsium/Carduus	thistles	–	1	1	–	–
Sonchus asper	prickly sow-thistle	–	–	–	–	1
Alisma cf. *plantago-aquatica*	water plantain	–	–	–	–	cf.1
Juncus sp.	rush	–	–	–	1c.	2
Juncus gerardii	saltmarsh rush	5	3	–	16	15
Cyperaceae	sedge family	–	–	–	1	–
Scirpus sylvaticus	wood club-rush	–	cf.2	–	–	–
Carex sp. (lenticular)	sedge	–	–	–	–	1
Carex sp. (trigonous)	sedge	1	4	–	4	4
Poaceae (small)	grasses	–	1	–	–	–
Bromus sp.	brome grass	–	–	–	cf.1	–

also common, including hemlock (*Conium maculatum*), poppy (*Papaver* sp.), fumitory (*Fumaria* sp.), small nettle (*Urtica urens*), many-seeded goosefoot (*Chenopodium polyspermum*), orache (*Atriplex* sp.), common chickweed (*Stellaria media*), knotgrass (*Polygonum aviculare*), dock (*Rumex* sp.), henbane (*Hyoscyamus niger*) and prickly sow-thistle (*Sonchus asper*).

Other species such as hairy-buttercup (*Ranunculus sardous*), while common on cultivated ground and grassland, are more frequently found in coastal areas, such as near the mouth of the Ebbsfleet. It might also be noted that a large proportion of the seeds of *Chenopodium* were very small in size, with a cell pattern more closely resembling stinking goosefoot (*Chenopodium vulvaria*) than fat-hen (*Chenopodium album*). The seeds of orache from the well closely resembled those of grass-leaved orache (*Atriplex littoralis*) and sea purslane (*Atriplex portulacoides*) or spear-leaved orache (*Atriplex prostrata*). As with *Ranunculus sardous* all these are commoner in coastal areas. More significantly were frequent finds of saltmarsh rush (*Juncus gerardii*), recovered from both the well and the cistern.

A few species found within waste-ground are also indicative of rough grassland, and in the case of buttercup (*Ranunculus* sp.), clustered dock (*Rumex conglomeratus*) and marsh stitchwort (*Stellaria palustris*), often wet grassland, while others such as bladder campion (*Silene vulgaris*), hogweed (*Heracleum sphondylium*), thistle (*Cirsium/Carduus* sp.) and cinquefoil (*Potentilla* sp.) are indicative of wasteland and rough grassy places in general. It might be noted that hogweed, buttercup, and clustered dock can all encroach into coastal marsh and other communities (Rodwell 2000).

The cistern is likely to have contained standing water for long periods, even when quite silted. Therefore, it is unsurprising to find species associated with water bodies, including water-crowfoot (*Ranunculus* subg. Batrachium) and water-plantain (*Alisma* cf. *plantago-aquatica*) or those to be found at the edges of such bodies, for example rush (*Juncus* sp.), wood club-rush (*Scirpus sylvaticus*), sedges (*Carex* sp.), blinks (*Montia fontana* subsp. *chondrosperma*) and small water-pepper (*Persicaria minor*). A few seeds of burdock (*Arctium lappa/minus*) were recovered from the cistern; this species tends to favour damp, slightly shaded places.

As with the Springhead samples there is some indication of hedges or overgrown shrubland from the presence of elder (*Sambucus nigra*) and bramble (*Rubus* sp.), although comparatively these species would seem to form quite a minor component of the vegetation around the cistern.

While cereal crops are well represented within the charred assemblage, crops and utilised species were generally poorly represented within the waterlogged samples and no waterlogged cereal remains were recovered from archaeological features. Only two of the identified species may have been brought in by humans; a probable stone of glean or wild cherry (*Prunus* cf. *avium*) and a fragment of flax capsule (*Linum usitatissimum*), both from the cistern.

Discussion of the Waterlogged Plant Remains

The samples provide a comprehensive picture of the local environment surrounding the archaeological features during the Roman period at both sites. There is much similarity between the samples from Springhead and Northfleet, although, as might be expected, those from Northfleet provided some limited evidence for the presence of saltmarsh, while those from Springhead yielded only a few species reflecting the close proximity of the coast. The samples from both sites provide little to no evidence for woodland or wooded fen, and on the whole most provide evidence for marshland, rough wet grassland, wasteland and disturbed, nitrogen enriched soils.

Springhead

The assemblage from Roman Springhead provides a picture of grassy disturbed ground, possibly with patches of overgrown shrub or a hedgerow-type assemblage. A reasonable number of species indicate trampled and nitrogen enriched disturbed areas that might be associated with animals and midden waste. Within wetter patches of the site and on its fringes wet grassland overgrown with buttercups probably gave way to more marshy areas, dominated by sedges, reeds and rushes. It is probable that these deeper features, which preserved waterlogged material, had water standing within them for long periods, and that some of these also had marshland plants around their edges.

The finds of apple, flax and fig all probably derive from plants brought to the site and discarded as waste. The absence of cereal chaff, given the high presence of charred cereal remains within some of these samples, would seem most probably due to the poor preservation of chaff. As noted, many of the species represented in these samples had woody or siliceous, and hence highly robust, seeds.

Northfleet

The Northfleet samples contained a broadly similar range of environments to those listed above. The most notable difference, as might be expected, was the evidence at Northfleet for extensive marshland and the presence of brackish water probably both within the channel and around the cisterns and wells. In particular, saltmarsh rush (*Juncus gerardii*) point to the infiltration of saltmarsh vegetation into this marshland. Of the other species present several are also particularly common close to the coast, and/or are associated with brackish water, for example, orache (*Atriplex* sp.) and hairy buttercup (*Ranunculus sardous*). The combination of these species suggests that elements of brackish marshland were present in the wetter areas surrounding the site.

The abundance of these species raises the question of the use of the cisterns and wells and the source of freshwater for the occupants of the site, as it would seem probable that these features contained, at the very least, slightly saline water. The marshland would have extended into areas of species-rich grassland with patches of overgrown scrub and possibly hedgerows, although species associated with the latter were generally poorly represented. Seeds of species associated with bare, trampled or disturbed soils were also common in the samples and, as with Springhead, may be associated with animals, as well as general activity areas and middens.

Insects from Northfleet

by David Smith

Detailed insect analysis was undertaken on nine samples from a range of deposits at Northfleet dated to the Roman period. Two samples (11201, 12207) are from boundary ditches associated with the villa complex. These samples are unusual since they are not waterlogged but instead consist of charred grain. Seven waterlogged samples (13058, 13078, 13079, 13083, 13085, 13087 and 13100) are from a 1st to 2nd century AD well (16516) and a timber lined 'cistern' which has been interpreted as a possible steeping pit for malt production (16731). Samples for analysis were initially selected based on obvious waterlogged preservation and an assessment of the potential for insect analysis undertaken by Chris Stevens. The exception to this is the charred material from the boundary ditches. These were examined after Wendy Smith observed the remains of charred beetles whilst undertaking the analysis of the charred plant remains for the site (see Chap 4).

It was hoped that the study of the insect remains from these features might provide information on the landscape and land-use associated with the Roman villa. In terms of the well and cistern, it was hoped that insect remains could indicate the nature of deposition in this features. With reference to the charred insect remains it was hoped analysis could help characterise the deposition of substantial amounts of charred plant remains into the various ditches associated with the villa.

Methods

The waterlogged samples were processed using the standard method of paraffin flotation as outlined in Kenward *et al* (1980). The weights and volumes of the samples processed are presented in *Table 75*. The insect remains present were sorted from the flots and stored in ethanol. The charred plant remains were sorted by hand and all insect remains removed. Sample 11201 had already been riffled into 16 sub-samples of which five were examined. Sample 12207 had been divided into 64 sub-samples of which nine were examined.

The Coleoptera (beetles) present were identified by direct comparison to the Gorham and Girling Collections of British Coleoptera. The various taxa of insects recovered are presented in *Table 75*. The taxonomy for the Coleoptera (beetles) follows that of Lucht (1987).

Where applicable each species of Coleoptera has been assigned to one, or more, ecological groupings and these are indicated in the second column of *Table 75*. These groupings are derived from the preliminary classifications outlined by Kenward (1978). The classification used here replicates that used in Kenward and Hall (1995). The groupings themselves are described at the end of *Table 75*. Not all taxa have a coding and some taxa occur in more than one ecological group. As a result percentages do not equal 100%.

Results

Villa boundary ditches

Two deposits were examined from the boundary and field ditches associated with the villa. Sample 12207 came from context 19341 and was the fill of the north-east to south-west field ditch 19312, dated from the early to middle Roman period. Sample 11201 came from context 10203 that was the fill of the boundary ditch 10205 of the villa. What is unusual about these deposits is that they contain large quantities of charred plant material. Wendy Smith (see below, Chap 4) has recovered abundant spelt chaff and detached coleoptiles (cereal grain sprouts), which she has interpreted as the 'comings' (eg, rubbed off chaff and sprouts after malting). These deposits have been interpreted as being the remains of malting waste that was used as fuel and subsequently dumped into the ditches (W. Smith below, Chap 4).

The insect remains recovered are predominantly charred rather than waterlogged. In the case of both samples the insects present are predominantly pests of stored grain (see *Table 76* and Fig 26). In sample 11201 this consisted of 46 individuals of the 'saw toothed grain beetle' *Oryzaephilus surinamensis*. This species usually occurs in waste material ('frass') and spoilt grain around granaries and can also be encountered in 'clean grain' (Coombs and Woodroffe 1963; Hunter *et al* 1973; Freeman 1980). In addition a single individual of the 'small eyed grain beetle' *Palorus ratzeburgi* was recovered which is also associated with similar materials. Sample 12207 was slightly more diverse in terms of the insects present, but is again dominated by insect pests of stored grain. In addition to *O. surinamensis* and *P. ratzeburgi*, the 'granary weevil' *Sitophilus granarius* was also recovered. This is a primary pest of stored grain whilst it is still in a good condition and its activities can result in a substantial loss or spoilage of grain (Coombs and Woodroffe 1963; Hunter *et al* 1973; Freeman 1980). All of these species have been encountered as pests in all stages of the malting process ranging from the grain store, the malting floor and the malt store (Hunter *et al* 1973).

The presence of these species clearly suggests that insects, to some extent, infested the grain used in the malting process at Northfleet. However, it is difficult to suggest the level of infestation. The charring of insect remains is archaeologically unusual and comparatively rare and the extent to which the individuals preserved here might be part of a small or large population is not clear. Wendy Smith (see below, Chap 4) has outlined the ways in which infested malt such as this could have been used and the effects that this might have on the palatability of any ale produced.

The finding of charred grain pests is relatively unusual in the archaeological record and is known at four Roman sites in Britain. These include the fort ditch at Malton, North Yorkshire (Buckland 1982), the villa at Droitwich (Osborne 1977), the warehouse at Coney Street, York (Kenward and Williams 1979) and deposits at 5 Rougier Street, York (Hall and Kenward 1990). In the case of all four sites the burning of infested grain seems to have been a deliberate attempt to dispose of the material before the infestation could spread. This is probably not the case at Northfleet where we are dealing with infested malting waste that appears to have then been used as fuel and kindling.

Roman wells

The interpretation of insect faunas from wells, or in this case a cistern, is notoriously problematic (Kenward 1978; Kenward *et al* 1986; T Simpson 2000). This stems from three features of wells; they act as large pitfall traps collecting insects from a wide area; they are often open for a long period of time; and the contexts present often appear to suffer from mixing. This functions to blur attempts at interpretation. Despite this there do commonly seem to a number of ways in which deposits form. Some well faunas appear to result from either long periods of sedimentation or the eventual collapse of the well itself. Classic examples of this can be seen in the Roman wells at Piddington, Northamptonshire (T Simpson 2000), Heybridge, Essex (D Smith 1997a) and at Farmoor, Oxfordshire (Robinson 1979). Equally, there are very clear examples of Roman wells being used as 'dumping grounds' for waste materials and therefore becoming infilled very fast. This can be seen in the well at the Mancetter Roman fort, Warwickshire that contained quantities of stabling matter and waste (D Smith 1997b) and general settlement waste at Droitwich, Worcestershire (Osborne 1977). Equally, the dumping of spoilt grain occurs in several Roman wells, examples being the Skeldergate and Bedern wells in York (Hall *et al* 1980; Hall *et al* 1983; Kenward *et al* 1986) and Invereskgate, East Lothian (D Smith 2001).

The timber-lined cistern 16731 produced the largest series of insect faunas from any feature examined at Northfleet. The cistern is believed to have been open between AD 70 and 150 with final silting and infilling occurring up to the end of the 2nd century. This feature has been interpreted as possibly being a 'steeping' tub where grain for use as malt is soaked (see Vol 1, Chap 3). The lowest fill examined here, sample 13100 context 16597, probably dates from the earlier period and is also one of the richest and most diverse insect faunas recovered from the Northfleet villa. Though of a slightly later date the four faunas in the samples from the overlying context 16586 (samples 13083, 13085, 13087 and 13098) share the same characteristics and so will be discussed together.

Present in the lowest sample from the cistern, context 13100, is a relatively high proportion of species associated with decayed grain and stored products (see ecological group 'g' in *Table 76* and Fig 26). This consists of large numbers of *Oryzaephilus surinamensis* and a single individual of *Palorus ratzeburgi*. These species do occur in the faunas from the other sampled contexts that occurred further up the cistern but were much less common. A noticeable addition in these upper samples is a number of individuals of *Sitophilus granarius*.

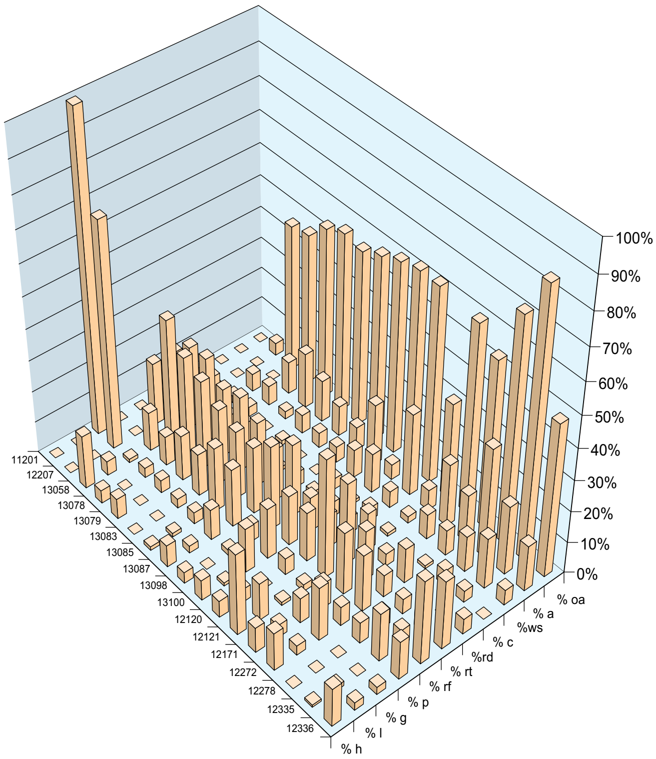


Figure 26 The proportions of the ecological grouping of Coleoptera from Northfleet

Also present throughout the depth of the cistern is a small proportion of species of beetle that are commonly associated with human settlement and housing. This is the range of species that make up Kenward's (Kenward and Hall 1995; Carrott and Kenward 2001) putative 'house fauna' ('h' in *Table 76* and Fig 26). This consists of a range of lathridiids, cryptophagids 'mould beetles', which along with the 'hairy fungus beetle' *Typhaea stercorea* and the 'spider beetle' *Ptinus fur*, are usually associated with hay and straw or other dry organic matter. The last member of this group is the 'woodworm' *Anobium punctatum*. These species are often common in archaeological settlement waste and their presence may suggest that rubbish has been deposited into the well. Equally, these are all common pests in granaries and warehouses where they form part of the community of insects that occur in very decayed grain and flour (Coombs and Freeman 1956). Unfortunately, none of the species of flies (Diptera) that are characteristic of settlement rubbish, cess or carrion (Panagiotakopulu 2004) were recovered. This is particularly striking given that the complete skeleton of a horse was recovered from fill 16554. This would appear to suggest that the corpse had not started to decay when it was deposited.

A large component of the insect faunas is also clearly derived from the landscape surrounding the cistern (see ecological groups 'oa' and 'p' in *Table 76* and Fig 26). A large number of Carabidae (ground beetles) typical of open grassland, arable or wasteland were recovered. This includes *Clivina fossor*, *Loricera pilicornis*, *Pterostichus versicolor*, *P. melanarius*, *Calathus fuscipes*, *C. melanocephalus*, *Zabrus tenebrioides* and *Platynus assimilis*

(Lindroth 1974). *Harpalus* cf. *rubicola*, *H. rufipes*, *Platynus assimilis* and *Syntomus truncatellus* are associated with more open conditions, often where sand and gravel are present (Lindroth 1974). These latter species perhaps represent the scuffed ground around the head of the cistern itself. The presence of similar ground conditions near the well is also indicated by a number of plant feeding beetles that are typical of rough ground and grassland. This includes *Gastroidea viridula*, *Apion violaceum* and *Apion hydrolapathi* that feed on dock (*Rumex* spp.), *Sitona cambricus* that feeds on birds foot trefoil (*Lotus pedunculatus* L.) and *Sitona lineatus*, *S. sulcifrons, S. hispidulus* and *S. humeralis* which feed on clover (*Trifolium* spp). *Gymnetron* spp. are associated with plantains (*Plantago* spp.) and *Ceutorhynchus erysismi* with shepherd's purse (*Capsella bursa-pastoris* (L.) *Medik*.), both plant species commonly found in waste ground, rough grassland and farmland. Similarly the presence of poppies (Papaveraceae) and mignonettes (Resedaceae) are indicated by *Ceutorhynchus contractus*. There is some circumstantial evidence that the area around the cistern may have become rather shrubby in later periods with *Apion aeneum* and *A. ulicus* indicating that mallows (*Malva* spp.) and gorse (*Ulex europaeus* L.) now grew close by. There are also very strong indications for the presence of stinging nettle (*Urtica dioica* L.) in the immediate area throughout the period, represented by the fills of the cistern. This is clearly suggested by the large numbers of *Bracypterus urticae*, *Apion urticarium*, *Cidnorhinus quadrimaculatus* and *Ceutorhynchus pollinarius* recovered.

There are also clear indications that pasture and grazing herbivores (probably cattle) were present in the area. This is most clearly suggested by the range of *Geotrupes*, *Onthophagus* and *Aphodius* dung beetles recovered, all of which are associated with dung pats lying in open pasture (Jessop 1986). It is difficult to establish how far away this pastureland may have been since these species have a wide flight potential (Kenward 1975). However, compared to sites such as the Bronze Age Wilsford shaft, Wiltshire (Osborne 1969) and the Roman watering holes at Little Paxton, Cambridgeshire (D Smith 2003a), Covert Farm, Northamptonshire (D Smith 1999) and Whitemoor Haye, Staffordshire (D Smith 2002), the proportions of these species in terms of the whole fauna is rather low. This may suggest that though pasture was located nearby, herds of domestic animals were not regularly watered at this feature.

There are also indications that estuarine or tidal conditions were also local. This is clearly suggested by the recovery of the ground beetles *Dyschirus salinus* and *Bembidion normannum*, *B. minimum* and the water beetle *Ochthebius dilatatus*, which are all associated with muddy areas or saline pools in salt marshes and coasts (Lindroth 1974; Hansen 1986). Equally, a range of dytiscid and hydraenid water beetles were also recovered which are associated with fresh water in slow flowing ponds and rivers. Examples of species that favour these conditions are *Hygrotus inaequalis*, *Hydroporus palustris, Colymbetes fuscus, Agabus bipustulatus*, *Hydreana palustris* and *Octhebius minimus* (Nilsson and Holmen 1995; Hansen 1986). If these species were 'local' to the cistern they suggest that it contained an open body of water that may have been slightly saline. Alternatively, these species could be have become incorporated by accident during flight (*sensu* Kenward 1975; Kenward 1978) or as the result of periodic flooding of the cistern.

In terms of the mode of deposition it is probable that the cistern at Northfleet represents a combination of two of these processes. Infested grain, probably being steeped for malting, has entered the feature and we are probably examining the residue left by accident at the end of the process. However, after this activity the cistern appears to have remained open and to have continued to collect a range of insects from the surrounding landscape and environment. Whether the grain pest insects from further up the profile in the cistern represent other periods of steeping or result from 'mixing' within the feature is not clear.

A single sample, 13058, was also obtained from the Roman well 16516. The small insect fauna recovered is essentially similar to that from the cistern and suggests that a similar environment existed at this location. Equally, there are very small numbers of grain pests and species associated with human settlement. Therefore, the well seems to have been filled by a combination of slow sedimentation and deliberate dumping.

Discussion

Roman grain pests

If the date for the formation of the lower deposits of the well is between AD 70 and 150 this makes it, along with the slightly earlier and contemporary sites at Poultry, London (D Smith 2011a), Gresham Street, London (D Smith 2003b) and the fort at Carlisle (D Smith 2010), one of the earliest examples of the presence of the 'grain pest fauna' in Roman Britain. It seems that these species arrived in Britain with the Roman invasion, initially in imported grain (Buckland 1978). Their common presence at the majority of Roman sites examined probably represents a considerable loss of stored grain to insect pests at this time (Buckland 1978; 1982). Equally, given the number of deposits from Roman sites that contain large proportion of grain pests there does appear to have been a pressing need to dispose of this material.

Dumping of rotting grain into disused pits and wells, such as the cistern at Northfleet, is rather common at a number of Roman sites in central London (D Smith 2011a, 2011b), York (Hall and Kenward 1990; Hall *et al* 1980) and at Invereskgate, East Lothian (D Smith 2001). The deliberate burning of infested grain is seen at Malton, North Yorkshire (Buckland 1982), Droitwich (Osborne 1977) and Coney Street, York (Kenward and Williams 1979). It has also been suggested that the prevalence of these grain pest species in the drains under the barrack houses at the fort in Carlisle may result from the feeding of infested grain to horses (D Smith 2010). Northfleet suggests another way of using, if not disposing, of infested grain. This is to use it initially for malting and then as material for kindling and fuel.

Comparison to other Roman and Saxon sites

The archaeoentomological work from Northfleet at present represents the only insect faunas from both the Roman and the Saxon periods in Kent. In Central and Greater London insects from a series of sites of comparable age to the deposits in Northfleet have been examined (de Moulins 1990; D Smith 2011b; Morris and Smith 2007) but these assemblages are predominantly urban in nature.

Within the Lower Thames Basin insect faunas from 'rural' sites of this type are essentially non-existent for the Roman and Saxon periods. The exceptions to this are Heathrow Terminal 5 (Tetlow 2010) and Saxon material from Edmington (D N Smith 2006). The nearest comparable material probably comes from the range of sites examined in the Upper and Middle Thames basin by Mark Robinson (eg, Robinson 1979; 1981; 2007; Booth *et al* 2007). In most cases the insect faunas produced from these sites are similar in nature to those recovered at Northfleet and all suggest cleared landscapes where pasture and meadow were common. What is obviously missing at these sites from the Upper Thames is of course the estuarine influence seen at Northfleet.

Species of biological importance

Only one species of beetle recovered is of notable biological interest. The Carabid *Panagaeus cruxmajor*, recovered in sample 13100 from the Roman cistern 16731, is at present listed as endangered (Red Data Book status: RDB 1; Hyman and Parsons 1992). It is usually found on soft ground in dense waterside vegetation by fresh water (Lindroth 1974). Although once widespread in the east and Midlands of Britain, at present the only known population is on the coast of Carmarthenshire (Hyman and Parsons 1992). Its decline is probably due to habitat loss in the last 200 years rather than the result of any climatic change. It has only been found once before in the archaeological record (D Smith *et al* 2001) but was presumably much more common in the past than today.

Radiocarbon Dating at Springhead and Northfleet

by Catherine Barnett

The requirements for absolute dating at Springhead (ARC SPH00, ARC ERC01, ARC SHN02, W51724 (non-HS1 Springhead Nursery) and ARC 342E02) and Northfleet (ARC EBB01) were assessed. The potential for radiocarbon dating was judged in parallel with other sources of dating evidence (eg, artefactual and dendrochronological). It was found that most phases of activity were already well dated by ceramic or artefact association and the calibrated ranges obtained from radiocarbon dating could not improve on those date ranges, particularly for Springhead. However, in a few specific instances samples were selected where the division between Roman and Saxon activity was unclear, or where there was a question if features were of prehistoric or later date, or to enable intra- and inter-site comparison.

Radiocarbon dating has also proved particularly valuable in providing a chronological framework for deep sedimentary sequences with associated palaeoenvironmental records under analysis (eg, pollen). However, most such sequences investigated proved to be dominantly of prehistoric date and are therefore reported separately in the Prehistoric Ebbsfleet volume.

In total, five AMS radiocarbon determinations were sought for presumed historic period archaeological contexts at Springhead and 20 for Northfleet. Of these, two at Springhead and ten at Northfleet were Roman and three at Springhead and six at Northfleet were Saxon (the latter are presented and discussed separately in Vol 4). The remaining four AMS radiocarbon determinations from the sequence under the millpond bund at Northfleet proved to be of prehistoric date and are therefore reported in the Prehistoric Ebbsfleet volume. In addition to the feature-based dating, a series of four AMS radiocarbon determinations was gained for the channel edge and channel deposits exposed in sections 1012/ 1013 (see *Sediments and soils* above).

Methods

The ability of radiocarbon dating to examine the questions posed by the excavators and individual specialists was carefully considered in each instance. Where it was felt that a particular question might be successfully addressed, rigorous examination of material available to date that event or phase was undertaken. This included the relationship of the material to the event to be dated, its taphonomy, issues of residuality and/or intrusiveness, stratigraphic security and physical suitability. A variety of material types was available for dating. In the main, short-lived plant material was chosen, often charred plant material and charcoal but, depending on the event to be examined, bone, cremated bone and waterlogged plants were also considered. The level of precision required to answer the question posed was also ascertained and in some cases, especially within the Roman period, artefact evidence was able to offer greater precision than radiocarbon dating would allow.

The samples chosen according to these criteria were identified (wherever possible to species level) and submitted for Accelerator Mass Spectrometry (AMS) dating at the Rafter Radiocarbon Dating Facility at Lower Hutt, New Zealand. All returned radiocarbon determinations were calibrated using OxCal ver 3.10 (Bronk Ramsey 1995; 2001) utilising the atmospheric data presented by Stuiver *et al* (1998) and expressed at the 94.5% confidence level and to 2 sigma level, with the end points rounded outwards to 10 years following the form recommended by Mook (1986). The results and sample details are given in Tables 77–78.

Table 77 Iron Age to Roman radiocarbon dates for Springhead (ARC SPH00)

Sub-group/ feature no	*Feature type*	*Context*	*Sample no*	*Material*	*Result no*	*δC^13^ ‰*	*Result BP*	*Date cal AD (2 sigma)*	*Phase*
5809	SFB	5810	8473	Charred grain *Triticum dicoccum*	NZA-28201	-21.6	1762±30	140–200 (4.0%) 210–390 (91.4%)	Mid–late Roman
5809	SFB	5845	8474	Charred grain *Triticum spelta*	NZA-28202	-22.0	1806±30	120–260 (86.8%) 280–330 (8.6%)	Early–late Roman

Table 78 Iron Age to Roman radiocarbon dates for Northfleet (ARC EBB01)

Group	*Sub-group/ Feature no*	*Feature type*	*Context*	*Sample no*	*Material (charcoal unless stated)*	*Result no*	*δC^13^ ‰*	*Result BP*	*Date cal AD (2 sigma, 94.5% unless stated)*	*Phase*
16900	15577/ 10587	Post-hole	10780	11111	Knotwood: *Quercus* sp.	NZA-27524	-24.8	2202±30	380–190 BC	Middle Iron Age
10996	10508	Layer	10481	11104	Roundwood: *Quercus* sp.	NZA-27433	-25.0	1778±30	130–340	Mid–late Roman
10996	10330/ 10795	Flue	10794	11449	Twigwood: *Quercus* sp.	NZA-27440	-23.1	1743±30	220–390	Mid–Late Roman
16900	15577/ 15963	Post-hole	15990	11444	Twigwood: *Quercus* sp	NZA-27531	-25.2	1968±30	50 BC–AD 90 (94.4%)	Early Roman
16901	16640/ 16621	Post-hole	16623	13074	Charred grain: *Triticum* sp.	NZA-27443	-22.8	1898±30	20–40 (1.7%), 50–220 (93.7%)	Early–mid-Roman
-	12591	Surface	19202	12169	Charred germinated grain: *Triticum spelta*	NZA-27438	-23.7	1652±30	260–280 (3.1%), 320–460 (84.3%), 480–540 (7.9%)	Late Roman–early Saxon
-	12591	Layer	19072	12165	Roundwood: *Corylus*	NZA-27447	-26.4	1696±30	250–420	Late Roman
-	16801	Layer	15177	11164	Roundwood: *Alnus* sp.	NZA-27441	-27.6	1896±30	30–40 (1.0%), 50– 220 (94.4%)	Early–mid-Roman
-	16801	Layer	15525	11230	Charred germinated grain: *Triticum spelta*	NZA-27444	-22.8	1915±30	0–140 (92.8%) 150–170 (1.3%), 190–210 (1.3%)	Early–mid-Roman
	20776/ 20700	Pit	20699	21161	juvenile *Quercus* sp.	NZA-27439	-23.3	1805±30	120–260 (86.1%), 280–330 (9.3%)	Roman

Where the dating of sediment (colluvial) sequences was considered of interest on site, samples for Optically Stimulated Luminescence (OSL) dating were taken by Dr E Rhodes, (then of the Oxford University Research Laboratory for Archaeology and History of Art). The OSL samples were also considered in assessment but it was felt that the sequencing of environmental events and correlation of sedimentary sequences was best achieved using radiocarbon dating.

Results

The Roman layers and features at Springhead are already well phased archaeologically and no feature-specific radiocarbon dates were sought. Two dates were, however, gained on charred *Triticum dicoccum* grain and on *Triticum spelta* grain from the same feature (Saxon SFB 5809) as a control after questions were raised regarding the assumption that its cultivation could all be attributed to the Saxon period at both sites. The dates returned (see Table 77) show that the spelt and emmer grains from SFB 5809 at ARC SPH00 were residual, of Roman date at cal AD 140–200 (4.0%), cal AD 210–390 (91.4%) (1762±30 BP, NZA-28201) and cal AD 120–260 (86.8%), cal AD 280–330 (8.6%) (1806±30 BP, NZA-28202). Those of a probable Saxon date at Northfleet are confirmed as relating to Saxon cultivation (see Vol 4), highlighting the unreliability of using the presence of these taxa as an indication of period.

Although the calibration curve for this period produces a somewhat wide date range, the radiocarbon determinations detailed in Table 78 help to clarify the chronology and development of the Roman bath-house (group 10996) and villa (groups 16900 and 16901) at Northfleet. The radiocarbon submissions all dated successfully and their δ13C‰ values were within the normal expected ranges for the type and terrestrial source of the materials dated (see eg, Coleman and Fry 1991; http://gsc.nrcan.gc.ca/c14/delc13_e.php). Charcoal from the flue of hot room 10330 and from one of the earlier rooms in the bath-house complex indicates its development in the middle–late Roman period (cal AD 130–390). A date on the outer rings of a charred post from the eastern aisled building (context 15990) in the villa complex indicates an earlier date of initial construction at 50 cal BC–cal AD 90 (NZA-27531, 1968±30 BP), with continuation in construction/use of the western aisled building in the early–middle Roman period. Date NZA-27524 (2202±30 BP) on the outer rings of a large charred oak post in post-hole 10780 proved surprisingly early at 380–190 cal BC, dating to the middle Iron Age. This is discussed further in Vol 1, Chap 4; one possible reason might be the reuse of this substantial timber from an earlier structure not identified on site.

Table 79 Details of the analysed Iron Age-Roman dendrochronological samples from Northfleet

Context/Sample	*Subgroup*	*Size (mm)*	*Rings*	*Sap rings*	*Date of measured sequence*	*Interpreted result*
11538 12019	12700	160 x 20	87+9	–	62 BC–AD 25	after AD 44
11571 12006	12700	140 x 25	96	–	38 BC–AD 58	after AD 68
11571 12017	12700	125 x 25	95	–	36 BC–AD 59	after AD 69
11571 12018	12700	125 x 20	92	–	35 BC–AD 57	after AD 67
11571 12020	12700	125 x 20	92	–	25 BC–AD 67	after AD 77
12680 7	12661	265 x 30	64	8	AD106–AD 169	AD 171–207
15403 11311	15011	140 x 140	65	–	AD 70–AD 134	after AD 144
15404 11310	15011	140 x 140	64	–	AD 71–AD 134	after AD 144
16656 11318	16731	245 x 25	88	–	109 BC–22 BC	after 12 BC
16659 11323	16731	280 x 25	107	–	102 BC–AD 5	after AD 15
16662 11320	16731	225 x 30	127	–	152 BC–26 BC	after 16 BC
16663 11328	16731	185 x 30	107	–	129 BC–23 BC	after 13 BC
16664 11321	16731	200 x 30	111	–	104 BC–AD 7	after AD 17
16667 11319	16731	275 x 25	47	–	24 BC–AD 23	after AD 33
16668 11322	16731	225 x 30	73	–	27 BC–AD 46	after AD 56
16669 11327	16731	230 x 25	81	–	42 BC–AD 39	after AD 49
16675 11324	16731	215 x 30	80	–	42 BC–AD 38	after AD 48

Two overlapping dates were gained for two layers in the lime kiln (feature 16801), giving a combined date range of cal AD 30–210, indicating its use in the early to middle Roman period, supporting the ceramic evidence and confirming that the feature may relate to the early construction phases of the villa complex. On the other hand, charred germinated grain from use of the malting oven (feature 12591) and wood charcoal from its demolition layers were dated to cal AD 260–540 (cal AD 260–280 (3.1%), cal AD 320–460 (84.3%), cal AD 480–540 (7.9%), NZA-27438, 1652±30 BP) and cal AD 250–420 (NZA-27447, 1696±30 BP) respectively, confirming that the feature is of late Roman date, post-dating much of the villa occupation, as is also suggested by its pottery assemblage.

Dendrochronology

by Ian Tyers

A total of 35 samples (out of 61 original samples) of timbers from the site were subjected to dendrochronological analysis between 2002 and 2006. This material was derived from a number of different Roman and Saxon structures, with 17 samples were successfully dated to the Roman period (Table 79) and a further 11 dated to the Saxon period (the latter discussed in Vol 4).

Methods

The samples were all oak and supplied as cross-sections. It is assumed here that each had been sampled at the optimum location for sapwood and bark-edge survival. The samples were assessed for the number of rings each contained, and whether the sequence of ring widths could be reliably resolved. For dendrochronological analysis samples need to contain 50 or more annual rings, and the sequence needs to be free of aberrant anatomical features such as those caused by physical damage to the tree whilst it was still alive. Standard dendrochronological analysis methods (see eg, English Heritage 1998) were then applied to each suitable sample. The sequence of ring widths in each sample were revealed by preparing a surface equivalent to the original horizontal plane of the parent tree with a variety of bladed tools. The width of each successive annual growth ring was revealed by this preparation method. The complete sequence of the annual growth rings in the suitable samples were then measured to an accuracy of 0.01 mm using a micro-computer based travelling stage. The sequence of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (eg, Baillie and Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated (Tyers 2004). Highly correlated positions were checked using the graphs and, if any of these were satisfactory, new composite sequences were constructed from the synchronised sequences. Any t-values reported below were derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position needs to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

Results

All 17 of the Roman samples were suitable for measurement. The details of these samples are provided in Table 79. The measured sequences were initially compared with each other sequence from the site. This procedure identifies strongly matching samples, in some cases likely to be derived from individual trees, and also allows a series of longer and internally replicated composite series to be constructed from the assemblage. The various composite groups and the non-matching material were then individually compared with absolutely dated reference chronologies from England. The analysis of this material was greatly assisted by the geographical proximity of the site to the pre-existing assemblage of Roman tree-ring data derived from excavations across former Greater London. Many of the individual series from Ebbsfleet exhibit exceptional levels of cross-correlation with many of the contemporaneous series from London excavations.

Once all the data had been compared with all the others, and with reference data sets, the results were reviewed to provide final composite series for the site. Three separate composite tree-ring series have been produced from the material, in addition a further single sample has been dated by direct reference to reference chronologies. Two of the composite series, and a single sample were each found to cross-match against many Roman era reference series from the south-eastern regions of England providing consistent calendar dates for each of these sequences (details in site archive).

This initial analysis dated the tree-rings present in the datable samples. The correct interpretation of those dates relies upon the character of the final rings in the samples. If a sample ends in the heartwood of the original tree, a *terminus post quem* (*tpq*) for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings that may be missing. This *tpq* may be many decades prior to the real felling date. Where some of the sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. If bark-edge survives then a felling date can be directly utilised from the date of the last surviving ring. The sapwood estimates applied here are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from England and Wales. Table 79 includes the interpreted date of each of the datable Roman samples. These dates do not necessarily indicate the date of the structure from which the samples were derived since the timbers may be reused or repairs to the structure.

Discussion

The Northfleet assemblage represents some of the first major groups of waterlogged material suitable for dendrochronological analysis that has been excavated in Kent, tripling the amount of datable Roman oak material thus far derived from the county. The following section summarises the material by context group.

Roman group 12700 (Northfleet wood-lined pit)
Five samples from this group were datable, four of these are derived from a single tree, the exception being 12019. These are all radial oak planks lining a Roman pit (see Vol 1, Chap 3, Fig 3.12). There is a complete absence of sapwood surviving on these samples. It is possible that the reasonable clustering of end-dates indicates that this material is near to the original sapwood surfaces of the trees. The tree-ring results indicate this lining was produced after AD 77, thus excluding the first decades of the Roman settlement of the south-east. The material was in a fairly poor state of preservation by the time it was analysed, and it may be that there has been significant loss of outermost rings, and there is nothing from the tree-ring analysis that precludes this material being of 2nd century date.

Roman group 12661 (Northfleet revetment)
A single piece of plank from a Roman revetment, forming a quay along the river (see Vol 1, Chap 3, Figs 3.22 and 3.24) was dated. This is the only datable Roman timber retaining some sapwood and it is thus the only Roman timber where it is possible to be reasonably precise about the felling date. Applying normal sapwood estimates indicates this tree was felled between AD 171 and AD 207. The stratigraphic database indicates it is likely to be slightly later than this (AD 250–380). This discrepancy suggests that the records for this timber may need to be reviewed to determine if it is reused, or alternatively it may indicate that the quay may be slightly earlier than is currently anticipated.

Roman group 15011 (Northfleet well)
Two oak timbers from a well lining were datable from this group (Vol 1, Chap 3, Fig 3.18). They are fairly short tree-ring sequences, but it is possible that they both end at their heartwood/sapwood boundary. However their poor preservation prevents this from being a certain identification. Both were felled after AD 144, how much later cannot be determined. If both were complete to the start of sapwood, it would suggest that this structure dates from before AD 180.

Roman group 16731 (Northfleet well)
Nine samples are datable from this group, consisting of a wood lined well (Vol 1, Chap 3, Fig 3.11). Most of this material is tangentially derived planks. There is again a complete absence of sapwood, and the tree-ring results merely identify that this material cannot predate AD 56, as with much of the other Roman material there is nothing from the tree-ring analysis that precludes this material being of 2nd century date.

Chapter 4

Prehistoric – Roman Environmental Evidence for Subsistence and Economy

In contrast to the longer records of environmental change and human impact on the landscape provided by the analyses above, the examination of individual archaeological dumps, feature fills and landsurfaces allows consideration of shorter lived human activities such as agricultural practice, exploitation and management of wild resources, eating and drinking, trade, manufacturing and industrial processes. The combination of a number of lines of evidence such as charred plant remains, charcoal and marine shell has been used as appropriate, as reported below.

Charred Plant Remains from Springhead

by Chris J Stevens

A total of 651 bulk samples were taken from late Iron Age and Roman deposits at Springhead. All 265 samples from the Roadside Settlement (ARC SHN02) came from Roman contexts. Of the 386 samples from the Sanctuary site (ARC SPH00), 35 were from late Iron Age features, a further 12 came from transitional late Iron Age to early Roman deposits, and the remainder were of Roman date.

Based upon the results of the assessment, a total of 89 samples were selected for analysis from Roman features on the Sanctuary site and 44 from the Roadside Settlement. Samples dating from the early Roman (AD 43–120) to the middle Roman period (AD 120–250) were analysed from both sites. A further 12 samples were examined from late Iron Age features. In addition, two samples from a Saxon sunken-featured building (SFB, ARC SPH00) are included as they were seen to contain a large amount of reworked Roman material including pottery and a dump of charred remains, grains of which were radiocarbon dated to the Roman period (see Barnett, Chap 3 and Table 77).

The samples were selected to provide information concerning agricultural practices and, in particular, it was hoped, given the presence of late Iron Age features at Springhead, that archaeobotanical samples from these features might provide some insight into the changes occurring with Romanisation within 'native', agricultural practices. It was also hoped to look at changes in consumption and production, including not only the ways in which cereals were consumed, but also the cultivation of the crop, its processing and distribution. Such information can then be linked to other artefactual and structural information relating to the production and consumption of crops.

Methods

The samples were processed by flotation in a modified Siraf-type machine, with the flots collected onto a 500µm mesh, with the exception of those seen to be mineralised or containing richer 'ashy' deposits, which were collected onto a 250 µm mesh. The residues were fractionated into 4, 2, 1 and 0.5 mm mesh sizes. The flot was dried and the coarse residue sorted by eye, while a low-powered binocular microscope was used for sorting the flot and small residue fractions. Plant macrofossils were then extracted, identified and quantified. The plant taxa identified from each sample are shown in *Tables 80–89* following the nomenclature of Stace (1997) for native species, Zohary and Hopf (2000) for cultivated taxa and the traditional nomenclature for cereals provided by Zohary and Hopf (2000, 28, table 3 and 65, table 5).

For the samples from Springhead, the flots were fractionated and the smaller 1 mm and 0.5 mm fractions sub-sampled to 5%, 10%, 25% or 50%, as signified within the tables. The resultant counts from these sub-samples were then multiplied by 20, 10, 4 or 2 respectively to produced estimated quantities (est.).

For most taxa, quantification refers to the minimum number of whole grains or seeds that are likely to be represented, for example, for legumes with split cotyledons the estimated seed count refers to the minimum number of pairs. For hazelnut (*Corylus avellana*) and sloe (*Prunus spinosa*) often fragments rather than whole nuts or stones are quantified.

Grains of oats (*Avena* sp.) are listed with the grasses, mainly as most are believed to be wild type (probably *Avena fatua*) rather than cultivated type. This is based upon the identification of mainly wild floret bases on the basis of the characteristic horseshoe shape of the disarticulation scar.

For hulled wheats (*Triticum spelta/dicoccum*), glumes were quantified only if the base of the glume was present. Spikelet forks were quantified where the two glumes could be seen to be clearly joined. Only the basal rachises of hulled wheats were quantified, and here each

Plate 7 A single grain spikelet of spelt wheat from shaft 2856, Springhead Sanctuary

was counted separately even if still joined. Similarly for barley (*Hordeum vulgare sl.*), basal rachises were quantified separately and joined rachis fragments were counted individually. Terminal spikelet forks of spelt were seen in a number of the richer samples, but no attempt was made to classify them separately.

Fragmented cereal grains were quantified by an estimate of the total number of whole grains they represent. Germinated coleoptiles (cereal sprouts) were counted only when the coleoptile had the trefoil-shaped base (two rootlet bases and the base of the acrospire) fully preserved.

Results

Late Iron Age

Most of the Springhead samples (*Table 80*) examined from this period produced evidence for barley (*Hordeum vulgare*), probably of the 6-row hulled variety, spelt (*Triticum spelta*) and emmer (*T. dicoccum*).

The dominant crop appears to have been spelt and the most common remains were glumes of spelt wheat. However, while glumes of emmer wheat were generally less well represented than those of spelt, they are proportionally better represented within these late Iron Age samples than in the Roman ones (see below). Barley was also generally better represented in this period and in some samples barley grains were almost as well represented as grains of spelt.

Some of the samples contained detached coleoptiles, the germinated embryos of cereal grains, most probably spelt wheat. These were most common in the samples from pit 3931 and the tree-throw hole 3921. There is, however, a distinct possibility that some of the material within these features may be intrusive from later Roman activity (see below). The only other possible crop remains were a fragment of broad bean (*Vicia faba* var. *minor*) and a mineralised seed of flax (*Linum usitatissimum*). Several larger cotyledons of legumes were also recovered that may be of pea (*Pisum sativum*) or bean.

Fragments of hazelnuts (*Corylus avellana*) were present in a few of the samples, most notably those from pit 3931. Additionally, stones of sloe (*Prunus spinosa*) and charred and mineralised seeds of bramble (*Rubus* sp.) may also represent the utilisation and bringing of wild resources to the site.

In most of the samples larger seeded species were better represented than smaller seeded ones, the main exception being pit 3931. The most common were those of black bindweed (*Fallopia convolvulus*), knot-grass (*Polygonum aviculare*), vetches, tares and/or wild pea (*Vicia*/*Lathyrus* sp.), corn gromwell (*Lithospermum arvense*), rye-grass (*Lolium* sp.), brome-grass (*Bromus* sp.) and docks (*Rumex* sp.). The last were most likely curled-leaved dock (*Rumex crispus*), suggested by the sharper edges to the seed. Grains of oat (*Avena* sp.) were also common and the presence of well preserved floret bases in the sample from the tree-throw hole 3921 suggests most are representative of the wild species (*Avena fatua*).

Species representing a range of differing soils types were seen in the Iron Age samples. Characteristic of wetter soils were buttercup (*Ranunculus acris*, *repens*, *bulbosus*), blinks (*Montia fontana* subsp. *chondrosperma*), fool's watercress (*Apium* sp.) and spikerush (*Eleocharis palustris*).

Of some interest were a few seeds of corn spurrey (*Spergula arvensis*), a species that is highly characteristic of the cultivation of drier sandier soils. Seeds of wild mustard (*Brassica* sp.) were also recovered, probably black mustard (*Brassica nigra*), but wild cabbage (*Brassica oleracea*) cannot be entirely discounted given the proximity of the site to the coast. These species are also often found on lighter drier sandier soils, along with sheep's sorrel (*Rumex acetosella*). It might be noted that all these species came largely from pit 3864 and tree-throw hole 3921, although the latter did produce seeds of common spikerush. Whilst not indicative of sandy soils, several species such as field madder (*Sherardia arvensis*), corn gromwell, medick (*Medicago lupulina*), fairy-flax (*Linum catharticum*) and fool's parsley (*Aethusa cynapium*) are commoner on dry, calcareous soils.

Seeds of species associated with nitrogen-rich soils and/or spring-sown crops, such as fat-hen (*Chenopodium album*) and orache (*Atriplex* sp.), were frequent within these samples. Other species included poppy, probably *P. dubium* or *P. argemone* from the find of a capsule top with five rays, campion (*Silene* sp.), clover (*Trifolium* sp.), scentless mayweed (*Tripleurospermum inodorum*), pimpernel (*Anagallis* sp.), parsley-piert (*Aphanes arvensis*), cinquefoil (*Potentilla* sp.) and nipplewort (*Lapsana communis*).

It is interesting to note seeds of mallow (*Malva* sp.), hemlock (*Conium maculatum*) and probable grass vetchling (*Lathyrus nissolia*) within these samples. While the exact date of introduction of these species to the British Isles is unknown, they are often seen as arriving with the Roman occupation (Godwin 1984, table 45), and may further suggest that some of the material within these features may possibly be intrusive.

Plate 8 Germinated grains of spelt from pit 16902, Property 4, Roadside Settlement, Springhead

Roman

Generally little difference was seen between the assemblage from the Sanctuary site (*Tables 81–86*) and that from the Roadside Settlement (*Tables 87–89*), and the results from these two sites are reported together.

Some 80% of the samples examined from both sites contained over 200 cereal remains, in particular the glumes and grains of spelt wheat (*Triticum spelta*). Finds of emmer wheat were frequent in the samples, but remains of spelt overwhelmingly dominated all but one sample. This was an early, 1st century AD pit (5609) from the Sanctuary site, with a large proportion of spikelet forks and glume bases of emmer wheat (*Triticum dicoccum*).

Though finds of whole spikelets were relatively uncommon in the samples, several of spelt were recorded, in particular from the Roadside Settlement. Spikelets of spelt wheat usually have two grains, but while some of the normal two-grain spikelets were recovered, the vast majority could clearly be seen to contain, and only to have ever contained, single grains (Pl 7). These grains were quite characteristic in that the ventral surface of the grain was more rounded than seen in two-grain specimens, the two grains growing against each other resulting in a 'flatter' profile. That probably the greater majority of the 'free-grains' seen in the samples did not exhibit the more rounded profile, however, may suggest that single-grain spikelets were not the norm.

The most notable characteristic of the assemblages, especially in samples that had large numbers of glumes, was the high number and consistent presence of germinated grains of spelt wheat (Pl 8) and detached coleoptiles (the germinated embryo/sprout). These remains were found in the majority of the samples across both sites, and within both the early and middle Roman periods. They were most common within the samples from the Roadside Settlement, especially property 12, the north-west corner of adjacent property 11, and property 2.

Remains of barley, both grains and rachis fragments, were present in the greater proportion of the samples, but rarely numbered 50% of the identified cereal remains. The one exception was pit 2236 on the Sanctuary site, in which they formed a significant proportion of the deposit. In the cases where well preserved specimens were present, barley grains could be seen to still have the palaea and lemma attached. While barley grains themselves were relatively uncommon and rarely seen to be germinating, it was notable that in many of the samples dominated by the glumes, germinated grains and coleoptiles of spelt, rachis fragments of barley were quite common, often outnumbering barley grains.

Grains and rachises of free-threshing type wheats, whilst rare, were present in a number of samples, in particular those from the Roadside Settlement. Generally, these grains and rachises were only present in features that had large numbers of remains of spelt. As many of the identifications are only tentative it is probable in many cases the grains are within the normal range of spelt, possibly, as discussed above, even grains from single-grained spikelets. The rachises were often basal rachises and are further discussed below.

The one exception where grains of free-threshing wheat were encountered in number was an early Roman crop dryer (3590/300240) at the Sanctuary site. Although this feature did contain some glumes of spelt wheat, remains of hulled wheats were far less well represented than those of free-threshing wheats. While grains of free-threshing wheat are generally associated with Saxon features on the site, there is no reason to suspect the feature is not early Roman in date.

Other cultigens and edible wild species

The samples from Roman contexts produced a number of other crop species or species with edible seeds. Remains of pea (*Pisum sativum*), bean (*Vicia faba*) and probable lentil (*Lens culinaris*) were recovered from both the Sanctuary and the Roadside Settlement sites. Given the smaller number of samples examined from the Roadside Settlement, these remains would seem slightly more common on this site. More significantly they were less common within samples with large numbers of glumes and germinated spelt grains.

Several charred seeds of flax (*Linum usitatissimum*) were recovered from both sites, along with several less readily identifiable mineralised seeds from a few samples. Several fragments of flax capsule were identified from the Roadside Settlement.

A single seed of beet (*Beta vulgaris*) was recovered from the Roadside Settlement, from demolition deposit 12353 (context 12351) in property 2. Given the proximity to the coast this may represent the wild variety (*Beta vulgaris* sub-sp. maritima), rather than that of the cultivated species (*Beta vulgaris* ssp. *vulgaris*). From the Sanctuary site a single seed of possible onion (*Allium cepa*) was recorded within pit 2958, identifiable by its distinctive shape and reticulate surface texture. A possible mineralised seed of coriander (*Coriandrum sativum*) came from an early Roman pit (19217) within the Roadside Settlement, while a further possible charred specimen was identified from layer 5414 on the Sanctuary site.

Grape pips (*Vitis vinifera*) were only recorded within two samples, from pits 2318 and 2420, both on the Sanctuary site. In both cases the specimens were mineralised. Finds of fig (*Ficus carica*) were present in several samples from the Sanctuary and the Roadside Settlement sites, as well as from the nearby cemetery site at Pepper Hill (Davis 2006b). From the Sanctuary only mineralised seeds were recovered, from pits 2214 and 2236, although a single fruit of fig was recovered from an early fill of enclosing ditch 3134 (300346), in a sample with no other charred remains. From the Roadside Settlement, charred remains came from pit 10058 (property 12), pot burial 12222 (property 2) and kiln 19253 (property 9). An unidentified charred fruit was recovered from channel 12490 (property 2); the remains may be of grape, and it might be noted whole fruits of grape were recovered from Pepper Hill cemetery (Davis 2006b), although in other aspects it did resemble immature date (*Phoenix dactylifera*).

Charred remains of stone pine (*Pinus pinea*) appeared in two samples from the Sanctuary site. Two cone scales and a single nut shell were recovered from chalk quarry 2500 (300203) and a single fragment of cone scale was recovered from a spring infill deposit (5082). It might be noted that this species was also found at the cemetery site at Pepper Hill (Davis 2006b).

A fairly large number of stones of plum, cherry or sloe (*Prunus* sp.) were recovered. The vast majority were mineralised and came from samples from the Sanctuary site. In a few cases they were identifiable to species, mainly sloe (*Prunus spinosa*), but also occasionally cherry (*Prunus avium*). This suggests that most represent wild rather than cultivated foods such as domesticated plums (*Prunus domestica*).

A reasonable number of other potential wild foods were also present within the samples, including mineralised and charred seeds of bramble (*Rubus* sp.) and elder (*Sambucus nigra*).

Weed seeds

Many of the main weed species seen from the late Iron Age, such as black bindweed, knot-grass, docks, rye-grass, corn-gromwell, clover, vetches, tares, oats and brome grass, were common in the Roman period. Generally most of the species discussed below were recorded from both sites.

Seeds of wetland species were well represented, for example buttercup (*Ranunculus acris/repens/bulbosus*), blinks (*Montia fontana* ssp. *chondrosperma*), spikerush (*Eleocharis palustris*), rush (*Juncus* sp.), bristle club-rush (*Schoenoplectus lacustris*) and probably sedge (*Carex* sp.). There were also a few finds of hairy buttercup (*Ranunculus sardous*), a species common in coastal areas, whose seeds dominated the waterlogged samples (see Stevens, Chap 3, *Waterlogged plant remains*, above).

As with the late Iron Age samples there are a number of species that are found mainly on drier calcareous soils, including corn gromwell, black medick, fumitory (*Fumaria* sp.), fool's parsley (*Aethusa cynapium*) and field madder (*Sherardia arvensis*). It would also seem probable that at least some of the capsule tops, most commonly with five rays, are from long-headed poppy (*Papaver dubium*), and in at least two cases (post-hole 5577 and ditch 5639) whole capsules were recovered that most closely resemble this species. The presence of the probably introduced prickly poppy (*Papaver argemone*) cannot be entirely discounted, but it may be noted that both species are more commonly found on dry soils.

Seeds of corn spurrey (*Spergula arvensis*), sheep's sorrel (*Rumex acetosella*), along with corn marigold (*Chrysanthemum segetum*), and more unusually bird's-foot (*Ornithopus perpusillus/sativa*), can all be taken as indicating the cultivation of sandier soils, although none were common. Only a single seed of stinking mayweed (*Anthemis cotula*), an indicator of the cultivation of heavy clay soils, was recovered, from a well/dene hole dating to the middle Roman period.

Although infrequent in the samples, a number of species are present that can be regarded as probable or at least potential Roman introductions (Godwin 1984, table 45). These include hairy buttercup (*Ranunculus sardous*), corncockle (*Agrostemma githago*), mallow (*Malva* sp.), grass vetchling (*Lathyrus nissolia*), corn marigold (*Chrysanthemum segetum*), stinking mayweed (*Anthemis cotula*) and hemlock (*Conium maculatum*).

More unusual were several seeds of greater stitchwort (*Stellaria holostea*) from pit 6166 on the Sanctuary site. This perennial species is found mainly in woodland and hedgerows, but is also a garden ornamental, and less likely to be found in cultivated fields. This same sample also produced several Rosaceae thorns.

A single seed of white bryony (*Bryonia dioica*) was recovered from pit 3228 on the Sanctuary site, and like greater stitchwort it too is a plant of hedgerows and woodlands. This same sample also contained other potential hedgerow species including a large number of seeds of hemlock (*Conium maculatum*), some of elder (*Sambucus nigra*) and a possible seed of dogs mercury (*Mercurialis annua*). In addition, there were several seeds of cinquefoil or strawberry (*Potentilla* sp.), and ivy-leaved speedwell (*Veronica hederifolia*), species that while found in arable fields, also occupy hedgerows. The unusual nature of the samples from pit 3228 and pit 6166 suggests that some of their components come from habitats other than the arable field.

A number of samples from the Sanctuary site also had pinnules of bracken (*Pteridium aquifolium*), while a single sample from a channel fill (17864) at the Roadside Settlement contained high numbers of these. Bracken grows both in woodland and heath and can be used for animal bedding, tinder and also, when burnt, the ashes can be used in the manufacture of soap and glass.

Mineralised and other material

A large number of samples produced at least some evidence for plant remains preserved by calcium phosphate mineralisation. There were some differences between the sites in that around 20% of the samples from the Sanctuary site produced such remains, while only just over 10% of those from the Roadside Settlement contained mineralised matter.

There were also notable differences between the samples from each site in terms of the range of species whose seeds were preserved. Most of the mineralised remains of edible and cultivated species, for example fig (*Ficus carica*), grape (*Vitis vinifera*), sloe/plum (*Prunus* sp.), bramble (*Rubus* sp.) and elder (*Sambucus nigra*) came from the Sanctuary site, although remains of both bramble (*Rubus* sp.) and cherry (*Prunus avium*) were recovered from the Roadside Settlement.

In terms of wild non-edible species, mineralised seeds of buttercup (*Ranunculus acris/repens/bulbosus*), knotgrass (*Polygonum aviculare*), goosefoot/orache (*Chenopodium/Atriplex* sp.), common nettle (*Urtica dioica*), docks (*Rumex* sp.), campion (*Silene* sp.), knotted hedge parsley (*Torilis* sp.), ribwort plantain (*Plantago lanceolata*), deadnettle (*Lamium* sp.) and hemlock (*Conium maculatum*) were all very common within the Sanctuary site samples.

In contrast, it was notable that the few samples with mineralised remains recovered from the Roadside Settlement, while containing a similar array of species, were dominated to a greater extent by seeds of nitrogen-rich disturbed soils, in particular goosefoots (*Chenopodium* sp.), orache (*Atriplex* sp.) and chickweed (*Stellaria media*).

Discussion

The grains and chaff remains of cereals, along with the seeds of wild species within the samples, provide information on the cultivation methods and general crop husbandry practises at Springhead during the late Iron Age and Roman periods. *Tables 90* and *91* provide summary statistics for the samples used in the interpretations for Springhead Roadside Settlement and Sanctuary.

Late Iron Age

While during the late Iron Age spelt wheat seems to be the dominant crop, both barley and emmer would appear to have still been cultivated. The cultivation of emmer wheat may have continued in Kent longer than is seen in many other parts of England (*cf* Stevens 2006b; Giorgi 2006; Robinson and Wilson 1987; G Campbell 2000; van der Veen 1992).

The range of species within the Iron Age samples indicates the cultivation of drier calcareous soils and wetter soils, the latter probably associated with fields that extended into areas that were seasonally flooded. There are also some species associated with the cultivation of drier sandier soils. Overall, the evidence suggests that cultivation stretched across the wide range of soil types that are to be found in the local area.

During this period it is probable that fields were cultivated by ard and crops were broadcast sown in both autumn and spring. The presence of lower growing species, such as clover (*Trifolium* sp.), suggest harvesting, probably by sickle or 'reaping' hook, relatively low down on the culm (*cf* Hillman 1981; 1984b).

Glumes were generally better represented in most of the samples than hulled wheat grains, and no samples indicated anything other than probably having been derived from the regular burning of waste resulting from the processing of spikelets taken from storage throughout the year. The higher presence in general of larger seeded species in most of these samples suggests that the crops had been reasonably well processed prior to being brought to the settlement, having been threshed, winnowed, coarse- and fine-sieved in the field or, at least, not at the point of consumption following harvest.

Roman

Spelt, as seen across England as a whole, is by far the dominant cereal within the Roman period. There is still some evidence for the continued cultivation of emmer, and at least one sample suggests it was still grown as a crop in its own right in the earliest phase of Roman settlement at Springhead, if not later.

As with the late Iron Age, the wide range of species present indicates the cultivation of a similarly wide suite of soils. There is little indication that crops arriving at the site were anything but cultivated locally. It is interesting to note that seeds of stinking mayweed (*Anthemis cotula*), indicative of the cultivation of clay soils, were largely absent from this site, particularly as it is recorded from Northfleet villa (see W Smith, below), as well as at other earlier and later Roman sites in Kent (Stevens 2006c; Smith and Davies 2006). Given the large numbers of samples examined from Springhead the absence of this species lends further support to the suggestion that grain coming to the settlement derived predominately from crops grown upon local soils.

To what extent these crops were cultivated by the inhabitants of the settlement is difficult to ascertain. In general it appears that spelt wheat was both transported and stored in the spikelet. Certainly the evidence suggests that large amounts of cereals arrived and were processed at the site.

It is probable that crops were broadcast sown in spring or autumn. The presence of iron coulters from many Romanised settlements, along with the presence of stinking mayweed (*Anthemis cotula*), which can be seen as generally absent prior to the Roman period, has been associated with the cultivation of heavier clay soils by plough, as opposed to ard, in the Roman period (Stevens 2006a; 2006c; *cf* M Jones 1981). The absence of this species does not, however, necessarily preclude the use of asymmetrical ploughs at the site. As in the Iron Age, it is probable that crops were harvested low on the culm, and by sickle or 'reaping-hooks'.

During the analysis of the samples it was apparent that some considerable variation was present with respect to their composition. This variation primarily centred on the degree of evidence for germinated cereals, but in turn could be related to variations in the way that the crops were processed.

Examination of processing

To look at information concerning the processing stages represented, a number of factors were examined (see *Tables 90–91*). The first was the ratio of glumes to estimated numbers of hulled wheat grains. Samples rich in glumes can be taken to be composed of waste generated from the processing of spikelets, to separate the glumes, rachis, palaea and lemmas from the grains (*cf* Stevens 2003b). Those high in grain may represent clean grain, unprocessed semi-clean spikelets or possibly, but less likely, waste from early stages prior to pounding (*cf* Hillman 1981).

The second approach was to look at the ratio of grain to weed seeds. As weed seeds are removed through the processing sequence it is often found that waste from earlier processing stages tends to include much higher percentages of weeds than waste generated during later processing stages (*cf* Stevens 2003b).

The final approach was to examine the percentage of large, smaller and intermediate weed seeds. Generally, smaller weed seeds are removed early in the processing sequence, while grain-sized weed seeds remain until the final hand-sorting (Hillman 1981; 1984b; G Jones 1984; Stevens 2003b). The size of weed seeds is taken as the average width/length of modern specimens, with large weeds being classified as those with an average width/length greater than 2.5 mm and those less than 2.5 mm as small. The third category, comprising intermediate weed seeds, are those whose species have seeds with an average length/width of around 2.5 mm or just under, but whose seeds are released in indehiscent or semi-indehiscent fruits, spikelets or pods which are grain or spikelet-sized. This category included seeds of docks (*Rumex* sp.), perennial rye-grass (*Lolium perenne*), medick (*Medicago* sp.) and orache (*Atriplex* sp.).

Division of samples by stages of crop-processing

The results of these three approaches to analysis demonstrated the majority of samples to be rich in glumes, most probably deriving from glume waste separated after sieving and pounding. Charring preserves grain more readily than glumes (Boardman and Jones 1990) and, therefore, it is inevitable that most samples will be biased towards the preservation of grain. It is notable that even under the most favourable conditions we should not expect more than one glume to survive for every grain charred (*cf* Stevens 2003b). Given that none of the samples are likely to have been burnt *in situ*, it is still unlikely that even samples with less than ten grains to each glume represent anything other than processing waste.

Of all the samples examined only four, two from the Sanctuary site and two from the Roadside Settlement, contained more than ten grains to every glume. One of these samples (pit 3114) was not particularly rich and so can be dismissed. The remaining three, pit 3546 on the Sanctuary site and layers 10703 and 10747 (property 11) from the Roadside Settlement, were all grain-rich and appear to have either whole spikelets and/or a high proportion of clean grain within them.

A further sample, from kiln 19253 (property 9), also had a high ratio of grain to glumes, and the presence of several whole spikelets may indicate that the sample originally comprised whole spikelets. The sample contained a high number of large- and intermediate-sized weed seeds and can perhaps be interpreted as resulting from the accidental charring of whole spikelets prior to or perhaps even during parching, before the removal of the glumes, although it is probable that some general glume waste has also become mixed in.

Examination of the weed seeds showed most of the samples to be dominated by large- and/or intermediate-sized species. Of the two samples from the Sanctuary site with higher numbers of smaller weed seeds, one came from late Iron Age feature 3931, the other from early Roman cremation burial 6345. For the former it is possible that some fine sieving or earlier processing waste is present. In the case of the latter, while the bulk of the charred plant macroscopic remains can be related to processing waste, the high number of small grass seeds may derive from grass material used as tinder.

A general relationship between the number of glumes to hulled wheat grains and the number of large weed seeds can be seen (Fig 27). Upon this basis the samples can be divided into two groups:

- Group A: rich in larger seeds, but proportionally less rich in glumes to grain.
- Group B: rich in glumes and intermediate weed seeds.

The ratio of grain to weed seeds showed a wide range of variation, with some samples dominated by grain, others by weed seeds. For some of these samples, especially those falling into Group A, the predominance of weed seeds is almost entirely due to dominance of the samples by seeds of corn gromwell (*Lithospermum arvense*).

A final observation regarding processing concerns the coleoptiles, the germinated embryo of cereal grains, which were particularly common in those samples falling into Group B. Given the fragile nature of coleoptiles, it can be assumed that where more cereal coleoptiles are present than cereal grains then the coleoptiles have been separated with the glumes and discarded within the waste fraction. It was noted that within almost a third of the samples coleoptiles dominated over cereal grains. In all the samples containing reasonable quantities of coleoptiles and germinated grain the former far outnumbered the latter.

Differences in processing for malt and bread

The results indicate several trends. In particular, it might be suggested that almost all the samples derive from the charring of waste from two main activities, and that the variation seen between the two groups can be accounted for accordingly. However, it must be noted that the distinction between each group is far from discrete, probably due to a great deal of mixing between the waste from each activity.

The distinction between the groups is thought to be related to the production of malt, and for this reason samples were further categorised according to the degree to which they showed evidence for malt production.

Indications of germination were generally only observed on reasonably well preserved grains. As such, the percentage of germinated hulled wheat grains in the total number of identified hulled wheat grains was the first criterion used to classify samples as malting waste. Samples of which 25% of the identified hulled wheats showed clear signs of germination were classified as potentially derived from malting waste. Secondly, the proportion of coleoptiles to grain was also examined, and samples with over three coleoptiles to every cereal grain were classified as potential waste from malting.

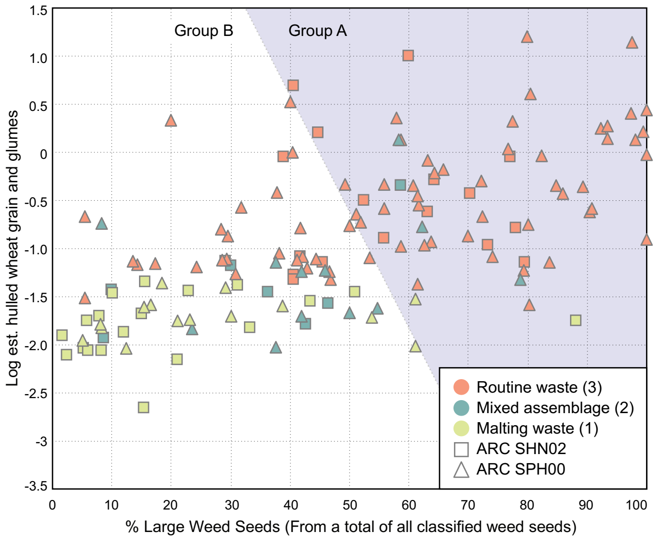


Figure 27 Distribution of samples from the Sanctuary site (ARC SPH00) and the Roadside Settlement (ARC SHN02). Samples are plotted on the X-axis according to the % of large weed seeds as a % of all classified weed seeds and on the Y-axis according to the Logged (10) value of estimated hulled wheat grains divided by glume bases. The key shows how samples were classified according to the degree of evidence for malting waste

Thirdly, as coleoptiles are likely to have been separated with the glumes, the ratio of coleoptiles to glumes was also calculated. Given their extremely fragile nature coleoptiles were highly under-represented even compared to glumes, therefore a figure of over one coleoptile to every 25 identified glume bases was then used to categorise samples with potential malting waste.

Finally, as such operations are likely to have been carried out in bulk and the resultant waste charred and dumped *en masse*, two further criteria were used to identify potential malting waste. The fourth criterion was the number of items per litre, with more than 300 items per litre taken to indicate probable malting waste. Finally, the ratio of grain to glume bases was calculated, with over 25 glumes to every grain (Log^{10} -1.4 or less) used to indicate potential waste from malting.

Using these tests the samples were ranked from 1–3 as to the degree to which they were likely to contain malting waste:

1.	Malting waste:	Samples passing at least four of the five tests.
2.	Mixed waste:	Samples that passed only two-three of the tests.
3.	Routine domestic waste:	Samples that failed all or passed just one test.

These tests indicated that around 17% (23 of the 136 classified samples) of the samples from the Sanctuary and the Roadside Settlement sites showed strong indications of having derived from malting waste and a further 11 were seen as predominantly containing waste from such activities.

Just over 50% of the samples (a total of 71) failed all these tests and were therefore considered as showing little to no indication of having derived from malting waste, while a further 17 showed few signs of being derived from such waste.

As seen in Figure 27, it was notable that the differences between samples showing strong indications of deriving from malting waste extended to the ratio of seeds of large and intermediate-sized seeds species. In those samples classified as waste from malting, the percentage of intermediate species was over 40% while the percentage of large-seeded species was under 40%. In those samples showing little to no indication of malting waste the opposite was true. The differences seen between these two groups of samples are easily explained by the nature of the processing activities and the intended use of the cereal remains.

Routine processing for grain for flour

Those samples that showed less indication of resulting from malting waste are best interpreted as the processing of spikelets for the production of flour. Given the general low number of seeds of smaller seeded species, and that the majority of samples are not dominated by weed seeds, most samples would appear more characteristic of waste generated from the processing of semi-clean spikelets. This involves the pounding of spikelets, sieving to remove the glumes, in which intermediate weed seeds along with remaining smaller weed seeds would be removed, followed by hand-sorting (see Hillman 1981; Stevens 2003b).

Within such operations some grain would be lost during the processing of glumes and, given that most of the weed seeds would have been removed, it is unsurprising that such assemblages are usually dominated by grains and larger weed seeds. The dominance of weed seeds within some samples is unusual, but often these samples are dominated by seeds of corn-gromwell (*Lithospermum arvense*). In part the high presence of seeds of this species is undoubtedly due to their more robust nature and that they therefore survive not only charring but also post-depositional destruction to a much greater extent compared to other weed seeds. Besides being easy to identify, the robust nature of the seeds would have made them highly undesirable as a contaminant of processed grain, and undoubtedly they would have been more readily removed during hand-sorting compared to seeds of other species.

This group of samples can, therefore, be related to small-scale processing for clean grain involving parching, pounding, sieving to remove the glumes and remaining weed seeds and, finally, hand-sorting of undesirable grain-sized weed seeds, along with other contaminants. The presence of possibly accidentally charred spikelets within kiln 19253 may indicate that such features may have been used for this purpose amongst other functions.

Processing for malt

Spelt wheat for malt must be germinated within the spikelet (Samuel 2000). Examination of spelt grains after pounding reveals visible damage to the embryo on many grains, and it is probable that parching prior to pounding, a necessity for hulled wheats within Britain, would also be detrimental to germination. The high number of items per litre alone would seem to indicate, as might be expected, that the processing of cereals destined for use as malt was conducted in bulk.

The high ratio of chaff to grain may be in part due to the germination process itself. During germination starches are converted into soluble sugars, a process that can be identified on carbonised grains. Notably it results in poor preservation with many carbonised grains having a more friable nature, often being hollow in the centre. Consequently the preservation of these grains is likely to be much poorer than for non-germinated grain and may in part explain the higher ratio of chaff.

Such high ratios of chaff to grain have been seen at other sites, most notably Hanbury Street, Droitwich where huge amounts of chaff, accompanied by germinated grain and coleoptiles, were spread over a substantial area (de Moulins 2006). Straker (2006) noted that similar deposits at the nearby site of Bays Meadow, Droitwich, also had germinated grain and interpreted them as the destruction of spoilt grain. However, the majority of samples from this part of Droitwich are, as seen at Springhead, extremely glume-rich not grain-rich, as would be expected if the assemblage was indeed composed of spoilt grain. As such the presence of charred germinated grain at Droitwich is more in keeping with the production of malt rather than deriving from the destruction of spoilt grain (*contra* Vaughan 1982; de Moulins 2006).

The quantity of glumes in these deposits, even taking into account the poor preservation of germinated grain, seems quite exceptional. Therefore, it might be considered that differences in the type of process led to different methods being employed to separate glumes and grain for preparation of malt compared to those conducted on spikelets for use as bread. It might be noted that while many modern brewers in Germany use a mixture of spelt and barley malt there was little evidence for germinated barley within this set of samples. Furthermore, while barley rachis fragments were sometimes well represented, proportionally they were rarely more frequent than seen in the 'non-malt waste' samples. Indeed, barley grains, as in proportion to all cereal grains, were often better represented in these 'non-malt waste' samples. There is thus no clear evidence that barley malt was used in beer production, although the possibility that non-malted grains were added at the fermentation process cannot be dismissed.

The low number of large weed seeds and high number of intermediate weed seeds would seem to indicate that the waste does not include hand-sorted weed seeds. While it is possible that this operation was conducted elsewhere it is more probable that it was omitted entirely. Intermediate seeds, as seen above, are those that are often released with the addition of attachments that make them harder to separate with the grain, for example, rye grass (*Lolium* sp.) is released in long awned spikelets, docks (*Rumex* sp.) in tubercled fruiting tepals and orache (*Atriplex* sp.) in bracteoles. While many of these seeds will be released and separated from the crop during threshing operations, pounding will remove most of the attachments, facilitating the removal of the remaining seeds of these species with the glumes.

Distribution of malting and routine cereal waste

In terms of differences between the periods, the late Iron Age samples showed little to no indication for the presence of malting waste and the small amounts of material relating to germinated grain within these samples are likely to be intrusive.

Malting waste was most common on the Roadside Settlement, in particular during the middle Roman period, being most frequent within property 2. It is notable that the only sample in this property not to produce such evidence came from an oven. Property 12 also showed a strong association with such material in the earlier Roman period, as did the adjacent north-west corner of property 11. The remainder of property 11 and property 3 (next to property 2) to the south, however, showed little such evidence.

In terms of feature types, it is probable that such waste generally accumulated or was dumped in open features. Notably, the one type of feature not associated with malting waste was ovens. Crop dryers, in particular, have often been associated with such waste (van der Veen 1989), however, it is worth noting that the samples from the crop dryers (2289 and 3590) at Springhead showed little evidence for malting waste in comparison with other samples. In contrast, the later crop dryer at Northfleet produced quite strong evidence for malting (see W Smith, below).

The crop dryers from Springhead are earlier than the vast majority of those recorded from Britain, which tend to date to the 3rd and 4th centuries (Morris 1979; Millet 1990). Nevertheless the results, as seen from Northfleet, do not necessarily preclude their use, especially within villas and more rural sites, in connection with brewing at a later date (van der Veen 1989). However, an increasing amount of evidence is coming to light suggesting that such operations were conducted in specialised buildings with associated ovens. Examples include the sites at Beck Row, Mildenhall, Suffolk (Bales 2004; Fryer 2004), Rectory Farm, Godmanchester (Murphy and Fryer forthcoming), and more recently at Weedon Hill, Buckinghamshire (Wessex Archaeology 2007a). Documentary evidence also suggests the existence of specialist brewers and/or retailers of beer from the earliest Roman occupation of Britain, as testified from tablets at *Vindolanda* on Hadrian's Wall (Bowman and Thomas 1994, 24–9, 32–5). The evidence from the aforementioned sites centres on the later Roman period, but the documentary evidence provides the possibility that specialised buildings may be present in the earlier Roman period, and the substantial building, possibly a barn, in property 12 on the Roadside Settlement is a candidate at Springhead.

Imports, horticultural and wild food

A number of species were identified in the samples that are seldom found within British charred assemblages. These include potentially imported species, introduced cultigens, and plant foods probably collected from the wild.

Within the first category (imported species) can be included stone pine (*Pinus pinea*), fig (*Ficus carica*), grape (*Vitis vinifera*), and possibly lentil (*Lens culinaris*). Stone pine (*Pinus pinea*) is fairly well documented within Roman Britain and often associated with sites where 'public' or 'institutional' temples are located. For instance charred finds of cones were found at the Temple of Mithras in London (Grimes 1968), the Antonine Wall (Blackburn 1951), *Verulamium* (Wheeler and Wheeler 1936) and Winchester (Ross 1975) and the roadside shrine at Westhawk Farm near Ashford (Pelling 2008), in all these cases suggesting altar fuel/offerings, while further finds of both cones and nuts from the continent indicate that their use for such purposes was widespread (Zach 2002; Robinson 2002; Ciaraldi and Richardson 2000; Ross 1975). The remains of stone pine found at the Pepper Hill cemetery are likely to have similar associations (Davis 2006b). Finds of stone pine have also been recovered more generally from waterlogged and charred deposits in London dating from the 1st to 4th century (Willcox 1977; Davies 2000; Norman and Reader 1904), as well as in Essex (Murphy *et al* 2000; Murphy 2003a).

Today stone pine is mainly regarded as an economic species, valued for its edible seeds which are used directly in cooking and for oil. Roman authors frequently refer to its use in cooking, for example Apicius in *De Re Coquinaria*, quoting Marcus Terentius Varro, suggests the use of pine seeds together with cooked onions, white mustard and pepper. Galen, a Greek of the 2nd century AD indicates that a mixture of pine seeds, honey and almonds taken before bedtime on three consecutive evenings might produce desirable effects (Grant 2000).

However, as seen above, there is a distinct possibility that whole cones were imported for use as votive offerings within temples (Willcox 1977). This raises a question of whether stone pines are likely to have been imported in different states according to their intended use. Traditionally, when gathered for food, stone pine cones are piled into heaps to dry in the sun to initiate the opening of the cone scales. Subsequently they are beaten or threshed by hand to release the nuts, and the cone scales winnowed off. These early stages are usually conducted close to where the nuts are harvested. The nuts are then crushed or cracked *en masse* to release the edible inner kernel or seed.

There are two obvious disadvantages in transporting whole cones, as opposed to the pine nut or even the separated inner kernel. The first is that it greatly increases the volume of the cargo. Secondly, there is the question of whether if stone pine was transported to England for the nuts, the cones of stone pine are more likely to have been processed immediately after harvest on the Continent, rather than being transported and then processed, especially given the uncertainties of the English summer.

It is possible that cones were occasionally transported, as the evidence discussed by Kislev (1988) suggests, but that such cones were only transported for altar fuel. Equally it is possible that pine nuts were sometimes transported and that cone scales were still present as contaminants, accounting for their presence within charred samples in Britain. Given the small number of finds from Springhead it is uncertain which role their transport to the site served. However, that they were recovered from the Sanctuary site only may suggest that they played at least some role in offerings.

Seeds of grapes (*Vitis vinifera*) are commonly found on Roman sites in Britain, although seldom in great quantity. While archaeological evidence suggests that grapes and wine were likely to be imported (Greig 1991), it is possible that some were locally grown given evidence for probable vine trenches around Wollaston, Northamptonshire (Brown *et al* 2001; Dark 2000). As with grapes, figs (*Ficus carica*) are likely to have been imported, although they too could potentially be cultivated within parts of England (Greig 1991).

Lentils (*Lens culinaris*), like many of the species discussed within this section, have been found most often from sites in proximity to London (Straker 1984; Willcox 1978; Hinton 1988; Davies 2000; Stevens 2009; 2010a), as well as other more Romanised settlements (van der Veen 1991; Murphy 1986; Hall and Kenwood 1990; Helbaek 1964).

Because of the shorter growing season and colder climate, lentil is a difficult crop to cultivate within many areas of England, and as such is usually regarded as an imported species (Straker 1984). Nevertheless, its frequent recovery from rural sites during the Saxon and medieval period has led to the suggestion that it may have been locally cultivated during at least this later period (Moffett 1988; Grieg 1991; Stevens 2004). However, its restricted distribution during the Roman period perhaps indicates it was imported at this time, as with the exception of the 1st century AD and a brief period in the latter half of the 3rd century, the climate is believed to have been similar or colder than present (Lamb 1981; Turner 1981).

The few finds of seeds from herbs and vegetables are perhaps unlikely to derive from imported species and probably represent plants grown within this country. As with the species above, very few of the plants discussed in this section are likely to be found archaeologically as, in comparison with cereals, they are less likely to come into contact with fire.

Finds of coriander come mainly from more Romanised sites, and often from waterlogged deposits (Conolly *et al* 1971; Reid and Lyell 1911; Hillman 1986; Robinson 1976; Wilson 1979; Willcox 1977; Tyers 1988c). Other sites include those peripheral to Roman towns such as Alchester (Giorgi and Robinson 1984) and Innova Park in the Lea Valley (Stevens 2009), although finds from more rural sites in southern-central England are also known (Robinson 1979; Greig 1988). It is the seeds of coriander (*Coriandrum sativum*) that are mainly used as a spice (Apicius, *De Re Coquinaria* 3.11.3, 4.4.1, 4.4.2, 5.2.3), although the fresh leaves were also utilised (Apicius *op cit*, 5.2.3).

Beet (*Beta vulgaris*) has been recovered from a number of sites, including both Romanised and less Romanised settlements (Stephens 2006a; Stevens 2010a; Conolly *et al* 1971; Hall and Kenward 1990). While it is possible that all these finds represented the cultivated form of beet, it might be noted that early writers on beet listing it as a desirable garden cultivar often cite it alongside wild herbs (see Hill 1988; Neckham 1967; Crisp and Childs Paterson 1966), raising the possibility that wild sea beet was cultivated rather than the domesticated form (see Stevens 2006d). As it is the leaves or the root that are most commonly used, the finding of seeds upon archaeological sites is likely to be a rare occurrence. It might, however, be noted that a further possibility is that sea beet (*Beta vulgaris* ssp. *maritima*) can invade arable fields within coastal areas (Hanf 1983).

If the finding of the seed does represent the utilisation of the species, then it is more probable that it was grown for its leaf as opposed to its root. Beet is unlikely to have been cultivated specifically for its swollen root until after the medieval period (Ford-Lloyd 1995). Furthermore, it might be noted that while the root of beet is referred to by Roman writers, for example Apicius (*De Re Coquinaria* 3.2.1, 3, 4;) and Dioscorides (*De Materia Medica*, iv, 153; Gunther 1933), such references appear to relate only to medicinal purposes and on the whole it appears that it was the leaf that was more commonly used.

The finding of a single seed of onion (*Allium cepa*) is of particular interest as, to the author's knowledge, this species has not been reported from Roman Britain before. Finds of possible leek, identified within waterlogged deposits from its leaf (*Allium porrum*) and epidermis, are recorded from Roman Nantwich, Cheshire and York (Tomlinson 1987; Hall and Kenward 1990). Onion is certainly recorded within recipes by the Roman author Apicius, and often those intended for the Roman plebeians as opposed to the Roman elite.

Amongst the other crops, broad bean (*Vicia faba*) and garden pea (*Pisum sativum*) have been recorded from late Bronze Age to Roman sites in Kent (Stevens 2006b). Generally, pea appears uncommonly until the late Iron Age/Roman period, and even within the Roman period, remains of pulse crops from rural sites in Kent are rare and usually confined to no more than a few items (Stevens 2006b; 2006c; Smith and Davies 2006).

Flax, while uncommon within the samples, has also been recorded from within Kent from the late Bronze Age to the late Iron Age (Stevens 2006b; 2010b), and may be cultivated for linseed or for its fibre.

Wild foods, as is often the case within more Romanised settlements such as towns, forts and villas, were fairly common, appearing in well over 50% of the samples, and particularly those derived from more routine waste. As stated above, it would seem probable that many of the stones of *Prunus* sp. come from either sloe (*Prunus spinosa*) or wild cherry (*Prunus avium*). The latter has been identified from Roman sites in London (Willcox 1980), the Thames Valley (Robinson 1979) and Warwickshire (Greig 1988), although it is possible that some examples may be of cultivated or naturalised dwarf cherry (*Prunus cerasus*). Hazelnuts (*Corylus avellana*) may have been collected in quantity from the wild, although they are believed to have been planted by the Romans (White 1970, 259; Zohary and Hopf 2000), and it is possible that they were cultivated in Roman Kent as they are in the county today.

Charred Plant Remains from Northfleet

by Wendy Smith

In total, 247 samples were collected from Roman and Saxon features during the excavations at Northfleet villa (see Vol 4 for analysis of Saxon samples). Preservation of Roman plant remains was of exceptionally high quality and, as a result, some 225 samples scored as rich to super-abundant (A, A*, A**) in terms of the recovery of cereal grain or chaff (Stevens *et al* 2005 and Elizabeth Huckerby pers comm). Selection of samples for full analysis also necessitated consideration of the security of the deposit (many of which were considered disturbed or cross-contaminated), whether the deposit could be dated and whether the deposit replicated another sample. As a result, a total of 44 samples were selected for full analysis, 33 of which derived from Roman contexts. The sorting and identification was much more time-consuming than is usual for archaeobotanical analyses due to the exceptional richness of the Roman charred plant remains, despite sub-sampling, and additional time was required for specifically re-sorting four samples for the recovery of charred insect remains (an extremely rare occurrence in archaeoentomology/archaeobotany nationally; see D Smith, Chap 3). As a result, five further samples were dropped from the analysis of Roman charred plant remains.

The remarkably consistent nature of Roman archaeobotanical deposits (ie cereal chaff-rich, with limited diversity of weed taxa and samples consistently producing coleoptiles), however, meant that analysis of further samples was unlikely to substantially increase the information already gained from the 28 samples which were fully analysed from Roman phases at Northfleet. In total, 92,981 identifications have been made from sub-samples of this Roman assemblage alone.

Methods

Samples were processed on-site by an Oxford Archaeology environmental officer using water flotation. Flots were sieved to 0.25 mm and the heavy residues were sieved to 0.5 mm. All heavy residues were sorted for charred plant remains (along with other artefacts and ecofacts), but only charcoal was recovered from the samples analysed here. Assessment of deposits was 'rapid', primarily focusing on the main categories of charred plant remains (cereal grain, cereal chaff and weed/wild taxa); however, when other taxa (particularly large pulses or hazel nutshell fragments) were observed this was noted. The samples selected for full analysis were preliminarily sorted by Sandra Bonsall (Oxford Archaeology North) and these were then checked by the author to ensure complete recovery of identifiable fragmentary charred plant remains, such as coleoptiles and small fragments of chaff. In addition, the recovery of insect remains in four samples necessitated the careful re-examination of these samples for Coleoptera. Where possible large samples were sub-sampled using the riffling method (van der Veen and Fieller 1982). Samples were sieved into coarse, medium and fine fractions before sorting. In several cases, under-estimation of the quantity of cereal chaff in the medium fraction of the Northfleet villa flots meant that even the selected sub-sample was extremely rich. In these cases, given the available timeframe, it was decided to sort a representative sub-sample of the selected fraction. Where possible both the sorted and unsorted portions were re-sorted by the author; however, several samples were so rich that only the sub-sample of the medium fraction was re-sorted and the scores from these samples have been multiplied up to make up 100% of the medium fraction (ie, if only 1/3 of the medium fraction was fully sorted, the scores were multiplied by a factor of 3 and these scores are indicated with a 'M' in *Tables 92–99*). The sub-samples of the medium fraction were 'representative sub-samples' and were not riffled sub-samples; however, those scores indicated by an M should be seen as merely representative and not statistically reliable sub-samples.

All charred plant remain samples were fully quantified (with the proviso of those samples where the medium fraction was only partially sorted – indicated by an M in the data tables; see above) and identifications were based on whole seeds or plant parts. Quantification of cereal grain and grass caryopses was based on the apical end, primarily because the majority of cereal grain was missing the embryo end. Estimate counts (where fragmentary material was quantified in terms of whole seeds or plant parts) are indicated in the tables by an 'E' and 'guestimate' counts (where the quantity of super-abundant cereal grain or cereal chaff remains is estimated roughly by the volume of known quantities) is indicated by a 'gE' in the tables.

Quantification of sprouts was made on those coleoptiles which had the trefoil-shaped base (two rootlet bases and the base of the acrospire) fully

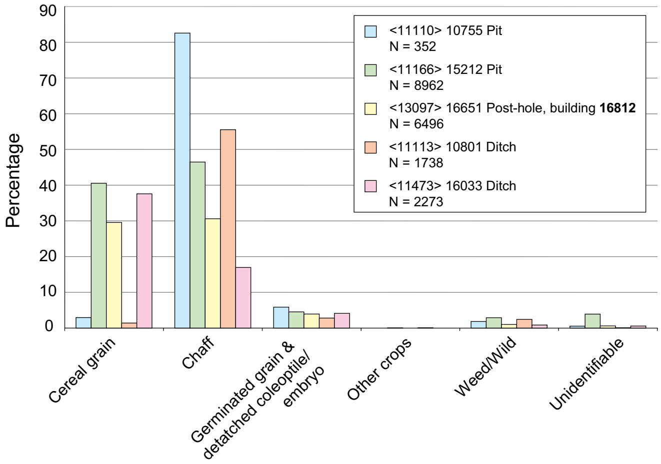


Figure 28 Breakdown of plant categories for charred plant remains from the early Roman phase at Northfleet villa

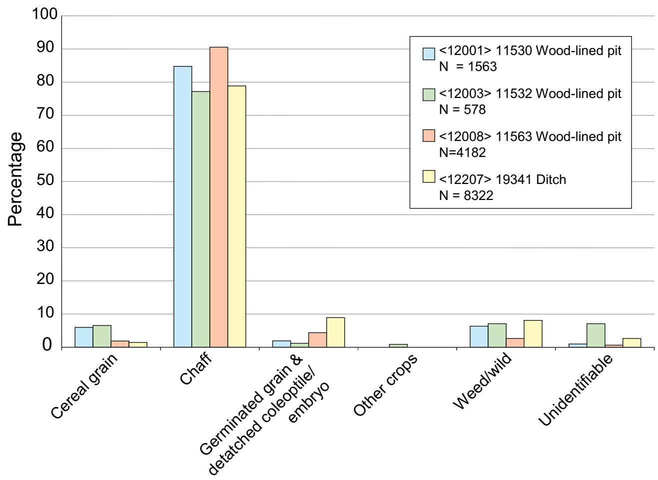


Figure 29 Breakdown of plant categories for charred plant remains from the early – middle Roman phase at Northfleet villa

preserved. This probably under-represents the quantity of sprouts present, but avoided quantification of highly fragmentary sprouts which had broken up along the length, as if they were the same as the largely intact sprouts preserved in several of these samples. The length of the coleoptiles was not measured. In most cases, the tip of the sprout had broken away. However, where sprouts were preserved on the grain they were generally 3/4 the length of the grain and measured between 6–10 mm. Intact, detached coleoptiles also measured 6–10 mm.

Identifications were made at magnifications between x15 and x45 and in comparison with the Oxford Archaeology's reference collection and illustrations or photographs in floras or standard keys (eg, Cappers *et al* 2006; Stace 1997). Nomenclature for the plant remains follows Stace (1997) for indigenous taxa and Zohary and Hopf (2000) for cultivated taxa. The traditional binomial system for the cereals is maintained here, following Zohary and Hopf (2000, 28, table 3 and 65, table 5).

Results

The results for the Roman samples are presented by phase in *Tables 92–98*. The samples span all phases of occupation – early Roman, early–middle Roman, middle Roman and late Roman. In general the Roman deposits are exceptionally well preserved and strongly dominated by spelt (*Triticum spelta* L.) chaff remains. Sprouted cereal grain, detached sprouts (coleoptiles) and detached embryos of cereal grain/large grass (a definite identification is not possible, although it is likely that they are from cereal grain) were recovered in all Roman samples, sometimes in large numbers (eg, 984 minimum number of items (MNI) for a flot from ditch sample 11201, subgroup 16698, feature 10205, context 10203 (a sub-sample of a 4 litre soil sample, equivalent to a flot from 0.25 litres of sediment). Most of the Roman samples were so rich that sub-sampling was necessary (see *Methods*, above).

Early Roman deposits

Five samples were studied from this phase at Northfleet villa – two from pits (samples 11110 and 11166), two from ditches (samples 11113 and 11473) and one from a post-hole (sample 13097), within the first Roman building (*Tables 92* and *98*, Fig 28). All of the assemblages contain mixtures of cereal chaff, cereal grain and detached sprouts/germinated grain; however, the ratio of these three components does vary between samples. Both ditch sample 11113 and pit sample 11166 produced fairly even mixtures of cereal grain (41.2% and 45.0% respectively) and cereal chaff (47.2% and 46.6%, respectively), the post-hole sample 13097 was dominated by cereal grain (62.6%), and the remaining pit and ditch samples (samples 11110 and 11473) were strongly dominated by cereal chaff remains (>88% of all items identified – see *Table 98*). Small quantities (between 4.5% and 6.9% of the overall assemblage) of sprouts (coleoptiles) were recovered in all five early Roman samples. Weed/wild taxa recovered are primarily weeds of arable fields or cultivated/disturbed ground and never accounted for more than 6.9% of all identifications in an assemblage, suggesting that although chaff- and/or grain-rich, these cereal remains may be fully or partially cleaned of contaminants.

The post-hole sample (13097) contained approximately 400 spelt glume bases (an estimated count by volume), so it is likely that the indeterminate wheat grain is spelt. If the majority of cereal grain recovered in this sample had germinated, this could also explain the recovery of frequently warped grain, typically missing the embryo-end (where the grain would sprout); however, definite germinated grain was not identified in this sample. This deposit also produced a few charred remains of granary pests (see D Smith, above).

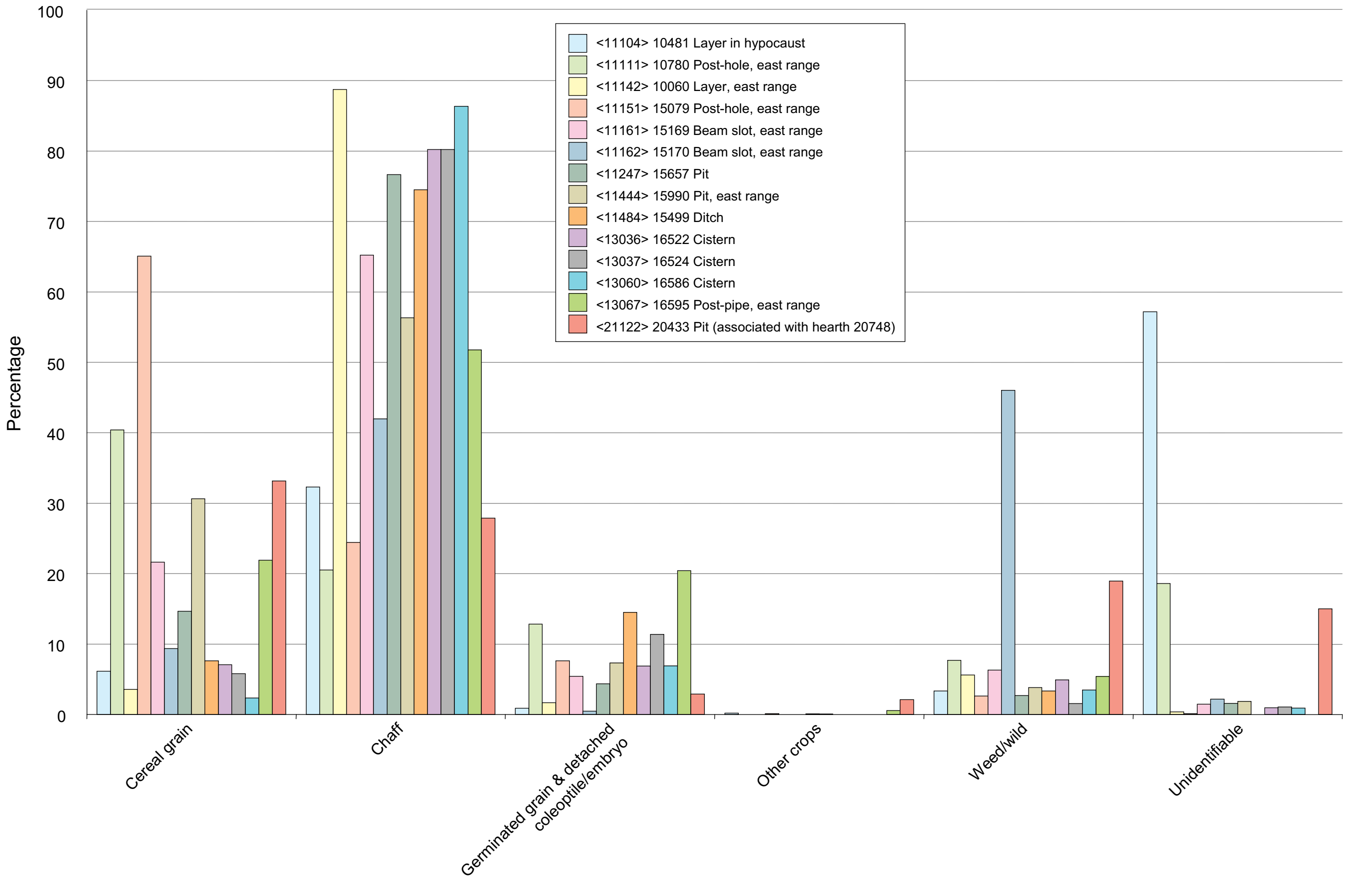


Figure 30 Breakdown of plant categories for charred plant remains from the middle Roman phase at Northfleet villa

Early–middle Roman deposits

Four deposits from this phase were fully analysed – three samples from a wood-lined pit (samples 12001, 12003 and 12008) and one sample from a ditch (sample 12207) (*Tables 93* and *98*, Fig 29). The wood-lined pit and ditch samples were all strongly dominated by cereal chaff (accounting for >75% of all identifications – primarily spelt spikelet forks and glume bases). Detached embryos and sprouts (coleoptiles) were recovered in all four samples, accounting for between 1.2% and 9.0% of all identifications, with several hundred identified from ditch sample (12207). Ditch sample (12207) was exceptionally rich, with 8322 identifications made from a 1/64th sub-sample of the 2.6 l of flot produced from an 18 l volume bulk soil sample (equivalent to 29,589 identifications per litre). The weed/wild taxa identified from this assemblage are primarily grasses of similar size to the spelt chaff, including *Lolium* spp. (rye or darnel grasses), *Avena* spp. (wild or cultivated oat) and indeterminate medium grass caryopses (see *Table 93*); all of which would be difficult to easily remove from cereal products and/or by-products (eg, see Hillman 1981; 1984a; 1984b; 1991, 292). Ditch sample (12207) also produced many charred remains of granary pests (see D Smith above).

Middle Roman deposits

Fourteen samples were fully analysed from this phase (*Tables 94–6* and *98*, Fig 30). These were from a layer within the hypocaust system of the Roman bath (sample 11104), from several features associated with the eastern villa (post-holes 11111 and 11151, post-pipe 13067, layer 11142, beam slots 11161 and 1162, and pits 11247 and 11444), a sample from the boundary ditch (11484), three samples from a cistern (samples 13036, 13037 and 13060) and a sample from a pit (21122) associated with a hearth (feature 20748).

The sample from the hypocaust (sample 11104) was dominated by unidentified remains, most likely as a result of the high temperatures in the heating system for the Roman bath-house. The majority of material which could be identified and quantified was cereal chaff, again primarily spelt glume bases, but also including considerable quantities of silicified wheat (*Triticum* sp.) awn, which are unquantified.

A post-hole (sample 11111), beam slot (sample 11162) and a pit (sample 21122) contained mixtures of cereal grain, cereal chaff, germinated grain and/or detached sprouts and seeds of weed/ wild taxa, which most likely occurred as weeds of the spelt crop. Weed/ wild taxa, most likely weeds of crop, were abundant in beam slot sample 11162. A large quantity of indeterminate medium grass caryopses (N = 126, see *Table 95*), most likely a crop contaminant which would be difficult to remove during normal crop processing techniques without hand-picking (see eg, Hillman 1981; 1984a; 1984b; 1991, 292), was recovered from beam slot sample 11162. Two other samples (post-hole 11111 and

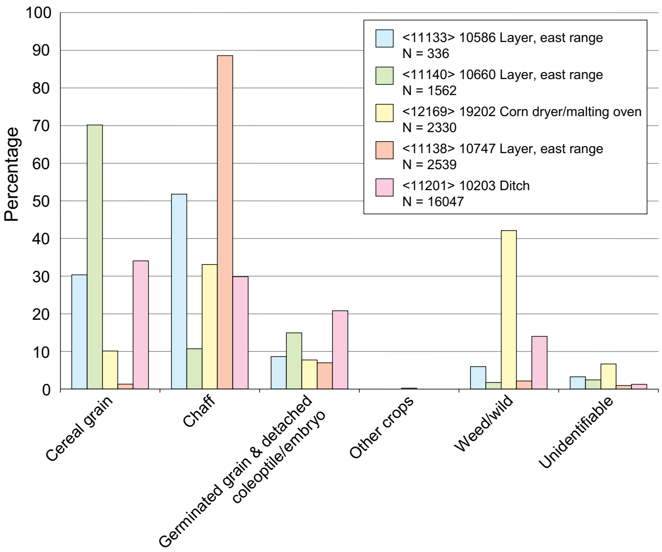


Figure 31 Breakdown of plant categories for charred plant remains from the late Roman phase at Northfleet villa

pit 21122) contained fairly even mixtures of cereal grain and cereal chaff, with accompanying weeds of crop and detached sprouts/germinated grain. All the remaining samples were dominated by cereal chaff remains (primarily spelt), which accounted for 51.8% to 88.8% of all identifications made (see *Table 98*). Germinated grain and/or detached sprouts (coleoptiles) were recovered from all samples accounting for between 0.5% and 20.4% of all identifications made.

Late Roman deposits

Five samples from the final phase of Roman occupation at Northfleet villa were fully analysed – three from ash layers from within the eastern villa (samples 11133 and 11138 from sub-group 15580 and sample 11140 from sub-group 16632), one from a ditch deposit (sample 11201) and a sample from the main square chamber of the crop dryer/malting oven (sample 12169) (*Tables 97* and *98*, Fig 31). In total, these samples, most of which were sub-sampled, produced 22,814 identifications. Both the ditch (sample 11201) and crop dryer/malting oven (sample 12169) samples were extraordinarily rich and exceptionally well preserved.

The three ash layer samples from the eastern villa (samples 11133, 11138 and 1140) all contained mixtures of cereal grain, cereal chaff, germinated grain/detached sprouts and weeds of crop. All three samples produced different proportions of these remains (see *Table 98*). Ash layer sample 11133 was dominated by cereal chaff remains, accounting for 51.8% of all identifications, ash layer sample 11138 was dominated by cereal grain remains, accounting for 70.2% of all identifications and ash layer sample 11140 produced a fairly even mixture of cereal chaff (33.3%) and weed (42.1%) identifications. All three samples contained fairly high quantities of germinated grain, detached sprouts (coleoptiles) and/or detached embryos accounting for between 7.7% and 14.9% of all identifications made in these samples (see *Table 98*). Notably, the crop dryer sample (sample 12169) also produced a fairly even mixture of cereal grain (34.0%), cereal chaff (29.9%), germinated grain/detached sprouts/embryos (20.8%) and weeds of crop (14.0%) (see *Table 98*). Finally, ditch sample 11201 was dominated by cereal chaff remains (88.6%) and also produced charred remains of granary pests (see D Smith, above).

Discussion

The exceptionally well preserved and extraordinarily rich deposits from Northfleet villa provide compelling evidence for crop processing and, specifically, malting activity throughout all phases of Roman occupation on site. Four deposits include charred remains of grain pests (see also D Smith, above). The weed flora is remarkably consistent throughout all phases of the Roman period and is not particularly diverse; however, there is some evidence for cultivation in a variety of soil conditions and limited evidence for nitrogen depletion in soils toward the end of the Roman period. The presence of corncockle, a poisonous weed, in these Roman samples is also of interest. Finally the range of taxa recovered from Northfleet villa compares well with that from other sites in Kent and surrounding counties. The abundance of germinated grain, coleoptiles and detached embryos is, however, unique in the region.

Evidence for crop processing

Since most of the deposits examined here are secondary, it is unlikely that they represent discrete assemblages of crop processing products or even a single crop processing event, but the general makeup of these samples does suggest the presence of at least two types of crop processing residues on site. Both mixtures of cereal grain, cereal chaff and weed seeds and deposits dominated by cereal chaff have been recovered, with remains of spelt and indeterminate glume wheat grain and/or chaff dominant.

The first type of deposit could be described as 'semi-clean cereal remains' and is a mixture of grain and similarly sized weed seeds, such as goosefoot (*Chenopodium* spp.), orache (*Atriplex* spp.), bedstraws (*Galium* cf. *mollugo* and *Galium* spp.), corn cockle (*Agrostemma githago*), docks (*Rumex* spp.), large-, medium- and small-seeded grasses (Poaceae), small-seeded legumes (*Melilotus*/*Medicago*/*Trifolium* and *Vicia* spp./*Lathyrus* spp.), sedges (*Carex* spp.) thistles and/or knapweeds (*Carduus* spp./*Cirsium* spp. and *Centaurea* spp.), nipple wort (*Lapsana communis*), scentless mayweed (*Tripleurospermum inodorum*) and stinking chamomile (*Anthemis cotula*), which are most likely to represent the fine sieve product (ie, the cereal grain and larger-sized weed seeds retained by a fine sieve) (eg, Hillman 1981; 1984a; 1984b; G Jones 1984). Fine sieving was probably performed just before milling (eg, G Jones 1984, 46) or some other activity, such as malting or parching (eg, Hillman 1981, 137). Large seeded weeds of crops were most likely removed by hand prior to preparing the grain for use (ie, milling, parching, malting, cooking, etc; G Jones 1981, 46). The assemblages recovered here appear to represent fine sieved grain, but not fully cleaned grain (although that is not to say that it was not considered clean grain by ancient standards). The second type of deposit is dominated by spelt and indeterminate wheat glume bases and spikelets and contains germinated grain, sprouts (coleoptiles) and detached embryos; sometimes in large quantities (Pls 8–10). This second type of assemblage is likely to be related to a specific form of crop processing (malting) and is worth detailed discussion.

Plate 9 Germinated grain from Northfleet late Roman crop dryer 12591, sample 12169

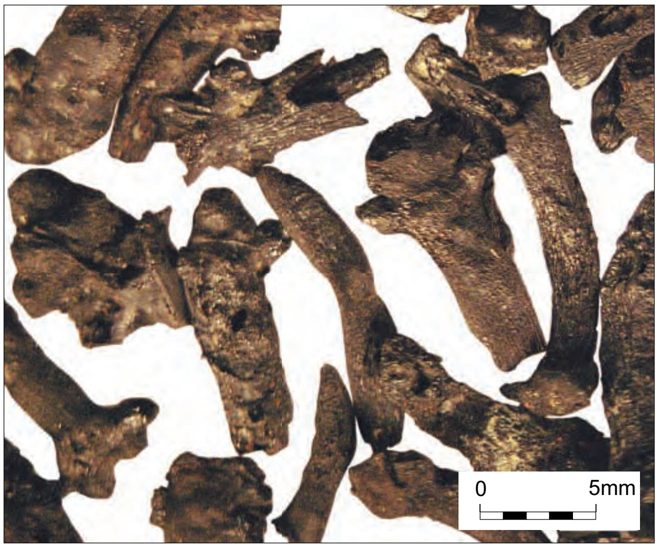


Plate 10 Detached sprouts from Northfleet late Roman ditch 16698, sample 11201

Evidence for malting at Northfleet villa

Malting and crop dryers are contentious issues in archaeobotany. The debate about the precise identification and functions of crop dryers is possibly further complicated by the fact that charring is a biased form of preservation of plant remains and there are a multitude of possible interpretations for charred cereal remains, even if they are directly associated with a crop dryer (eg, van der Veen 1989). Only one (sample 12169) of the 28 Roman samples analysed here was directly associated with a crop dryer, the remainder were from layers/structures, post-holes, beam slots and post-pipes and clearly secondary deposits such as ditches, wells and pits. Yet these 28 samples have consistently produced the following pattern from all phases of Roman occupation at Northfleet villa:

- abundant spelt and indeterminate glume wheat spikelet forks and glume bases
- coleoptiles recovered in all samples
- detached embryos recovered frequently and abundant in several samples
- germinated grain present in several samples. In some cases, germinated spelt grain is still held within the spikelet
- charred cereal grain, frequently missing the embryo-end, where it would germinate (or sprout).

Sprouted grain or detached sprouts/embryos can occur for one of two reasons – the grain has become wet accidentally and begun to sprout and therefore is spoiled; or the grain can be intentionally germinated and that germination can be arrested by heating the grain to make malt. An accident, although possible, seems unlikely given the ubiquity of evidence for germination – all 28 samples have produced such evidence. As a result, it seems likely that the assemblage from Northfleet villa reflects regular and repeated charring related to cereal crops and in this case, given the evidence for germinated grain, the most likely explanation is that malting was regularly carried out at Northfleet villa throughout the entirety of the Roman period.

The process of malting transforms starch within cereal grain to sugars, which fuels yeast during fermentation. Malt is produced by allowing the cereal grain to germinate and then arresting this process at the point where the sprout (coleoptile) is approximately the length of the cereal grain, by heating the germinating grain (Corran 1975, 11–12). Malting has two primary results:

- germination converts the starch stored in the grain to sugars (collectively known as diastase), which yeast can feed on during fermentation (Corran 1975; Hagen 1999, 205–9).
- malting results in a partial breakdown of the structure of the barley grain (this applies to any grain), which makes it easier to crush (Corran 1975, 12) and easier to digest (*ibid*, 16).

Once made, malt can be stored for up to one year before use (*ibid*, 12). In order to make beer or ale, the malt is coarsely ground and mixed with hot water at approximately 65°C in a process known as 'mashing' (*ibid*, 12). Mashing produces a product known as 'wort' (a brown liquid essentially made of malt sugar) and a by-product of husks of cereal grains, with little or no sugar content. The mashing by-product was often used as a fodder in the Saxon period (Hagen 1999, 105). In addition, it is clear that malt can be traded and exchanged as a product (eg, *ibid*, 212–3). Interestingly, even late 19th and early 20th century malters viewed malting as a winter activity that was good for the 'down time' in the agricultural year (Underdown 2003, 6 citing Evans 1970) and this appears to continue to be the case in early modern times (Underdown 2003, 56 citing a 1936 interview in the *Norfolk Chronicle*).

At Northfleet villa, grain is less well preserved than chaff and is usually missing its embryo end. This could be explained as an effect of germination, which is likely to damage, if not destroy, the embryo end of the cereal grain. The recovery of so much cereal chaff with germinated grain, sprouts (coleoptiles) and detached embryos is, however, somewhat more difficult to explain. One possible explanation is that at Northfleet villa spelt was malted whilst still within the spikelet (an ear of spelt is made up of a number of spikelets – a spikelet comprises of two glume bases and a rachis node, which usually tightly encase two spelt grains). Middle Roman cistern sample 13037 and post-pipe sample 13067 and late Roman ditch sample 11201 have produced intact spelt spikelets (ie, with the grain still held within the spikelet), and sample 13037 also produced a few clearly germinated spelt grains still held within their surrounding chaff. In addition the recovery of intact spelt spikelet forks was frequent, with 21 of the 28 samples producing them. In discussing the use of hulled barley in malting, Ross-Mackenzie (1934, 13) suggests that free-threshing wheat (assumed to be the case given the date of publication) was not used for malting because the 'acrospire grows through the pericarp' and is, therefore, far more liable to be damaged during the malting process (ie, as malt is raked or turned to produce even germination). Germinating spelt in the spikelet, however, would circumvent this problem and the glumes, which tightly encase the cereal grain, would ensure that the sprout (coleoptile) remained protected, tight against the grain. Indeed, all of the germinated grain where the coleoptile was preserved for any length had sprouts tightly adhering to the grain and those germinated grains without a coleoptile were deeply grooved, where the sprout had obviously been lying flat along the grain.

A key stage in some malting processes was the removal of the 'roots' or 'rootlets' (ie, the sprouts or coleoptiles) from the dried malt product, just before brewing (eg, Briggs 1998, 8, 10; Glamann 2005, 23). If the 'roots' or 'rootlets' (ie, sprouts or coleoptiles) were not removed, they would give a bitter flavour to the beer (or ale) (Glamann 2005, 23). In discussing Pharaonic brewing methods for emmer (another archaic wheat, quite similar to spelt), Corran (1975, 20) suggests that the removal of germinated grain from cereal ears (presumably meaning spikelets) was a laborious process and only carried out on a small-scale, perhaps 'in private houses or small breweries'. One of the difficulties for the archaeobotanist is that traditional, non-industrial methods of brewing and malting are not well documented and even in the historic period individual stages of malting are frequently glossed over, most likely because brewers fiercely guarded their malting 'recipes'. Nevertheless, this critical stage of removing the surrounding chaff and 'rootlets' or sprouts from the cereal grain does fit the repeated data pattern at Northfleet villa; suggesting that once the spelt grain was malted within the spikelet the majority of cereal grain was separated from the by-product chaff and sprouts (coleoptiles).

The by-products of malting, the unwanted chaff and sprouts (coleoptiles), also have uses. Briggs (1998, 8) suggests that rootlets are sold for animal feed, along with the 'grain-dust'. The chaff is also of use, with documentary and ethnographic evidence suggesting that chaff was frequently used as fuel for grain parching (malting) (eg, Hillman 1981); and, certainly in Essex, medieval inventories suggest that straw was the most common fuel used in malting (Crosby 2000, 41). The frequent recovery of samples which primarily contain charred spelt and indeterminate wheat chaff and detached sprouts (coleoptiles) and embryos at Northfleet villa may be explained as the use of malting by-products for fuel. Germinated grain, detached embryos and coleoptiles never amount to more than 20% of the identification from an individual sample (see *Table 98*), and are clearly outnumbered by cereal chaff remains; suggesting that all of these deposits are most likely the remains of chaff (in this case primarily spelt and indeterminate wheat spikelets and glume bases) used as fuel. The ubiquity of germinated grain, detached embryos and coleoptiles in the Roman samples, however, suggests that malting was regularly occurring on site or nearby. Unfortunately, it is not possible archaeobotanically to irrefutably prove malting; however, with only two possible interpretations – an accident where grains sprouted in storage or intentional sprouting of grain to make malt for brewing – cereal storage/processing at Northfleet villa must have been an activity extraordinarily prone to accidents if they were not malting.

What is of interest is that with the exception of the late Roman crop dryer – which is an obvious place to make malt during that period – where and how malting occurs in earlier periods on site is not clear. However, the wood-lined pits and cisterns on site may be likely candidates for such activities (see discussion by Biddulph, Vol 1, Chap 4). Indeed, this is a wider issue as the 'vast majority of corndriers date to the third and fourth centuries AD' (van der Veen 1989, 302 and pers. comm. Paul Booth). How and where malting was carried out at Roman sites prior to the use of crop dryers remains unknown. The difficulty of archaeological recognition of the malting process is well known (eg, discussion in Cool 2006, 142–3).

Charred preservation of granary pests

Four samples from Northfleet villa contain the charred remains of granary pests: an early Roman post-hole (13097), an early–middle Roman ditch (12207), a middle Roman cistern (13060) and a late Roman ditch (11201). David Smith (see Chap 3) has identified the granary weevil (*Sitophilus granarius*) and the saw-toothed granary beetle (*Oryzaephilus suranimensis*), as well as unidentified grubs in the post-hole and cistern samples. The charred remains of granary pests from two ditch deposits (samples 11201, early–middle Roman, and 12207, late Roman) are particularly rich and were fully analysed (see D Smith, Chap 3). In addition, waterlogged granary pests were recovered from deposits within the cistern (sub-group 16731).

The recovery of charred insect remains is extremely rare in Roman deposits. Only a few other deposits have been reported in England – at 5 Rougier Street, York (Hall and Kenward 1990), Coney Street, York (Kenward and Williams 1979), Malton, Yorkshire (Buckland 1982) and Droitwich, Worcestershire (Osborne 1977). The early 3rd century AD grain from Malton does not appear to have been germinated (Buckland 1982 citing unpublished data on re-examination of material by Allan Hall; Jessen and Helbaek 1944); however, deposits at 5 Rougier Street, York and Droitwich clearly were sprouted. The insect remains recovered from late 2nd century AD charred grain at 5 Rougier Street suggest a mixture of 'charred and rotting grain' (Hall and Kenward 1990, 383). Straker (2006, 221) notes that a great deal of the spelt in the Droitwich burnt grain deposit (4th century AD) had sprouted, 'with some sprouts running the whole length of the grain' and (*ibid*, 222) has interpreted this assemblage as spoiled grain (ie, grain which accidentally germinated in storage), possibly due to poor storage conditions, rather than malt. The late 1st/early 2nd century AD charred grain from Coney Street was also germinated (the proportion was not given, but Williams (Kenward and Williams 1979, 57) notes germination had occurred 'particularly of the wheat'). At Coney Street, York, one charred granary weevil (*Sitophilus granarius*) was recovered, along with a few waterlogged remains of the flat grain beetle (*Cryptolestes ferrugineus*) and the saw-toothed grain beetle (*Oryzaephilus surinamensis*). However, the deposit beneath this, which sealed the foundation of the structure in which the charred grain was stored, contained much more abundant waterlogged remains of granary pests (eg, *Cryptolestes* cf. *ferrugineus*, *Oryzaephilus surinamensis* and *Sitophilus granarius*), which could conceivably have percolated downward into the foundations during grain storage.

The Northfleet villa infested ditch samples were both phenomenally rich. The middle Roman ditch sample 12207 produced 8322 identifications from a 1/64th sub-sample of a 2.6 litre flot produced from 18 litres of sediment (ie, 8322 identifications from 0.28 litre of sediment). The late Roman ditch sample 11201 produced 16,047 identifications from a 1/16th sub-sample of a 1.01 litre flot produced from 4 litres of sediment (ie, 16,047 identifications from 0.25 litres of sediment). Cereal chaff remains, which are primarily spelt and indeterminate wheat spikelet forks and glume bases (88.6% in sample 12207 and 78.9% in sample 1120), dominate both samples. Each contains fairly large quantities of germinated grain, sprouts (coleoptiles) and detached embryos (N = 745 for sample 11201 and N = 1122 for sample 12207 – in both cases this score is the minimum number of items, see *Table 98*) accounting for 7% of all identifications in sample 12207 and 9% of all identifications in sample 11201. Cereal grain identifications from samples 11201 and 12207 are remarkably low (120 and 212 grains respectively). Archaeologically, neither deposit produced substantial quantities of sprouted grain. If this was spoiled grain – ie, accidentally germinated – and infested, one would expect the deposit to be made-up primarily of cereal grain (as was the case at Droitwich, Straker 2006). However, only the post-hole sample (sample 13097 – 62.6% cereal grain) was dominated by cereal grain, the other three infested deposits were strongly dominated by cereal chaff (ie, >75% of all identifications).

Certainly, given the likelihood that grain will survive charring better than cereal chaff (Boardman and Jones 1990), it seems probable that the four infested chaff-rich deposits are a by-product of a cereal processing activity, whereby the cereal grain was separated from its surrounding chaff and sprouts (coleoptiles). As discussed above (see section on Roman malting at Northfleet villa), the most likely interpretation of such an assemblage is that this represents the by-product, after malting, where the chaff and 'rootlets' (ie, sprouts/coleoptiles) are removed from the malted grain prior to brewing. This waste material is combustible, and is a likely source of fuel.

Presuming the interpretation is correct; we then have to consider its implications. In particular:

- Was this infested malt intentionally burned for disposal?
- Was this infested malt brewed anyway?

If these deposits represent the intentional disposal of infested malt grain, given that cereal grain is more likely to survive charring than cereal chaff (Boardman and Jones 1990), one would expect to have recovered substantial quantities of cereal grain. However, as discussed above, only small quantities of charred grain were present in either ditch sample. Nevertheless, the infested post-hole sample 13097 (62.6% cereal grain, 28.2% cereal chaff and 6.9% germinated grain, coleoptiles and detached embryos – N = 6496 from 10 l of sediment) was dominated by cereal grain, so either interpretation is possible at least for this particular sample.

If, in fact, we have three examples of infested by-products of the malting process (small quantities of charred insects in sample 13060 which was 86.4% cereal chaff, and larger quantities of insects in samples 11201 and 12207; however, bearing in mind that waterlogged granary pests were also recovered from the cistern sub-group 16731), we actually are in a situation where infested malt was brewed, possibly in spite of known infestation. Surveys of fully or partially traditional malting premises in the UK (1930s–1960s) clearly demonstrate that insect infestation is common, even when production is fairly modernised (eg, Freeman 1951; Hunter *et al* 1973; Munro 1940; Pattinson 1958; Tebb 1968). Most interestingly, in a survey of insecticide practice during the 1960s (Hunter *et al* 1973, 124–5), 35% of the malt stores were not sprayed for insects until they were actually observed to be infesting malt in storage. In their survey of infestations in various areas of a malthouse, Hunter *et al* (1973) establish that live infestations of *Oryzaephilus surinamensis* and *Sitophilus granarius* can occur in store (in this case barley grain stores), on the growing floor (where grain is germinated in moist conditions) and in the malt store. As a result, it is not possible to establish at what stage in the procedure the spelt from Northfleet villa became infested; however, because sprouted grain, sprouts (coleoptiles) and detached embryos are present, it is clear that malted grain (most likely spelt) was infested and this could have occurred at any point from storage of harvested grain, through to the growing floor and on to malting and storage of malt, prior to brewing. Low-level insect infestations can be and are clearly tolerated (eg, Briggs 1998, 275–283, Hunter *et al* 1973; Tebb 1968); however, there is a tipping point where grain is so infested that taste can be affected. This is particularly the case if grain/malt is infested by mites whose oily secretions have ‘a penetrating and unpleasant smell that leaves an offensive taint and taste’ (Briggs 1998, 280) to beer or ale, which can be more easily detected than the mites themselves (which range from 0.4 mm to 0.5 mm in length).

Evidence of infested grain is found in examples from around the ancient world (eg, Buckland 1978; 1982). At Northfleet, it seems likely that some of the grain malted and presumably brewed was infested. Whether the malters or brewers knowingly worked with infested grain is not known, but the following is possible:

- Infested grain could be malted and brewed unwittingly without any noticeable effect on the taste
- Infested grain could be malted and brewed knowingly, without any noticeable effect on the taste
- Infested grain could be brewed knowingly to produce a sub-standard product which was sold intentionally

Of course, the tradition of selling sub-standard goods to armies of occupation is well-known in more recent times and there is no reason to believe that similar sharp practices did not occur in the past. Britain is not a well-documented Roman province, but records from *Vindolanda* do specifically make reference to the supply of beer to soldiers (Bowman and Thomas 2003, 84, no. 628) and the supply of some 90 litres of beer to the *Vindolanda* commanding officer’s house in a one-week period in the month of June (Bowman and Thomas 1994, 153, no. 190; Cool 2006, 142). If the *Vindolanda* records are typical of the requirements of the occupying force in terms of ale/beer, it does seem likely that the villa at Northfleet may have been an active supplier to that market (although most likely locally, to the nearby Springhead town and temple complex and possibly even to London).

The Roman weed flora

The weed flora in the Roman samples was remarkably consistent; with the majority of weed/wild taxa typically occurring as weeds of arable crops or cultivated/disturbed ground (see *Table 99*). The four most consistently recovered taxa – dock (*Rumex* spp.), scentless mayweed (*Tripleurospermum inodorum* (L.) Sch. Bip.), rye-grass (*Lolium* spp.) and wild or cultivated oat (*Avena* spp.) – were present in all Roman phases. However, it appears that small leguminous taxa become more frequent in later periods (see especially the sample of a late Roman ash layer in the eastern villa (sample 11140) where 30% (N = 466) of all identifications from this sample were small-seeded vetch/vetchling species (*Vicia* spp./*Lathyrus* spp.)), which typically thrive in nitrogen-depleted soils. It is well recognised that crop processing differentially removes weed seeds on the basis of their size and/or weight (eg, G Jones 1981; 1984; 1987; 1996); therefore, it is difficult to ascertain the proportion of vetches in relation to the entire arable weed flora (see also discussion of this issue in Straker 2006, 222), so it is only possible to suggest limited evidence for a decline in soil fertility throughout the Roman period.

The recovery of certain weed/wild taxa does provide some insight into the types of soils cultivated (most likely for spelt cultivation, since these taxa were recovered with abundant spelt and indeterminate wheat chaff remains). Scentless mayweed (*Tripleurospermum inodorum*) most typically occurs on soils of medium or light texture; however, it can be ‘locally well-established’ on heavy soils and in poorly drained sites (Kay 1994, 682). Scentless mayweed’s range extends to the northern limit of arable cultivation in Britain; however, it is ‘unable to maintain itself in conditions of high summer temperatures or summer drought’ (*ibid*, 682). Stinking chamomile (*Anthemis cotula*) frequently occurs on heavier soils (Stace 1997, 733) and taxa such as rush (*Juncus* spp.), common/slender spike-rush (*Eleocharis palustris*/*uniglumis*), and sedge (*Carex* spp.) are all typical of wet or damp soil conditions.

The recovery of corncockle (*Agrostemma githago*) in some of the Northfleet samples is of interest. Corncockle seeds are poisonous and difficult to clean from cereal crops, because the seeds are roughly the same size as cereal grain and, therefore, are unlikely to be removed by sieving. Bread made from flour contaminated by corncockle could lead to serious illness, especially in the young or elderly (Hall 1981). As a result laws were passed in the medieval period to try and prevent the sale of grain containing high proportions of corncockle. At Northfleet villa, however, only small quantities of corncockle seed and possible corncockle calyx fragments were recovered, so it seems unlikely that in this period corncockle presented a major problem; however, the presence of seed in fully processed crop by-products does suggest that it would be present in seed corn and, therefore, continue if not increase in frequency in future crops.

Comparison with other Roman sites

The charred plant remains from Northfleet villa compare well with other results along the Channel Tunnel Rail Link route. Thurnham villa (Smith and Davies 2006), Springhead (see Stevens, above) and Bower Road (Stevens 2006c) all have produced abundant spelt and indeterminate glume wheat chaff remains. Stevens reports that there is abundant evidence for malting at Springhead. Remains from north of Saltwood Tunnel (Stevens 2006b) were not as rich, but spelt and indeterminate glume wheat chaff were frequently recovered and often dominant in individual assemblages. Only two villa sites in Kent have significant published results – Keston (Hillman 1991) and The Mount (Robinson 1999). The assemblage from Keston was extremely small (<15 identifications) and therefore not interpretable, but spelt grain and chaff were presented as well as indeterminate germinated grain. The assemblage from The Mount produced abundant spelt and glume wheat cereal grain and chaff remains, with cereal chaff dominant in several samples (Robinson 1999, 148). The range of weed taxa recovered from deposits at The Mount (*ibid*, 148) is remarkably consistent with that recovered from Northfleet villa. Robinson (*ibid*, 149) has also recovered malting evidence in samples largely dominated by cereal chaff from two samples at The Mount and interpreted these as 'burnt debris from the rubbing of parched, malted, spelt wheat in order to remove the husks and sprouts prior to grinding then brewing'. The Mount and Northfleet villa results do suggest that brewing was an activity regularly carried out at villas in the area and, possibly, given the ubiquity for malting evidence from Northfleet, carried out on a large scale. This type of result has also been identified elsewhere in Kent. At Springhead Roman town, Campbell (1998, 37) recovered a 'a large amount of wheat chaff associated with cereal sprouts', which she also interpreted as 'waste derived from the de-husking of malted grain or 'comings'. Similar deposits have been identified elsewhere in Britain; at Bancroft villa, Buckinghamshire (Pearson and Robinson 1994), Catsgore, Somerset (Hillman 1982) and at Alcester, Warwickshire (Pelling 2000, 54–6). What is unique about Northfleet is that the combination of spelt chaff in combination with sprouted grain, detached sprouts (coleoptiles) and embryos is found so frequently (17 of the 28 samples studied), whereas all of these other sites have only produced one or two examples. This strongly suggests that malting at Northfleet villa was likely to have been carried out on a large scale in order to leave such a strong archaeobotanical footprint.

Conclusions

Sampling from Northfleet villa has produced charred plant remains covering all phases of the Roman period, and they were extraordinarily rich and extremely well preserved. In total 28 Roman samples were fully analysed, all of which exhibited evidence for cereal grain germination (most likely of spelt wheat), 17 of which provided strong evidence for de-husking of malted grain – a critical stage in the brewing process, occurring before mashing malted spelt, where the surrounding chaff and sprouts are rubbed off. Such a density of archaeobotanical evidence is unprecedented in the British archaeological record and strongly suggests that malting was carried out on a large scale at Northfleet villa. Four of the Roman samples contained charred remains of granary pests – an extremely rare occurrence in archaeoentomology/archaeobotany in England. Only four other sites have produced such results and in each case only one deposit with such evidence was recovered. Such a result highlights the extremely high quality of preservation of charred plant remains on site and the recovery of multiple infested samples on site may suggest that low-levels of infestation were common at Northfleet villa.

Wood Charcoal

by Catherine Barnett

Following assessment, selected samples were chosen for full charcoal analysis in order to investigate aspects of the functional, industrial and economic history of the Springhead and Northfleet sites, and also to consider selection, management and exploitation of local resources in the Ebbsfleet Valley (Tables 100 and *104*).

Methods

All wood charcoal >2 mm was separated from the flots processed for charred plant remains and the residue scanned or extracted as appropriate. Large samples were sub-sampled, with fragments chosen at random to a level that allowed characterisation of the assemblage, normally 25–50%; smaller samples were analysed in their entirety. Fragments >2 mm were prepared for identification according to the standard methodology of Leney and Casteel (1975; see also Gale and Cutler 2000). Each fragment was fractured with a razor blade so that three planes could be seen: transverse section (TS), radial longitudinal section (RL) and tangential longitudinal section (TL). The pieces were mounted on a glass microscope slide using modelling clay, blown to remove charcoal dust and examined under bi-focal epi-illuminated microscopy at magnifications of x50, x100 and x400 using a Kyowa ME-LUX2 microscope. Identification was undertaken according to the anatomical characteristics described by Schweingruber (1990) and Butterfield and Meylan (1980) to the highest

Table 100 Summary of late Iron Age–Roman charcoal samples from Springhead (ARC SPH00 and ARC SHN02)

Phase	*Category*	*Feature type*
LIA	?Domestic	Pit
RB	Agricultural/food preparation	Corn dryer x1
	Domestic	Pot oven x3
		Hearth
	Ritual	Temple floor x3
	Funerary	Box burial (cremation)
		?Cremation burial
		Grave
		Pot burial
	Industry	Pit with smithy waste
	Other	Tank lining
		Roadside ditch adjacent to smithy

taxonomic level possible, usually that of genus, with nomenclature according to Stace (1997). Individual taxa were quantified (mature and twig separated), and the results tabulated (see *Tables 102–103, 106*).

Springhead

The samples chosen from late Iron Age and Roman contexts at the Sanctuary site (10 samples) and the Roadside Settlement (six samples) include domestic, funerary, ritual, industrial, agricultural and food preparation contexts. A summary of the feature types represented is given in Table 100.

The taxa identified from the wood charcoal assemblages of late Iron Age to Roman date at Springhead are listed in *Table 101*. Full details and quantification of the individual assemblages for the Sanctuary site are given in *Table 102* and for the Roadside Settlement in *Table 103*. Only one assemblage derives from a late Iron Age feature (3027), the majority of the remainder being early Roman, with four (5906, 5917, 18892, 12223) of middle and just two (12351–2) of late Roman date.

Sanctuary site late Iron Age pit 3027

A moderate-sized mixed assemblage of common deciduous types was recovered from context 3028 (late Iron Age pit 3027). Oak (*Quercus* sp.), field maple (*Acer campestre*) and hazel (*Corylus avellana*) dominate, but the assemblage also includes lesser quantities of ash (*Fraxinus excelsior*), alder (*Alnus glutinosa*), bird cherry (*Prunus avium*) and blackthorn (*Prunus spinosa* type), indicating their local availability at Springhead in the late Iron Age. The assemblage is not distinctive in character, but general domestic use as fuel is probable.

Crop dryer 2711, Sanctuary temple floor 5906, 'tank' lining 5917

These three large (40–75 g) charcoal assemblages were entirely of oak, mainly large mature pieces, some quick-grown, with rare roundwood fragments. In the case of the temple floor, the assemblage indicates *in situ* burning and collapse of a structural element such as a roof truss, rather than being related to the religious/ritual use of the temple. Oak was clearly both available and specifically targeted for both fuel purposes and structural use at this time. Coupled with the widespread occurrence of oak in most samples from Springhead, the possibility of deliberate management and cropping of oak arises.

Hearth 6015

The small wood charcoal assemblage from this domestic hearth was dominated by oak and oak roundwood but also contained lesser quantities of field maple, ash and elm (*Ulmus* sp.).

Pot ovens 5405 and 5942

The fuel/tinder used within the two pot ovens proved quite different in nature. The assemblage in 5405 was dominated by small (1–2 year) twigwood and numerous small, unidentified, buds, the twigs including oak and possible cherry type (*Prunus* sp., eg, bird cherry or blackthorn). In contrast, the fuel selected for use in 5942 was of mature and roundwood oak, field maple and hazel. Local collection is suggested and the differing assemblages may be indicative of differing cooking requirements, with that in 5405 being quick to light and burn at high, flashy heat, and that in 5942 on the other hand burning more steadily and for longer.

Cremation/box burial 6345, grave 6607, grave 6608/6610

These funerary features provided some of the most noteworthy wood charcoal assemblages from Springhead and Northfleet. The charcoal from cremation burial 6345 was dominated by oak, as would normally be expected, due to the long hot burn required which dense oak heartwood is capable of providing (as observed for pyre debris at other sites, for example West Malling, Kent (Barnett 2009)). However, other types were found in lesser quantities including hazel, ash, pomaceous fruits, elm and the only occurrence of yew (*Taxus baccata*) in this analysis. All the types found have some meaning or spirituality in traditional lore and may have been deliberately introduced to the pyre as objects, funerary furniture (eg, a bier or stretcher), or simply as unworked wood, but yew is of particular note in this context. It has long been associated with death, immortality and renewal, as indicated by deliberate planting by pagans at wells and springs and by Christians in graveyards (see Cornish 1946, 1–111; Chetan and Brueton 1994, chapter 5; Bevan-Jones 2002, chapters 3 and 5), and its use for ritual objects and decoration (Chetan and Brueton 1994, chapter 10). That this is the single representation of the species suggests that it was not a common tree at Roman Springhead and supports an interpretation that it was selected specifically for the cremation. Gale (1997; Gale and Cutler 2000) also noted the inclusion of yew in pyre debris and a cremation burial at Westhampnett and at Baldock Bypass, and similarly suggested ritual significance.

Several taxa were represented in the wood from grave 6608/6610, an enigmatic feature that was certainly intended or was used for burial but which contained no surviving human bone. The charcoal assemblage, though dominated by oak and hazel, also included field maple, ash, Pomoideae (probably hawthorn, *Crataegus* type), elm and willow/aspen (*Salix/Populus* sp.). Such a wide range in this small assemblage is of note in itself, but of exceptional interest were the finds of single fragments of traveller's joy (*Clematis vitalba*) and possibly laburnum (cf *Laburnum* sp.). It is feasible that the former, a woody hedgerow and open woodland climber, was accidentally introduced to the remains through adhering to another wood type. However, the presence of this taxon, valued and cultivated today for its pretty scented flowers, along with the possible non-native laburnum, also particularly prized for its long racemes of yellow flowers, does suggest an interpretation of deliberate placement in this funerary context as an offering or mark of respect. If flowering stems were used, the two together indicate deposition in late spring to early summer. It may also be of interest that the seeds of laburnum are highly poisonous to humans (Phillips 1978; Stace 1997), hence it has some connection with death and renewal. How the woods came to be burnt, if not part of a cremation, is unclear, but a small, deliberate funerary-associated fire is indicated.

The assemblage from grave 6607 (?part of grave 6608/6610) was far simpler; it was dominated by oak and oak roundwood, but also contained wood of pomaceous fruits (Pomoideae) and juvenile elm. Most of these fragments were glassy and vitrified, indicating burning at a particularly high temperature. As an inhumation grave, it is not clear why charcoal occurs in the feature, but the burial is partly disturbed and the charcoal assemblage is small, at 4 g, and mixed in terms of taxa. It may be that some or all of the charcoal derives from nearby cremation burial 6345 or background scatter.

Roadside Settlement Roadside ditch 11388

Although the upper charcoal-rich fill of this ditch is believed to just predate the adjacent smithy (in property 10), it was questioned whether this might be smithy waste. In fact, the charcoal assemblage contains a large number of open woodland/hedgerow taxa and a high proportion of young wood and twigwood, which together suggest localised clearance by burning, perhaps to make way for the construction of the smithy itself. The assemblage provides a useful indication of the type and structure of the semi-natural vegetation locally. The probable hedgerow represented was composed of field maple, birch, hornbeam (*Carpinus betulus*), hazel, ash, oak, pomaceous fruit (eg, whitebeams, hawthorn), elm and one or more members of the Rosaceae family. It can be seen, therefore, that the local flora was rich and diverse in species and hence in potential resources offered, not least for food in the form of nuts (eg, acorns and hazelnuts), fruit (eg, of the Rosaceae) and sugary sap (field maple).

Pit 10590

This pit contained a substantial dump of charcoal and slag related to use of the smithy (property 10). Mature oak proved to be the dominant fuel type at 89%, with lesser amounts of roundwood oak, ash, hazel and field maple. Many of the fragments contained redeposited iron (hammerscale), unsurprising given the association with metal-working, and a quarter were vitrified, an indication that high temperatures (>800° C, see Prior and Alvin 1983) were required and achieved, appropriate for both iron smithing and copper alloy working.

Pot burial 12223

Small quantities of several species were identified in this assemblage, including field maple, birch, hazel, ash and pomaceous fruits, but oak heavily dominated. The feature is an infant inhumation (in property 2), not a cremation burial, yet the charcoal assemblage is relatively large at 14 g, including a number of large oak pieces. The context is quite secure with only slight disturbance in antiquity and it is suggested the assemblage might relate to the lighting of a small fire at the time of burial.

Temple floor, contexts 12351 and 12352

These moderate-sized charcoal assemblages (7 g and 21 g respectively) from the temple floor in property 2 proved to be quite different in nature, the differences perhaps in part related to specific selection by individuals for different purposes.

Oak dominated context 12351 at 69%, but smaller quantities of elm and ash were identified. Three pieces of young viburnum (*Viburnum* sp.) wood were also present, the only representation of this species found during this analysis. The native species, *V. lantana* and *V. opulus* both grow in open woodland, scrub and hedgerows in southern England, but the latter (an ancient woodland indicator) is more common on base rich soils (Stace 1997).

The wood charcoal assemblage from context 12352 contained more taxa, with substantial quantities of field maple (at 20%), hazel (30%), hawthorn-type Pomoideae (16%) and oak (28%). Single but significant occurrences of sweet chestnut (cf *Castanea*), an introduced species, and the evergreen tree/shrub holly (*Ilex aquifolium*) were also identified, again the only representation of both at Springhead. The use of three species found in no other context at Springhead may well be significant given the religious/ritual importance of the temple. It might be that each was selected as special for particular properties, such as smell or due to some perceived spiritual meaning. The dried bark of viburnum ('Cramp Bark'), for instance, has a number of medicinal uses, notably as a sedative and anti-spasmodic (Culpeper 1653; Grieve 1931). Sweet chestnut was introduced by the Romans (Godwin 1975, 277) for its edible nuts which could be ground into flour and also for its durable timber (Grieve 1931; Taylor 1981, 54). Holly has many ritual uses and the Romans are said to have presented boughs of holly as gifts at the festival of Saturnalia, while Pliny stated that holly planted by a house repelled poison and witchcraft (Grieve 1931).

Sunken-featured building 11892

The small (4 g) wood charcoal assemblage from layer 11896 in this structure (property 12) included small quantities of birch, dogwood (*Cornus* sp.), ash and common oak, but comprised *c* 50% pomaceous fruit wood. The anatomical consistency of the 22 fragments and their exceptional preservation allows a tentative identification more specific than usually achieved for this type. They compare well with the Maloideae, a sub family of the Pomoideae, which includes apples, quinces, pears and whitebeam. If this building was agricultural, as suggested, one of the edible types harvested as a crop is perhaps indicated.

Conclusion

Overall, a wide range of woody taxa, with a minimum of 22 types, is represented in the Roman charcoal assemblages at Springhead. Most are native deciduous tree and shrub types, with the single pieces of yew from cremation burial 6345 and holly from the temple floor (12352) being the only evergreen or coniferous taxa found. The types identified have a range of ecological tolerances and requirements, but together indicate the presence of open, mixed deciduous woodland and hedgerows in the local environs during the Roman period. The possibility of management of oak and hazel also arises; both were represented many times by young roundwood which might indicate coppice management (see Buckley 1992; Edlin 1949) and oak in particular was present in large quantities, having being chosen both for fuel and structural use. Two introduced species were also identified, sweet chestnut (*Castanea sativa*) and possibly laburnum (*Laburnum* sp.), as described above. Both are believed to have been introduced to Britain by the Romans (Godwin 1975, 275 for sweet chestnut), with both represented here by single pieces in ritual and funerary contexts (the sweet chestnut found on the temple floor, the laburnum from box burial 6610, so it is feasible that these are from imported pieces or objects rather than from trees planted or cultivated in the Springhead area).

Northfleet

The 26 Roman samples come from a range of contexts including domestic, leisure, industrial, agricultural and food preparation contexts. A summary of the feature types represented is given in *Table 104*. The taxa identified are listed by phase in *Table 105*. Full details and quantification of the individual assemblages for Northfleet are given in *Table 106*.

Early Roman ditch 16723

This large dump of charcoal proved to contain only two taxa, with 95% oak (*Quercus* sp.), a quarter of which was roundwood, and a few fragments of hazel (*Corylus avellana*). The source and use of this charcoal is unknown but the assemblage serves to demonstrate the availability and selection of these types in the early Roman period at Northfleet.

Middle–late Roman aisled buildings, features 10857, 15031, 15963, 16593, and context 19747

Of the five samples analysed from the eastern and western aisled buildings, four were large charcoal samples (26–141 g) from middle Roman contexts, three of which are interpreted as structural posts of mature oak burnt *in situ*. The fourth (feature 15031, context 15032), the fill of a beam slot, had also been suggested to be possibly structural but proved to contain more than one taxon and substantial quantities of roundwood. Pomaceous fruits (Pomoideae, eg, hawthorn, whitebeams) dominated at 60%, with field maple (*Acer campestre*), blackthorn (*Prunus spinosa* type) and oak (*Quercus* sp) also found. The one small (3 g) assemblage from a late Roman layer (10747) was unusual in that it consisted solely of 86% cherry type (*Prunus* sp., eg, bird cherry and blackthorn) and 14% dogwood (*Cornus* sp.) roundwood, the latter found in only one other Roman context at Northfleet in this analysis. The reason for this selection is unknown, but the types indicate a source of open scrub or hedgerow.

Middle–late Roman bath-house, contexts 10481, 10794, 16060, 10486

Four charcoal-rich deposits from the bath-house were analysed. The wood charcoal assemblages are believed to be of fuel used in the lifetime of the complex, with no destruction/demolition layers apparent. Context 10481, a burnt layer overlying the floor and believed to relate to the use of the hypocaust, comprised 99% mature oak with small quantities of cherry type (*Prunus* sp.). One room in the bath-house, context 16060, had a similarly large but simple charcoal assemblage with 99% oak, including 15% roundwood. In contrast, context 10794, another broadly contemporary room in the bath-house, contained a more mixed fuel assemblage; in addition to 81% oak, field maple, silver/downy birch (*Betula pendula/pubescens*), hazel, ash (*Fraxinus excelsior*), pomaceous fruits and bird cherry (*Prunus avium*) were present. It is feasible, though unproven, that these less well-represented types were not selected simply as fuel but to add scent or colour to the flames in this particular room. Ash and birch wood, for instance, produce a pleasant scented smoke, and today are often used to smoke fish and meat (Taylor 1981). Another room (context 10486, possible cold room) also had a wider range comprising field maple, birch, hazel, blackthorn, alder, buckthorn (*Rhamnus cathartica*), with oak and pomaceous fruits equally important. It is suggested that these were available and collected locally, with very open woodland or mixed deciduous hedgerows indicated as the source.

Middle Roman cistern 16170

Both samples from the cistern were heavily dominated by large pieces of oak (mature and roundwood) with only single fragments of hazel, field maple and willow/aspen (*Salix*/*Populus* sp.). That from context 15696 was incompletely burnt, with several pieces only part-charred, and may relate to structural wood rather than fuel. Again, concentration on oak stands, perhaps managed, as a wood source is indicated.

Middle Roman lime kiln 10849

Four samples were selected from discrete layers through this substantial lime kiln in order to examine the selection of fuel for industrial-scale use at Northfleet. Oak was favoured, being dominant in three samples (at 90–100%) and 40% in the fourth assemblage. In context 15252 the oak pieces were highly fissured and flaky indicating they had been burnt damp; others were partially vitrified, yet several pieces in the assemblage were so well preserved that the bark, complete with lichen, could be seen. In the case of sample 11179 from context 15177, the majority was of oak roundwood indicating the use of managed (coppiced) oak stands.

However, a few differences in composition between the wood charcoal assemblages could be discerned through the kiln fills. Alder (*Alnus glutinosa*) formed 59% of the assemblage from the second sample from context 15177 (sample 11164), its presence indicating the collection of some fuel from wetter ground along the edge of the River Ebbsfleet. Small quantities of ash and blackthorn also occurred in context 10973, while context 15177 contained hazel in sample 11179 and a single fragment of beech (*Fagus sylvatica*) in sample 11164. It appears that in addition to the managed oak, other sources were exploited as required, potentially changing with seasonal or cyclical availability.

Middle Roman pit 15449

The fill of this clay-lined tank included a substantial charcoal assemblage of over 1 kg, this being almost entirely of mature oak with less oak roundwood. All the pieces were in good condition, with a lack of any fissured or vitrified pieces indicating a slow steady charring. It might be suggested that the purpose of this pit was for preparing charcoal on a large scale from a managed oak source.

Middle Roman pits (features 10569, 20700), ditches (features 16037, 20273), well (feature 16090) and gully (feature 20065)

Dump 16091 in well 16090 contained charcoal comprising 64% oak, a third of which was roundwood, including several pieces cut at age 25 years yet displaying such narrow rings that the diameter was only 15 mm. This indicates slow, potentially restricted growth due to some environmental limitation such as lack of light, poor substrate or too little/too much water. Silver/downy birch, which favours open conditions (Stace 1997), was also important in this assemblage, at 29%.

A very small (1 g) fragmentary charcoal assemblage from a grain-rich dump in pit 10569 proved surprisingly rich, with 36 pieces of ash along with oak, hazel, cherry type, pomaceous fruit wood and a fragment of ivy (*Hedera helix*), together indicating an open but mature deciduous woodland source. Pit 20700, though dominated by oak, also contained a number of open-loving species such as silver/downy birch, hazel, willow/aspen and cherry type roundwood.

Ditch 16037 was dominated by oak with a small quantity of hawthorn-type pomaceous fruit wood. Ditch 20273 contained deciduous types such as field maple, hazel/hazel roundwood, oak/oak roundwood and possible elm, and also the only Roman occurrence of the evergreen holly (*Ilex aquifolium*) at Northfleet. It is suggested the assemblage may have originated from a burnt out hedgerow rather than fuel use.

The charcoal from gully 20065 was different to most samples examined in comprising small roundwood and 1–2 year old twigwood. Many fragments were not identifiable due to their small size and immaturity but several pieces of oak, hawthorn, blackthorn were distinguished.

Late Roman malting oven 12591

The two samples from this malting oven contained a number of charcoal types. Oak and hazel were most common but taxa such as ash, dogwood and hawthorn were also utilised, and cherry type (eg, bird cherry or blackthorn) was important in context 19217. A small, degraded piece of charcoal which compared best with pine (*Pinus* sp.) was also found in context 19107. This fragment of possible pine is something of an enigma as pine is not normally thought to have persisted this late in Britain (after the late Neolithic and prior to its reintroduction in the 18th century, eg, Godwin 1975, 107–9; Bennett 1984, 133–55). A possible exception to this was however noted at the Romano-British salt working site of Scotney Court, Romney Marsh where pine as well as oak was used as fuel (Eddison 2000, 44). The piece from Northfleet might represent an import, but its single occurrence and small fragment size which prevented the full range of diagnostic characters being observed, plus its context, makes this a tentative suggestion. Residuality from an older local context is more likely.

Late Roman layer 10737

This sample proved quite different to the middle Roman assemblages. It contained 83% hawthorn-type pomaceous fruit roundwood (very likely hawthorn given the presence of numerous hawthorn fruits) and 6% beech (*Fagus sylvatica*) four year old roundwood, as well as small quantities of bird cherry and oak. Beech is poorly represented in earlier contexts examined in this analysis and, though a native, is thought to have been a late arrival in Britain, not found until the late prehistoric period. Once established, however, it thrived on base-rich soils (Stace 1997). Two pieces of rose (*Rosa* sp.) were also found, the only appearance in this analysis. The occurrence of the fruits gives some indication of late summer/autumn collection and the deposit appears to relate to domestic fuel use rather than being the remains of structural timber as previously thought.

Conclusion

Overall, a similarly wide range of taxa is represented at Northfleet as at Roman Springhead, with the addition of ivy (*Hedera helix*) and rose. Neither of the introduced taxa found at Springhead (sweet chestnut and possibly laburnum) were identified here however. Presence and exploitation of a rich variety of open woodland and scrub types for domestic/everyday use is indicated overall for the middle Roman period at Northfleet. While interpretation based on samples from a single layer and the malting oven is difficult, it is feasible that a shift in resource use happened by or during the late Roman period, with a declining mixed woodland resource requiring greater local reliance on scrubby growth such as hawthorn.

Discussion of the Roman Wood Charcoal

Although a number of woody taxa have been shown to have had continuity in presence, collection and use throughout the late prehistoric to late Saxon periods at Springhead and Northfleet, some contrasts in the nature of exploitation have been indicated. Broadly, a wide range of locally available woodland and hedgerow species were collected for domestic and other small-scale fuel use in the late Iron Age and Roman periods. Use of large volumes of wood from managed sources, notably hazel and oak coppice, is indicated for structural and industrial use, increasing in the early and middle Roman contexts. A decline in availability and increasing reliance on scrub types such as hawthorn (already commonly used earlier) is tentatively suggested for the late Roman period.

The types identified vary to some degree with type of feature and context, and have been described in detail in the preceding sections. Selection of particular taxa for specific purposes has been demonstrated, from the expected use of oak for large-scale building work to rare evidence for selection of introduced and flowering types such as laburnum, traveller's joy, yew and sweet chestnut for religious and funerary contexts. The scale of analysis enabled by the joint study of the two sites (with a total of 42 late Iron Age–Roman samples analysed in full) has provided insight both into the everyday availability and use of woody resources in the area and in so doing has enabled the unusual or exceptional to be discerned.

That there is a notable lack of detailed published pollen sequences for Kent or indeed south-east England (see Dark 2000) increases the usefulness of such charcoal and wood analyses in providing data on landscape and environment as well as human exploitation and management for this period. The few other charcoal analyses on material of late Iron Age or later date in the Kent, Essex and London area have tended to come from single cremation contexts or cemetery sites (Saltwood Tunnel, Aldritt 2006; Pepper Hill, Challinor 2006a), with only a few notable exceptions, discussed below.

Late Iron Age assemblages come mainly from the few analyses at hillforts, for instance that at Maiden Castle reported by Salisbury and Jane (1940) and Gale (1991) which indicate that oak and ash were dominant in the landscape prior to construction, with hawthorn, cherry type and hazel in open woodland and on woodland margins. More open patches probably supported yew, berberis, dogwood and rose. Collection for fuel during occupation focused on oak, hazel and probable blackthorn, but field maple, ash, alder, gorse and willow/aspen were also present, as observed here. A narrower range of taxa was identified by Poole (1984) at Danebury hillfort, Hampshire, with oak, hazel and hawthorn dominant and ash and elm of somewhat greater importance than demonstrated in Iron Age to Roman levels at Springhead.

The only directly comparable material of Roman date analysed for charcoal in the region comes from Thurnham Roman villa (Challinor 2006b) and the Roman settlement at Westhawk Farm, Ashford (Challinor 2008). Oak overwhelmingly dominated the charcoal assemblage at Westhawk Farm for all contexts, including structural remains, pits, a cremation and a waterhole. Lesser amounts of hazel, willow, wild cherry, pomaceous fruits, box (*Buxus* sp.), buckthorn (*Rhamnus cathartica*) and ash were also identified (Challinor 2008). Five contexts related to the villa at Thurnham were examined. There oak dominated, but interestingly, as here, very mixed assemblages were recovered from two ovens of 2nd and 4th century date respectively. These included ash, blackthorn, birch, maple, wild cherry and willow/poplar (Challinor 2006b). Ash, particularly, was used to a greater degree than at Springhead and Northfleet, as also observed at Saltwood Tunnel (Aldritt 2006) where it was dominant in several assemblages from cremation burials, pits, and ovens. This presumably reflects local availability or perhaps an absence of the practice of wood seasoning, since ash is one of the few woods that will burn green. At The Mount Roman villa, Maidstone, small-scale charcoal analysis showed the presence of alder, hazel, oak, pomaceaous fruits and cherry type (Robinson 1999, 149–50).

Further afield, the substantial waterlogged wood assemblage recovered from Dalton Parlours Roman villa, West Yorkshire, demonstrated the exploitation of an unusually large number of taxa for different purposes. Many bucket pieces were identified and most proved to be of oak, alder and ash, with use of cherry type, pomaceaous fruits and hazel for smaller parts. However, identification of buckets of silver fir (*Abies alba*), European sycamore (*Acer pseudoplatanus*) and pine (*Pinus* sp.) also demonstrated the importation of raw wood or finished objects. Pugsley (2003) has reviewed the use of wood in creation of domestic goods in Roman Britain. She suggests that box wood was favoured for making combs and boxes, but a wide variety of wood types were used for other personal items, such as oak, ash, alder and willow/aspen for wooden-soled shoes and yew, ash, willow, alder, field maple, Pomoideae, box and oak for carved and turned cups, plates and utensils.

Charcoal analysis by Gale (b; c) at an Iron Age to Roman farmstead and Roman settlement at Sites 29 and 15 of the M6 Toll (Birmingham Northern Relief Road) route demonstrated use of a similarly wide range of (native) woody taxa for domestic use, but with the addition of gorse or broom (*Ulex/Cytisus*) and heather (*Ericaceae*), indicating the presence and exploitation of open scrub and perhaps reflecting a less extensive woodland resource than at Springhead and Northfleet.

Site 12, Ryknield Street, Wall, also on the M6 Toll, provides a useful comparator for the cremation deposits analysed here. There too a greater mix of taxa was found in the Roman cremation burials and pyre debris deposits than would normally be expected. Oak was certainly used, but also birch, ash, alder, hazel, elm, pomaceaous fruits, field maple, willow/poplar, as well as pine and elder (*Sambucus nigra*) (Gale 2008a). One pyre also contained small quantities of holly and heather. As discussed above in relation to the finds of yew, clematis and possible laburnum in the Springhead graves, some of these taxa are likely to have had ritual or spiritual significance and introduced as unworked wood or as objects. Holly in particular was valued, and its occurrence on a temple floor at Springhead is unlikely to have been just a coincidence.

As noted, scant complementary pollen data exist for the time of the Conquest and for the Roman period in Britain as a whole, and most come from Northern England (see Dark 2000). It is clear, nevertheless, that the need to fuel industrial-scale iron-working, bath-houses, pottery and lime kilns would have taken a heavy toll on tree cover. At Sidlings Copse, Oxfordshire, however, Dark (2000; Day 1991) observed that within an already sparse woodland, mainly cleared by the late Iron Age, and despite wider clearance for arable fields, there is some pollen evidence for encouragement and/or planting of willow and oak at this time. Coppicing is also indicated by a number of finds of wattle of even-sized, quick grown rods in waterlogged Roman contexts in Britain. The use of management techniques such as the coppicing proposed in this study and also pollarding, would have increased the productivity of remaining woodland resources and maintained supply and some canopy. In contrast, however, a lack of consistent growth ring widths and age of cut (oak) roundwood related to Roman iron production and domestic activity at Westhawk Farm suggests little or no use of managed woodland resources there (Challinor 2008). Inter-site/inter-regional variability is indicated, perhaps dependent on scale of production and other local anthropogenic pressures on existing resources as well as ecological factors such as topography and soil type that control wood availability.

Marine Shell

by Sarah F Wyles

The total marine shell assemblage from Springhead and Northfleet comprised 14391 shell fragments retrieved from 1237 contexts. This can be broken into 10205 shell fragments from 745 contexts from the Springhead Sanctuary, 2219 shell fragments from 247 contexts from the Springhead Roadside Settlement and 1967 shell fragments from 245 contexts from the Northfleet villa. The majority of the assemblage, in all three areas, was retrieved from contexts of the Roman period. It was hoped that more detailed analysis of the shells from a selection of contexts would assist in addressing specific Project Design Aims concerning the nature of the types of settlement (eg, religious centre, roadside settlement and villa) and variations in terms of the evidence for the activities conducted within them. This analysis would also examine whether there was evidence for any changes in both the methods of retrieval (fished or farmed) across the site and also the possible location of exploited oyster beds.

Shells from a number of contexts were selected for further analysis subsequent to assessment. These comprised 6352 shell fragments recovered from 80 contexts of Roman date, analysed in 19 different groups (16 from Springhead, 3 from Northfleet; the one Saxon group analysed, from Springhead, is also included in the tables), representing a range of feature types and spatial differences.

Methods

The marine shell assemblage recovered from these contexts was recorded by species type, with the oyster shells being subdivided into measurable and unmeasurable right and left valves (*Table 107*). The measurable shells from these groups were analysed in more detail. This entailed measuring the shells and recording both their physical characteristics, such as whether they were worn or had other shells attached, and also any evidence of any infesters visible on the shell. A summary of the results can be seen in *Table 108.*

Results

Springhead

The total assemblage examined from Roman Springhead represented a minimum number of 3295 individuals, of which 2560 were oysters (*Ostrea edulis*) (78%). The other marine molluscs retrieved in significant numbers was mussel (*Mytilus edulis*), with a minimum number of 681 individuals forming 20% of the assemblage. The remaining 2% of the assemblage comprised cockle (*Cerastoderma edule*), whelk (*Buccinum undatum*), periwinkle (*Littorina* sp.) and carpet shell (*Veneridae*) (*Table 107*).

The oyster shells in the 16 groups from Springhead were subdivided, with 49% of the 2364 left valves and 55% of the 2330 right valves being deemed measurable. Although there were small fluctuations in the numbers of shells that it was possible to measure, these percentages were generally reflected across the groups. Only the shells recovered from pit 300215 (in the Sanctuary site) show a significant difference, with much higher numbers of both left and right valves being unmeasurable. This is likely to be a reflection of the methods of disposal.

Variations in the distribution of left and right oyster valves can indicate differences in usage of areas of sites, for example for food preparation or consumption. Unfortunately no differences can be discerned between the patterns of disposal of the left and right valves in these 16 groups. Around 22% of the measurable analysed shells showed knife marks and notches. Although, in general, a higher percentage of the measurable right valves displayed notches than left, there were no significant differences between the groups. A total of eight shells from four groups (ritual shaft, Viewing platform 1, pit 300214 and quarry) had complete holes in the centre of the shell that were not attributable to marine predators.

Some of the shells (9%) showed indications of staining, mainly by iron. This was particularly marked in the shells retrieved from the pit alignment and ritual shaft in the Sanctuary site and roadside ditch in the settlement area. Around 33% of the analysed assemblage was recorded as being worn and 11% as being flaky. There were more worn shells than average within the pit alignment, pit 300215, the Roadside Settlement pits, quarry, roadside ditch and SFB groups. Most of these groups also contained an above average number of flaky shells. A pattern of generally unstructured discarding and redeposition of the shells resulting in a mixture of worn, flaky, stained and broken shells can be discerned, rather than deliberate rapid disposal within pits and middens.

The shells were analysed for evidence of whether they were fished from natural beds using techniques such as dredging as opposed to being farmed from deliberately laid oyster beds. The percentage of shells with oyster fragments, spats (oyster young) or complete shells attached is around 7% over the 16 groups. It is up to 14% for the shells from pit 300214. The average percentage of shells with an irregular shape, either of the complete shell or only the heel, is 21%. Over 30% of the shells from the temple, the Roadside Settlement pits, the quarry, the roadside ditch and SFB groups are mis-shapen.

The majority of the left valves have a maximum diameter of between 60 and 85 mm, while the majority of the right valves are between 55 and 80 mm. The shells generally have a greater width than length. The majority of the group's mean size of left valve widths by group are between 65 and 75 mm, while most of group's mean size of right valve widths by group are mainly between 60 and 70 mm. It is unlikely that this assemblage is a result of some selection procedure as the appearance of some of the shells was rather poor. In addition to the mis-shapenness, 12% of the assemblage appeared to be rather thin but only about 2.5% rather thick.

Some indication of infestation on the shells was observed on about 20% of the assemblage. The infestation was usually only slight and the assemblage generally comprised healthy shells and no 'rotten backs' were recorded. Around 82% of the infested shells showed traces of the burrows left by the polychaetic worm *Polydora ciliata*, while acorn barnacles were recorded on 92 shells (20% of infested shells). The sea mat *Polyzoa* was only seen on 20 shells and the holes left by the sponge *Cliona celata* on seven shells. There was also a single instance of a possible bore hole caused by the sting winkle, *Ocenebra erinacea*. Only 20 shells showed signs of chambering, which can be caused by changes in salinity levels.

The shape of the shells was considered as the roundness of shells can be indicative of the nature of the substrate. The correlation co-efficient shows that the roundest shells were retrieved from the 'totem post' group, with a very high correlation of 0.96. The other groups that ranged from almost round to slightly elongated are those from the SFB, quarry, pit, roadside ditch, ritual shaft, beam slot, pit 300130 and the pit alignment. These are likely to have been recovered from a hard substrate, while the remaining groups, especially those from Viewing platform 1, pit 300216 and pit 300215, are indicative of shells recovered from soft substrates.

Student T-tests were carried out on the maximum diameter of the measurable left valves. About a third of the results showed a population match between the groups. The group from the SFB had no matches, while the groups from pit 300216, pit 300214 and the tank only had one or two matches. There were high correlations between the groups for the shells from the totem post and pit 300215 but this may be a reflection of the small number of shells within these groups. The majority of the groups had between five to seven matches. A higher correlation between the groups would be expected if the oyster shells had been from a single population.

Northfleet

The total assemblage examined from Roman Northfleet represented a minimum number of individuals of 163, of which 158 were oysters (*Ostrea edulis*) (97%). The only other marine shell species retrieved were mussel (*Mytilus edulis*) and cockle (*Cerastoderma edule*) (*Table 107*).

The oyster shells in these three groups were subdivided and of the 151 left valves recovered 42% were deemed measurable, while 53% of the 106 right valves could be measured. No significant differences in the patterns of disposal between the left and right valves in these three groups could be discerned. Of the analysed shells, around 36% of the measurable shells showed knife marks and notches. Although, in general, a higher percentage of the measurable right valves displayed notches than the left, there were no significant differences between the groups. A single shell from pit group 20776 had a complete hole in the centre of the shell.

Around 54% of the analysed assemblage was recorded as being worn and 23% as being flaky. This is significantly higher than the general trend at Springhead. A similar pattern of generally unstructured discarding and redeposition of the shells resulting in a mixture of worn, flaky, stained and broken shells can be discerned, rather than deliberate rapid disposal within pits and middens.

The percentage of shells with oyster fragments, spats or complete shells attached is around 2.5%. While the average percentage of shells with an irregular shape, either of the complete shell or only the heel, is 19%, over 35% of the shells from quarry pit 10874 were considered mis-shapen.

The majority of the group's mean size of left valve widths are between 60 and 85 mm, while most of the group's mean size of right valve widths are between 55 and 80 mm. As with those shells recovered from Springhead, the shells generally have a greater width than length. The mean size of left valve widths by group are mainly between 63 and 70 mm while the mean size of right valve widths by group are mainly between 55 and 63 mm. Again it is unlikely that this assemblage is a result of a particular selection procedure as the appearance of some of the shells was rather poor. In addition to the mis-shapenness, 29% of the assemblage appeared to be rather thin but only about 2.5% rather thick.

Some indication of infestation on the shells was observed on about 73% of the assemblage. However the infestation was usually only slight and the assemblage generally comprised of relatively healthy shells and no rotten backs were recorded. All of these shells showed traces of the burrows left by the polychaetic worm *Polydora ciliata*, while only two shells had traces of acorn barnacles and the holes left by the sponge *Cliona celata*.

No signs of chambering were recorded, while comparison of the correlation co-efficient of the three groups shows that the shells are slightly elongated and are likely to have been recovered from a hard substrate.

Student T-tests were carried out on the maximum diameter of the measurable left valve. There was no match between the groups from the quarry pit 16807 and pit 20776. However there were eight and four matches respectively with groups retrieved from Springhead.

Interpretation

The ratio of unmeasurable to measurable shells is an indication of the degree of post-depositional damage and wear. As just under half of the shells from the selected deposits were unmeasurable at both Springhead and Northfleet, it is probable that a significant amount of the shell was not disposed of rapidly, particularly those recovered from pit 300215.

No indication of different usage of areas of the site for food preparation and consumption could be discerned from the patterns of disposal between the left and right valves in these 19 groups. The small assemblage retrieved from wood-lined pit 12317 does not assist in ascertaining the function of the feature, but it is unlikely to have been used to store oysters.

The shells from the Northfleet villa area appear to be in a poorer condition than those recovered from Springhead, especially those from the areas of the site more likely to have had a religious function, and it is likely that they were generally not disposed of rapidly after consumption.

Both irregularity of shape and clumping of shells are indicative of derivation from natural oyster beds where there is competition for space. The general lack of other small marine shells together with a paucity of small oysters may be indicative of a managed natural oyster bed being fished with a dredge net of a fixed size, rather than a specially laid oyster bed. It also seems unlikely that this assemblage is a result of any particular selection procedure.

Indications of the likely location of this oyster bed are given by the traces of infestation upon the shells, chambering, the other marine shells in the assemblage and shape of the shells. The polychaetic worm, *Polydora ciliata*, is widespread and is most prevalent on hard, sandy or clay grounds, particularly in warm shallow water, whereas Acorn barnacles thrive on rocks between tide marks in open coastal areas rather than in estuarine conditions. The sea mat *Polyzoa* may be found on all types of hard substrate and generally favours shallow water, while the sponge *Cliona celata* is widely distributed on the lower shore. The sting winkle prefers rocks and muddy gravel on lower shore and below (Barrett and Yonge 1958; Yonge 1960). The preferences of these infesting micro-organisms would appear to indicate that these oysters were recovered from beds in shallow waters rather than deep waters and open coastal waters rather than estuarine ones.

There is a complete absence of traces of infestation caused by the polychaetic worm *Polydora hoplura* on the shells from this site. This infestation has been observed on shells from other Roman sites such as Halstock Roman villa (Winder 1993b) and Greyhound Yard, Dorchester (Winder 1993a) with shells originating from a south coast source. *Polydora hoplura* is absent or virtually absent from modern oyster populations from the Essex and north Kent coasts.

The low instance of chambering also indicates an open coastal area source. The other marine shells recovered would occur in this kind of environment; mussels favour dense beds on rocky, stony and also muddy shores on the middle shore and below, periwinkles favour rocks and seaweeds on the middle shore and below, whelks thrive on muddy gravel or sand on the lower shore and below, and cockles on sand or sandy mud on the middle and lower shore.

The shape of the shells is indicative of the assemblages having been recovered from both a hard substrate and a softer substrate source. The groups of shells indicating harder substrates generally were recovered from the Roadside Settlement area of Springhead and from Northfleet villa. Student T-test results appear to indicate that there was no single source of oysters exploited throughout the usage of both Springhead and Northfleet but that a number of natural beds were used.

During the Roman period, it is believed that a number of natural beds along the Essex and north Kent coasts, as well as within the Thames estuary itself, were exploited for the recovery of shellfish. For example, the oyster assemblage studied at the port of London site at Pudding Lane shows indications of the exploitation of the natural oyster beds around the north Kent coasts during the 1st century AD (Winder 1985).

The number of marine shells retrieved from the site is not high enough for shellfish to have formed a significant part of the diet. There were no huge dumps of shell along the roadside forming layers of shells, as seen at sites such as Balkerne Lane (Crummy 1984, 123, 126–7) and Balkerne Heights (Birbeck 2009) in Colchester. The shellfish are likely to have augmented the diet, with the dumps of oyster and mussel shells around the temple and viewing platforms in particular possibly representing religious feasting.

There appears to have been no selection procedure carried out at the source to obtain high quality oysters, such as those seen in Poole Harbour (Winder 1992); rather it seems likely that the marine shell was just collected by dredging a number of carefully managed natural beds with a net of fixed mesh size.

Bibliography

Note: the use of 'a', 'b' etc suffixes to denote publications by the same person in the same year has been standardised across the four volumes so that some entry suffixes here may not run in true consecutive order.

ADS, 2006 *CTRL Digital Archive*, Archaeology Data Service, http://ads.ahds.ac.uk/catalogue/projArch/ctrl

Adams, J C, 1987 *Outline of Fractures*. Churchill Livingstone, London

Ahrens, K, 1972 *Columella über Landwirtschaft*. Schriften zur Geschichte und Kultur der Antike 4, Berlin

Aldritt, D, 2006 The archaeological wood charcoal from Saltwood Tunnel, in Giorgi and Stafford (eds) 2006

Alexander, J and Pullinger, J, 2000 *Roman Cambridge. Excavations on Castle Hill 1956–1988*, Proc Cambridge Antiq Soc 88

Andersen, S T, 1970 The relative pollen productivity and pollen representation of north European trees and correction factors for tree pollen spectra, *Danmarks Geologiske Undersøgelse* R.II 96, 1–99

Andersen, S T, 1973 The differential pollen productivity of trees and its significance for the interpretation of a pollen diagram from a forested region, in *Quaternary Plant Ecology* (H J B Birks and R G West), 109–115. Blackwell, Oxford

Apicius, M G 1991 *Das römische Kochbuch des Apicius: Vollständige zweisprachige Ausgabe* (*De Re Coquinaria*, trans R Maier) Philipp Reclam, Stuttgart

Armitage, P, 1984 New evidence of Black Rat in Roman London, *London Archaeol* 4(14), 375–383

Aufderheide, A C and Rodríguez-Martín, C, 1998 *The Cambridge Encyclopaedia of Human Palaeopathology*. Cambridge Univ Press, Cambridge

Baillie, M G L and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bull* 33, 7–14

Baker, J and Brothwell, D, 1980 *Animal Diseases in Archaeology.* Academic Press, London

Bales, E (ed), 2004 *A Roman Maltings at Beck Row, Mildenhall, Suffolk.* E Anglian Archaeol Occas Paper 20, Ipswich

Barber, K E, 1967 Two pollen analyses on sediments from well (pit) 135, in *Excavations at Portchester Castle Volume II. Saxon* (B W Cunliffe) 297–299. Rep Res Comm Soc Antiq London 33, Oxford

Barnett, C 2009 Wood charcoal, 48–51, in C Ellis, Archaeology of the West Malling and Leybourne Bypass, West Malling, Kent: Archaeological Excavation, in *Kentish Sites and Sites of Kent. A Miscellany of Four Archaeological Excavations* (P Andrews, K Egging Dinwiddy, C Ellis, A Hutcheson, C Philpotts, A B Powell and J Schuster), 1–56. Wessex Archaeol 24, Wessex Archaeology, Salisbury

Barrett, J and Yonge, C M, 1958 *Collins Pocket Guide to the Sea Shore*. Collins, London

Bass, W M, 1987 *Human Osteology*. Missouri Archaeological Society, Columbia

Bates, M R, 1998 Locating and evaluating archaeology below the alluvium: the role of sub-surface stratigraphic modelling, *Lithics* 19, 4–18

Bates, M R and Whittaker, K, 2004 Landscape evolution in the Lower Thames Valley: implications of the archaeology of the earlier Holocene period, in *Towards a New Stone Age: aspects of the Neolithic in south-east England* (eds J Cotton and D Field), 50–70. Counc Brit Archaeol Res Rep 137, York

Battarbee, R W, 1986 Diatom analysis, in *Handbook of Holocene Palaeoecology and Palaeohydrology* (ed B E Berglund), 527–570. Wiley, Chichester

Baxter, I L, 2006 A dwarf hound skeleton from a Romano-British grave at York Road, Leicester, England, U.K, in Snyder and Moore (ed) 2006, 12–23

Baxter, I L, 2011, Temple precinct: faunal remains, in *The Roman Town at Great Chesterford* (ed M Medlycott). E Anglian Archaeol 137, Chelmsford

Beek, G C van, 1983 *Dental Morphology: an illustrated guide*. Wright PSG, Bristol and London

Beerenhout, B 1994 What conclusions can be drawn from mature haddock bones in a neolithic site in the Netherlands?, in *Archaeo-Ichthyological Studies: papers presented at the 6th meeting of the I.C.A.Z. Fish Remains Working Group* (D Heinrich), 341–347. Offa Sonderdruck 51, Neumünster

Bell, M G, 1982 The effects of land-use and climate on valley sedimentation, in *Climate Change in Later Prehistory* (ed A F Harding), 127–147. Edinburgh Univ Press, Edinburgh

Bell, M G, 1983 Valley sediments as evidence of land-use on the South Downs, *Proc Prehist Soc* 49, 119–150

Bell, M G and Boardman, J (eds), 1992 *Past and Present Soil Erosion: archaeological and geographical perspectives*. Oxbow, Oxford

Benecke, N, 2003 Haustierhaltung, in *Frügeschichte der Landwirtschaft in Deutschland* (eds N Benecke, P Donat, E Gringmuth-Dallmer and U Willerding), 173–195. Langenweissbach

Bennett K D, 1984 The Post-Glacial History of *Pinus sylvestris* in the British Isles, *Quat Sci Rev* 3, 133–155

Bennett, K D, Whittington, G and Edwards, K J, 1994 Recent plant nomenclatural changes and pollen morphology in the British Isles, *Quat Newslet* 73, 1–6

Berry, A C and Berry, R J, 1967 Epigenetic variation in the human cranium, *J Anat* 101(2), 261–379

Bevan-Jones, R, 2002 *The Ancient Yew*. Windgather Press, Bollington

Binford, L R, 1981 *Bones. Ancient Men and Modern Myths*. Academic Press, London

Birbek, V, 2009 Balkerne Heights, Colchester: Roman suburban development and cemetery use, Essex Archaeol Hist 40, 98–141

Blackburn, K, 1951 Report upon the natural pine-cones from the temple of Mithras, in The Temple of Mithras at Carrawburgh (I A Richmond, J P Gillam and E Birley), 86. *Archaeologia Aelinana*, 4th ser 29, 1–92

Boardman, S and Jones, G, 1990 Experiments on the effects of charring on cereal plant components, *J Archaeol Sci* 17, 1–11

Boessneck, J, 1969 Osteological differences between sheep (*Ovis aries* Linné) and goat (*Capra hircus* Linné), in *Science in Archaeology* (eds D Brothwell and E Higgs), 331–358. Thames & Hudson, London

Bond, J M and Worley, F L, 2004 The animal bone, in *The Roman Cemetery at Brougham, Cumbria. Excavations 1966–67* (ed H E M Cool), 311–331. Britannia Monogr 21, London

Booth, P, Clark, K M and Powell, A, 1996 A dog skin from Asthall, *Int J Osteoarchaeol* 6, 382–387

Booth, P, Dodd, A, Robinson, M A and Smith, A, 2007 *The Thames Through Time: the archaeology of the gravel terraces of the Upper and Middle Thames: the early historical period AD 1–1000*. Oxford Archaeol Thames Valley Landscape Monogr 27, Oxford

Boston, C and Witkin, A, 2006 Human remains from the Roman cemetery at Pepper Hill, Southfleet, Kent, in Mckinley (ed.) 2006b

Bowman, A K, and Thomas, J D, 1994 *The Vindolanda Writing Tablets* (Tabulae Vindolandenses *II*). British Museum Press, London

Bradley, R, 1990 *The Passage of Arms*. Cambridge Univ Press, Cambridge

British Geological Survey, 1954 *Sheet 272 Chatham 1:50,000 solid and drift version*. HMSO, London

Briggs, D W, 1998 *Malts and Malting*. Blackie Academic and Professional, London

Bronk Ramsey, C, 1995 Radiocarbon calibration and analysis of stratigraphy: The OxCal program, *Radiocarbon* 37(2), 425–430

Bronk Ramsey, C, 2001 Development of the radiocarbon program OxCal, *Radiocarbon* 43(2A), 355–363

Brothwell, D R, 1972 *Digging up Bones*. British Museum (Natural History), London

Brothwell, D, and Zakrzewski, S, 2004 Metric and non-metric studies of archaeological human remains, in Brickley and McKinley (eds) 2004, 24–30

Brown, A G, Meadows, I, Turner, S D, and Mattingly, D J, 2001 Roman vineyards in Britain: stratigraphic and palynological data from Wollaston in the Nene Valley, England, *Antiquity* 75, 745–757

Buckland, P C, 1978 Cereal production, storage, and population: a caveat, in *The effect of man on the landscape: The lowland zone* (eds S Limbrey, and J G Evans), 43–5. Counc Brit Archaeol Res Rep 21, London

Buckland, P C, 1982 The Malton burnt grain: a cautionary tale, *Yorkshire Archaeol J* 54, 53–61

Buckley, G P, 1992 *Ecology and Management of Coppice Woodlands.* Chapman & Hall, London

Buikstra, J E and Ubelaker, D H, 1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archaeol Survey Res Ser 44, Fayettevile, Arkansas

Butterfield, B G and Meylan, B A, 1980 *Three-Dimensional Structure of Wood: an ultrastructural approach.* Chapman & Hall, London

Campbell, G, 1998 The charred plant remains, in *Excavations at Springhead Roman Town, Southfleet, Kent* (A Boyle and R Early), 36–9. Oxford Archaeol Unit Occas Pap 1, Oxford

Campbell, G, 2000 Plant utilisation: the evidence from charred plant remains, in *The Danebury Eenvirons Programme. The Prehistory of a Wessex Landscape volume 1: introduction* (B Cunliffe), 45–59. English Heritage/Oxford Univ Comm Archaeol Monogr 48, Oxford

Cappers, R T J, Bekker, R M and Jans, J E A, 2006 *Digital Seed Atlas of the Netherlands.* Barkhuis Publishing/Groningen University Library, Groningen

Carrott, J and Kenward H K, 2001 Species associations amongst insect remains from urban archaeological deposits and their significance in reconstructing the past human environment, *J Archaeol Sci* 28, 887–905

Challinor, D 2006a The wood charcoal from Pepper Hill, Northfleet, Kent, in Giorgi and Stafford (eds) 2006

Challinor, D, 2006bThe wood charcoal from Thurnham Roman villa, in Giorgi and Stafford (eds) 2006

Challinor, D, 2008 The wood charcoal, in *The Roman Roadside Settlement at Westhawk Farm, Ashford, Kent: Excavations 1998–9* (P Booth, A Bingham and S Lawrence), 343–49. Oxford Archaeol Monogr, Oxford

Chetan, A and Brueton, D, 1994 *The Sacred Yew.* Arkana, London

Chilardi, S, 2006 Artemis pit? Dog remains from a well in the ancient town of Siracusa (Sicily), in Snyder and Moore (ed) 2006, 32–37

Ciaraldi, M and Richardson, J, 2000 Food, ritual and rubbish in the making of Pompeii, in *TRAC 99: Proceedings of the 9th annual theoretical Roman archaeology conference, Durham April 1999* (eds G Fincham, G Harrison, R R Holland, and L Revel), 74–82. Oxbow, Oxford

Clapham, A R, Tutin, T G, and Moore, D M, 1987 *Flora of the British Isles* (3 edn). Cambridge Univ Press, Cambridge

Clark, K M, 1995 The later prehistoric dog: the emergence of canine diversity, *Archaeozoologia* 7(2), 9–32

Coleman, D C and Fry, B (eds), 1991 *Carbon Isotope Techniques*. Academic Press, San Diego

Conolly A P, Levy J F and Dalby D H, 1971 Appendix 1: plant remains, wood, mosses, ferns, in The Roman Villa at Denton, Lincolnshire (E Greenfield), *Lincolnshire Hist Archaeol* 6, 29–57

Cool, H E M, 2006 *Eating and Drinking in Roman Britain*. Cambridge Univ Press, Cambridge

Coombs, C W and Freeman, J A, 1956 The insect fauna of an empty granary, *J Entomol Res* 46, 399–417

Coombs, C W and Woodroffe, G E, 1963 An experimental demonstration of ecological succession in an insect population breeding in stored wheat, *J Animal Ecol* 32, 271–279

Cornish, V, 1946 *The Churchyard Yew and Immortality*. Frederick Muller, London

Corran, H S, 1975 *A History of Brewing*. David & Charles, Newton Abbot

Crisp, F and Childs Paterson C, 1966 *Mediaeval Gardens: flowery medes and other arrangements of herbs, flowers, and shrubs grown in the Middle Ages, with some account of Tudor, Elizabethan, and Stuart gardens.* Hacker Art, New York

Crosby, T, 2000 The development of malthouses around the Hertfordshire-Essex border, *Ind Archaeol Rev* 22(1), 39–51

Crummy, P, 1984 *Excavations at Lion Walk, Balkerne Lane, and Middlesborough, Colchester, Essex*. Colchester Archaeol Report 3, Colchester

Culpeper, N, 1653 *Culpeper's Complete Herbal: a book of natural remedies for ancient ills* (Ware: Wordsworth Editions Ltd 1995)

Dark, P, 2000 *The Environment of Britain in the First Millennium AD*. Duckworth, London

Davis, A, 2000, The plant remains (with D de Moulins), in *The Eastern Cemetery of Roman London: Excavations 1983–1990* (eds B Barber and D Bowsher), 368–78. MoLAS Monograph 4, London

Davies, M, 2001 Death and social division at Roman Springhead, *Archaeol Cantiana* 121, 157–169

Davis, A, 2006b Charred plant remains from Pepper Hill, Kent, in Giorgi and Stafford (eds) 2006

Day, S P, 1991 Post-glacial vegetational history of the Oxford region, *New Phytol* 119, 445–470

de Grossi Mazzorin, J and Minniti, C, 2006 Dog sacrifice in the ancient world: A ritual passage? in Snyder and Moore (ed) 2006, 62–66

Denys, L, 1992 *A Check List of the Diatoms in the Holocene Deposits of the Western Belgian Coastal Plain with a Survey of their Apparent Ecological Requirements: I. Introduction, ecological code and complete list*. Service Geologique de Belgique, Professional Paper 246

Devoy, R J N, 1979 Flandrian sea-level changes and vegetational history of the Lower Thames Estuary, *Phil Trans Roy Soc London* 285, 355–407

Dimbleby, G W, 1988 *The Palynology of Archaeological Sites.* Academic Press, London

Dobney, K and Ervynck, A, 2000 Interpreting developmental stress in archaeological pigs: the chronology of linear enamel hypoplasia, *J Archaeol Sci* 27, 597–607

Downey, R, King, A and Soffe, G, 1979 *The Hayling Island Temple. Third Interim Report on the Excavation of the Iron Age and Roman Temple 1976–78*. Duncan-Jones, London

Driesch, A, von den, 1976 *A Guide to the Measurement of Animal Bones from Archaeological Sites*. Bulletin 1, Cambridge, Massachusetts

Drummond-Murray, J and Thompson, P, 2004 *Settlement in Roman Southwark*. Mus London Archaeol Service Monogr 21, London

Eddison, J, 2000 *Romney Marsh – Survival on a Frontier*. Tempus, Stroud

Edlin, H L, 1949 *Woodland Crafts in Britain: an account of the traditional uses of trees and timbers in the British countryside*. Batsford, London

English Heritage, 1998 *Dendrochronology: guidelines on producing and interpreting dendrochronological dates.* English Heritage, London

Evans, G E, 1970 *Where Beards Wag All: the relevance of the oral tradition.* Faber, London

Evans, J G, 1972 *Land Snails in Archaeology.* Seminar Press, London

Evans, J G, French, C and Leighton, D, 1978 Habitat change in two late-glacial and post-glacial sites in southern Britain, in *The Impact of Man on the landscape: the lowland zone* (eds J G Evans and S Limbrey), 63–65. Counc Brit Archaeol Res Rep 21, London

Ewersen, J, 2004 Die unterschiedliche Nutzung von Haus- und Wildtieren im Neolithikum Ostholsteins am Beispiel der Schnittspurenanalyse an Knochen aus Grube-Rosenhof, Wangels LA 505 und Heidmoor, *Archäologische Informationen*, 27(1), 109–121

Finnegan, M, 1978 Non-metric variations of the infracranial skeleton, *J Anat* 125(1), 23–37

Flower, R J, 1993 Diatom preservation: experiments and observations on dissolution and breakage in modern and fossil material, *Hydrobiologia* 269/270, 473–484

Ford-Lloyd, B V, 1995, Sugar beet and other cultivated beets, in *Evolution of Crop Plants* (eds J Smartt and N W Simmonds) 2 edn, 35–40. Longman, Harlow

Freeman, J A, 1951 Pest infestation control in breweries and maltings, *J Inst Brewers* 57, 326–337
Freeman, P, 1980 *Common Insect Pests of Stored Products.* British Museum (Natural History), London
Fryer, V, 2004 Charred plant macrofossils and other remains, in Bales 2004, 49–54
Fulford, M, 2001 Links with the past: pervasive 'ritual' behaviour in Roman Britain, *Britannia* 32, 199–218
Gale, R, 1997 Charcoal, in *Archaeological Excavation on the Route of the A27 Westhampnett Bypass, West Sussex 1992. Vol 2: The cemeteries* (A P Fitzpatrick), 77–82. Wessex Archaeology Report 12, Salisbury
Gale, R, 1991 Charred wood, in *Maiden Castle Excavation and Field Survey 1985–6* (N M Sharples), 125–129. Batsford/English Heritage, London,
Gale, R, 2008a Charcoal [from Ryknield Street, Wall (Site 12)], in Powell *et al* 2008, 176–82
Gale, R, 2008b Charcoal [from Shenstone Linear Features (Site 15)], in Powell *et al* 2008, 218–20
Gale, R, 2008c Charcoal [from North of Langley Mill (Site 29)], in Powell *et al* 2008, 330–4
Gale, R, and Cutler, D, 2000 *Plants in Archaeology*. Westbury and Royal Botanic Gardens Kew, Otley
Giorgi, J, 2006 The plant remains from White Horse Stone, in Giorgi and Stafford (eds) 2006
Giorgi, J and Stafford, E (eds), 2006 Palaeo-environmental evidence from Section 1 of the Channel Tunnel Rail Link, Kent, in ADS 2006
Giorgi, J, and Robinson, M, 1984 The environment, in Excavations at Faccenda Chicken Farm, near Alchester, 1983 (M Foreman and S Rahtz), *Oxoniensia* 49, 38–46
Glamann, K, 2005 *Beer and Brewing in pre-industrial Denmark* (trans G French). Syddansk Universitetsforlag, Odense
Godwin, H, 1975 *History of the British Flora*. Cambridge Univ Press, Cambridge
Godwin, H, 1984 *History of the British Flora* (2 edn). Cambridge Univ Press, Cambridge
Grant, A, 1982 The use of tooth wear as a guide to the age of domestic ungulates, in *Ageing and Sexing Animal Bones from Archaeological Sites* (eds B Wilson, C Grigson and S Payne), 91–108. Brit Archaeol Rep 109, Oxford
Grant, A, 1987 Some observations on butchery in England from the Iron Age to the medieval period, *Anthropozoologica* 1, 53–58
Grant, M, 2000 *Galen on Food and Diet*. Routledge, London
Greig, J R A, 1981 The investigation of a medieval barrel-latrine from Worcester, *J Archaeol Science* 8, 265–282
Greig, J R A, 1982 Past and present lime woods of Europe, in *Archaeological Aspects of Woodland Ecology* (eds M Bell and S Limbrey), 23–55. Brit Archaeol Rep S146, Oxford
Greig, J, 1988 The interpretation of some Roman well fills from the midlands of England, in *Der prähistorische Mensch und seine Umwelt* (ed H J Küster), 367–378. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Wurttemberg 31, Stuttgart
Greig, J, 1991 The British Isles, in *Plants and Ancient man: Studies in the palaeoethnobotany, Proceedings of the 6th symposium of the International Work Group for Palaeobotanists* (eds W van Zeist and W A Casparie), 229–334. A A Balkema, Rotterdam
Grieve, M, 1931 *A Modern Herbal*. Jonathan Cape, London (online at http://www.the-tree.org.uk)
Grimes, W F, 1968 *The Excavation of Roman and Medieval London*. Routledge and Kegan Paul, London
Grimm, J M, 2007 A dog's life: animal bones from a Romano-British ritual shaft at Springhead, Kent (UK), in *Beiträge zur Archäozoologie und Prähistorischen Anthropologie VI* (ed N Benecke), 54–75. Gesellschaft für Archäozoologie und Prähistorischen, Langenweißbach
Gunther, R T (ed), 1933 *The Greek Herbal of Dioscorides. Illustrated by a Byzantine AD 512; Englished by John Goodyer, 1655.* Oxford Univ Press, Oxford
Habermehl, K H, 1975 *Die Altersbestimmung bei Haus- und Labortieren* (2 edn). Verlag Paul Parey, Berlin
Hagen, A, 1999 A Second Handbook of Anglo-Saxon Food and Drink: production and distribution. Anglo-Saxon Books, Hockwold cum Wilton
Hall, A R, 1981 The cockle of rebellion, insolence, sedition, *Interim* 8(1), 5–8
Hall, A R and Kenward, H K, 1990 *Environmental Evidence from the Colonia: General Accident and Rougier Street*. Archaeol York 14/6, York
Hall, A R, Kenward, H K and Williams, D, 1980 *Environmental Evidence from Roman Deposits in Skeldergate*. Archaeol York 14/3, York
Hall, A R, Kenward, H K, Williams, D and Grieg, J R A, 1983 *Environment and Living Conditions at two Anglo-Scandinavian Sites*. Archaeol York 14/4, York
Halstead, P, 1985 A study of mandibular teeth from Romano-British contexts at Maxey, in *The Fenland Project Volume 1. Archaeology and Environment in the Lower Welland Valley* (eds F Pryor, C French, D Crowther, D Gurney, G Simpson and M Taylor), 219–224. E Anglian Archaeol Rep 27(1), Cambridge
Hanf, M, 1983 *Weeds and their Seedlings*. BASF UK Ltd, Agricultural Division, Ipswich
Hansen, M, 1986 *The Hydrophilidae (Coleoptera) of Fennoscandia and Denmark Fauna*. Fauna Entomologyca Scandinavica 18, Leiden
Harcourt, R A, 1974 The dog in prehistoric and early historic Britain, *J Archaeol Sci* 1, 151–175
Harman, M, Molleson, T I and Price, J L, 1981 Burials, bodies and beheadings in Romano-British and Anglo-Saxon cemeteries. *Bull Brit Mus Natur Hist (Geol)* 35(3), 145–188

Hartley, B, Barber, H G, Carter J R and Sims, P A, 1996 *An Atlas of British Diatoms*. Biopress Ltd, Bristol

Haselgrove, C, 1996 Iron Age coinage: recent work, in *The Iron Age in Britain and Ireland: recent trends* (eds T C Champion and J R Collis), 67–85. Univ Sheffield, Sheffield

Hatting, T, 1995 Sex-related characters in the pelvic bone of domestic sheep (*Ovis aries* L.), *Archaeofauna* 4, 71–76

Helbaek, H, 1964 The Isca grain: a Roman plant introduction in Britain, *New Phytol* 63, 158–164

Hill, J D, 1995 *Ritual and Rubbish in the Iron Age of Wessex: a study on the formation of a specific archaeological record*. Brit Archaeol Rep 242, Oxford

Hill, T, 1988 *The Gardener's Labyrinth*. Oxford Univ Press, Oxford

Hillman, G, 1981 Reconstructing crop husbandry practices from the charred remains of crops, in *Farming Practice in British prehistory* (ed R J Mercer), 123–162. Edinburgh Univ Press, Edinburgh

Hillman, G, 1984a Traditional husbandry and processing of archaic cereals in recent times: the operations, products and equipment which might feature in Sumerian texts. Part I: the glume wheats, *Bull Sumerian Agric* 1, 114–152

Hillman, G, 1984b Interpretation of archaeological plant remains: the application of ethnographic models from Turkey, in van Zeist and Casparie (ed) 1984, 1–42

Hillman, G, 1986 Plant remains, 101–103 in Excavations in Caernarfon 1976–7 (R B White), *Archaeol Cambrensis* 134, 53–105

Hillman, G, 1991 A sample of carbonised plant remains, in *The Roman Villa Site at Keston, Kent. First Report* (B Philp, K Parfitt, J Willson, M Dutto and W Williams), 292. Kent Monogr 6, Dover

Hillson, S W, 1979 Diet and dental disease, *World Archaeology* 2(2), 147–162

Hinton, P, 1988 Environmental evidence from Southwark and Lambeth, in *Excavations in Southwark 1973–76 and Lambeth 1973–79* (ed P Hinton), 443–477. London Middlesex Archaeol Soc/Surrey Archaeol Soc Jnt Publ 3, London

Hodgson, J M, 1976 *Soil Survey Field Handbook*. Soil Survey Tech Monogr 5, Harpenden

Holden, J L, Phakley, P P and Clement, J G, 1995a Scanning electron microscope observations of incinerated human femoral bone: a case study, *Forensic Sci Int* 74, 17–28

Holden, J L, Phakley, P P and Clement, J G, 1995b Scanning electron microscope observations of heat-treated human bone, *Forensic Sci Int* 74, 29–45

Horwood, A R H, 1919 *British Wild Flowers in their Natural Haunts*. Gresham, London

Hume, I N, 1956 Ritual burials on the Upchurch Marshes, *Archaeol Cantiana* 70, 160–167

Hunter, F A, Tulloch, J B M and Lambourne, M G, 1973 Insects and mites of maltings in the East Midlands of England, *J Stored Product Res* 9, 119–141

Hustedt, F, 1953 Die Systematik der Diatomeen in ihren Beziehungen zur Geologie und Ökologie nebst einer Revision des Halobien-Systems, *Sv Bot Tidskr* 47, 509–519

Hustedt, F, 1957 Die Diatomeenflora des Fluss-Systems der Weser im Gebiet der Hansestadt Bremen, *Ab naturw Ver Bremen* 34, 181–440

Hyman, P and Parsons M S, 1992 *A Review of the Scarce and Threatened Coleoptera of Great Britain*. UK Nature Conserv Vol 3/1, Peterborough

Jessen, K and Helbaek, H, 1944 *Cereals in Great Britain and Ireland in Prehistoric and Early Historic Times*. Det Kongelige Danske-Videnskabernes Selskab Biologiske Skrifter 3(2)

Jessop, L, 1986 *Coleoptera: Scarabaeidae*, Handbooks for the identification of British insects 5/11. Royal Entomological Society of London, London

Jessup, R F, 1959 Roman barrows and walled cemeteries in Roman Britain, *J Brit Archaeol Assoc* 22, 1–32

Johnstone, C and Albarella, U, 2002 *The Late Iron Age and Romano-British Mammal and Bird Bone Assemblage from Elms Farm, Heybridge, Essex*. English Herit Centre Archaeol Rep 45, Portsmouth

Jones, A K G, 1986 Fish bone survival in the digestive systems of the pig, dog and man: some experiments, in *Fish and Archaeology* (eds D C Brinkhuizen and A T Clason), 53–61. Brit Archaeol Rep S294, Oxford

Jones, G, 1981 Crop-processing at Assiros Toumba – a taphonomic study, *Zeitschrift fur Archäeologie* 15, 105–111

Jones, G, 1984 Interpretation of archaeological plant remains: ethnographic models from Greece, in van Zeist and Casparie (ed) 1984, 43–61

Jones, G, 1987 A statistical approach to the archaeological identification of crop-processing, *J Archaeol Sci* 14, 311–323

Jones, G, 1996 An ethnoarchaeological investigation of the effects of cereal grain sieving, *Circaea* 12(2), 177–182

Jones, M K, 1981 The development of crop husbandry, in Jones and Dimbleby (ed) 1981, 95–127

Jones, M and Dimbleby, G, (eds) 1981 *The Environment of Man: the Iron Age to the Anglo-Saxon period*. Brit Archaeol Rep 87, Oxford

Juggins, S, 2003 *C2 User guide: software for ecological and palaeoecological data analysis and visualisation*. Univ Newcastle, Newcastle upon Tyne

Kay, Q O N, 1994 Biological flora of the British Isles: *Tripleurospermum inodorum* (L.) Schultz Bip, *J Ecol* 82, 681–697

Kenward, H K, 1975 Pitfalls in the environmental interpretation of insect death assemblages, *J Archaeol Sci* 2, 85–94

Kenward, H K, 1978 *The Analysis of Archaeological Insect Assemblages: a new approach*. Archaeol York 19/1, York

Kenward, H K and Hall A R, 1995 *Biological Evidence from Anglo-Scandinavian Deposits at 16–22 Coppergate*. Archaeol York 14/7, York

Kenward, H K, Hall, A R and Jones, A K G, 1980 A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits, *Sci and Archaeol* 22, 3–15

Kenward, H K, Hall, A R and Jones, A K G, 1986 *Environmental Evidence from a Roman Well and Anglian Pits in the Legionary Fortress.* Archaeol York 14/2, York

Kenward, H K and Williams, D, 1979 *Biological Evidence from the Roman Warehouses in Coney Street.* Archaeol York 14/2, York

Kerney, M P and Cameron, R A D, 1979 *A Field Guide to the Land Snails of Britain and North-west Europe*. Collins, London

Kerney, M P, Preece, R C and Turner, C, 1980 Molluscan and plant biostratigraphy of some late Devensian and Flandrian deposits in Kent, *Phil Trans Roy Soc London* B291, 1–43

King, A, 1978 A comparative survey of bone assemblages from Roman sites in Britain, *Bull Inst Archaeol* 15, 7–232

King, A, 1991 Food production and consumption – meat, in *Britain in the Roman Period: recent trends* (ed F J Jones), 15–20. Univ Sheffield, Sheffield

King, A, 1999a Diet in the Roman world: a regional inter-site comparison of the mammal bones, *J Roman Archaeol* 12, 168–202

King, A, 1999b Animals and the Roman army: the evidence of animal bones, in *The Roman Army as a Community* (ed A Goldsworth and I Haynes), 138–149. J Roman Archaeol Supple Ser 3, Portsmouth: Rhode Island

King, A, 2005 Animal remains from temples in Roman Britain, *Britannia* 36, 329–369

King, A and Soffe, G, 1998 Internal organization and deposition at the Iron Age temple on Hayling Island, *Proc Hampshire Fld Club Archaeol Soci* 53, 35–47

Kislev, M E, 1988 *Pinus pinea* in agriculture, culture and cult, in *Der prähistorische Mensch und seine Umwelt* (ed H J Küster), 73–79. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Wurttemberg 31, Stuttgart

Knüsel, C, 2000 Activity related changes, in *Blood Red Roses: the archaeology of the mass grave from the battle of Towton AD 1461* (V Fiorato, A Boylston and C Knüsel), 103–118. Oxbow, Oxford

Koch, K, 1992 *Die Käfer Mitteleuropas*, Ökologie Band 3, Goecke and Evers, Krefeld

Krammer, K and Lange-Bertalot, H, 1986–91 *Bacillariophyceae*. Gustav Fisher Verlag, Stuttgart

Lamb, H H, 1981 Climate from 1000 BC to 1000 AD, in Jones and Dimbleby (ed) 1981, 53–66

Lauwerier, R C G M, 1988 *Animals in Roman Times in the Dutch Eastern River Area*. ROB, Amersfoort

Legge, A J and Dorrington, E J, 1985 The animal bones, in *The Romano-British Temple at Harlow, Essex* (N E France and B M Gobel), 122–133. West Essex Archaeological Group, Gloucester

Legge, A J, 1992 *Excavations at Grimes Graves, Norfolk 1972–1976, Fascicule 4: animals, environment and the Bronze Age economy*. Brit Mus Press, London

Legge, A J, Williams, J and Williams, P, 2000 Lambs to the slaughter: sacrifice at two Roman temples in southern England, in *Animal Bones, Human Societies* (ed P Rowley-Conwy), 152–157. Oxbow, Oxford

Leney, L and Casteel, R W, 1975 Simplified procedure for examining charcoal specimens for identification, *J Archaeol Sci* 2, 153–159

Levine, M A, Bailey, G N, Whitwell, K E and Jeffcott, L B, 2000 Palaeopathology and horse domestication: the case of some Iron Age horses from the Altai Mountains, Siberia, in *Human Ecodynamics* (ed G Bailey, R Charles and N Winder), 123–133. Oxbow, Oxford

Lindroth, C H, 1974 *Coleoptera: Carabidae*, Handbooks for the Identification of British Insects 4(2). The Royal Entomological Society of London, London

Locker, A, 1991 The animal bone, in *The Roman Villa site at Keston, Kent, First report (excavations 1968–1978)* (B Philp, K Parfitt, J Willson, M Dutto and W Williams), 285–292. Kent Monogr 6, Dover

Locker, A, 1999 The animal bone, in *The Roman Villa Site at Keston, Kent* (B Philp, K Parfitt, J Willson and W Williams), 145–158. Kent Monogr 8, Dover

Locker, A, 2007 *In piscibus diversis*: the bone evidence for fish consumption in Roman Britain, *Britannia* 38, 141–180

Long, A J, Scaife, R G and Edwards, R J, 2000 Stratigraphic architecture, relative sea-level, and models of estuary development in southern England: new data from Southampton Water. , in *Coastal and Estuarine Environments: sedimentology, geomorphology and geoarchaeology* (ed K Pye and J R L Allen), 253–279. Geol Soc London Spec Publ 175, London

Lovell, J, 2006 Excavation of a Romano-British farmstead at RNAS Yeovilton, *Proc Somerset Archaeol Natur Hist Soc* 149, 7–70

Lucht, W H, 1987 *Die Käfer Mitteleuropas (Katalog)*. Goecke and Evers, Krefeld

MacGregor, A, 1985 *Bone, Antler, Ivory and Horn: the technology of skeletal materials since the Roman period.* Croom Helm, London

Magilton, J R, 1995 Lindow Man: the Celtic tradition and beyond, in *Bog Bodies: new discoveries and new perspectives* (eds R C Turner and R G Scaife), 183–187. British Museum Press, London

Mays, S, 1993 Infanticide in Roman Britain, *Antiquity* 67, 883–888

McKinley, J I, 1992 Cremation and inhumation burials from St Stephen's cemetery, St Albans. Unpubl rep

McKinley, J I, 1993 Bone fragment size and weights of bone from modern British cremations and its implications for the interpretation of archaeological cremations, *Int J Osteoarchaeol* 3, 283–287

McKinley, J I, 1994 *The Anglo-Saxon Cemetery at Spong Hill, North Elmham. Part VIII: the cremations.* E Anglian Archaeol 69, Dereham

McKinley, J I, 2000 The analysis of cremated bone, in *Human Osteology* (eds M Cox and S Mays), 403–421. Greenwich Medical Media, London

McKinley, J I, 2004a Compiling a skeletal inventory: disarticulated and co-mingled remains, in *Guidelines to the Standards for Recording Human Remains* (ed M Brickley and J I McKinley), 13–16. British Association for Biological Anthropology and Osteoarchaeology/Institute of Field Archaeologists, Reading

McKinley, J I, 2004b Human remains, pyre technology and cremation rituals, in *The Roman cemetery at Brougham, Cumbria: excavations 1966–67* (H E M Cool), 283–310. Britannia Monogr 21, London

McKinley, J I, (ed), 2006 Human remains from Section 1 of the Channel Tunnel Rail Link, Kent, in ADS 2006

McKinley, J I, 2008 In the heat of the pyre: efficiency of oxidation in Romano-British cremations – did it really matter, in *The Analysis of Burned Human Remains* (eds C W Schmidt and S S Symes), 163–183. Academic Press, London

McKinley, J I and Heaton, M, 1996 A Romano-British farmstead and associated burials at Maddington Farm, Shrewton, *Wiltshire Archaeol Mag* 89, 44–72

McKinley, J I and Smith, P, 1997 Cremated animal bone from burials and other cremation-related contexts, in *Archaeological Excavations on the Route of the A27 Westhampnett Bypass, West Sussex, 1992, Volume 2* (A P Fitzpatrick), 253. Wessex Archaeol Rep 12, Salisbury

Millett, M, 1990 *The Romanization of Britain: an essay in archaeological interpretation.* Cambridge Univ Press, Cambridge

Milne, G, 1995 *Book of Roman London, Urban Archaeology in the Nation's Capital.* Batsford/English Heritage, London

Moffett, L, 1988 *The Archaeobotanical Evidence for Saxon and Medieval Agriculture in Central England, c 500 AD to 1500 AD*, unpubl MPhil thesis, Univ Birmingham

Molleson, T I, 1993 The human remains, in *Poundbury. Volume 2: the cemeteries* (D E Farwell and T I Molleson), 142–214, Dorset Natur Hist Archaeol Soc Monogr 11, Dorchester

Mook, W G, 1986 Business meeting: recommendations/resolutions adopted by the twelfth International Radiocarbon Conference, *Radiocarbon* 28, 799

Moore, P D, 1977 Ancient distribution of lime trees in Britain, *Nature* 268, 13–14

Moore, P D and Webb, J A, 1978 *An Illustrated Guide to Pollen Analysis.* Hodder and Stoughton, London

Moore, P D, Webb, J A and Collinson, M E, 1991 *Pollen Analysis* (2 edn). Blackwell Scientific, Oxford

Moorees, C F A, Fanning, E A and Hunt, E E, 1963 Age variation of formation stages for ten permanent teeth, *J Dental Res* 42, 1490–1502

Morris M and Smith, D N, 2007 Insects, in *The London Guildhall: an archaeological history of a neighbourhood from early medieval to modern times* (D Bowsher, T Dyson, N Holder and I Howell), 480–482. Mus London Monogr 36, London

Morris, P, 1979 *Agricultural Buildings in Roman Britain.* Brit Archaeol Rep Brit Ser 70, Oxford

Moulins, D de, 1990 Environmental analysis, in *The Upper Walbrook Valley in the Roman period* (ed C Maloney), 85–115. Counc Brit Archaeol Res Rep 69, London

Moulins, D de, 2006 Charred plant remains, in *Roman Droitwich: Dodder Hill fort, Bays Meadow villa, and roadside settlement* (D Hurst), 69–75. Counc Brit Archaeol Res Rep 146, York

Müller, H-H, 1973 Zur Nutzung der frühgeschichtlichen Haustiere (auf Grund osteologischer Untersuchungen), in *Berichte über den II. Internationalen Kongreß für slawische Archäologie Berlin 1970* (eds J Hermann and K-H Otto), Band 3, 429–439. Berlin

Munro, J W, 1940 *Report on a Survey of the Infestations of Grain by Insects.* HMSO, London

Murphy, P, 1986 Culver Street under the microscope, *Catalogue* (News of Archaeological Excavations in Colchester) 18, Winter 1985/6, 2–5

Murphy, P, 2003a Plant macrofossils, in *Excavations at Great Holts Farm, Boreham, Essex, 1992–94* (M Germany), 204–213. E Anglian Archaeol 105, Chelmsford

Murphy, P, 2003b Plant macrofossils and molluscs, insects and pollen, in *Power and Island communities: excavations at the Wardy Hill Ringwork, Coveney, Ely* (C Evans), 84–114. E Anglian Archaeol 103, Cambridge

Murphy, P, Albarella, U, Germany, M and Locker, A, 2000 Production, imports and status: biological remains from a late Roman farm at Great Holts Farm, Boreham, Essex, *Environ Archaeol* 5, 35–48

Murphy, P and Fryer, V, forthcoming Plant macrofossils, in *Excavations on a Multi-period landscape at Rectory Farm, West Deeping, Lincolnshire* (J Hunn and J Rackham). BAR British Series, Oxford

Neckham, A, 1967 *De naturis rerum libri duo, with the poem of the same author, De laudibus divinae sapientiae* (ed T Wright), *Rerum Britannicarum Medii Aevi Scriptores*, or Chronicles and Memorials of Great Britain and Ireland during the Middle Ages (Rolls Series) 34. Longman, London (1863 edition reprinted by Kraus reprints)

Nilsson, A N and Holmen, M, 1995 *The Aquatic Adephaga (Coleoptera) of Fennoscandia and Denmark: II. Dytiscidae.* Fauna Entomologyca Scandinavica 35, Leiden

Noddle, B, 1983 Size and shape, time and place: skeletal variations in cattle and sheep, in *Integrating the Subsistence Economy* (ed M Jones), 211–238. Brit Archaeol Rep S181, Oxford

Norman, P and Reader, FW, 1904 Recent discoveries in connexion with Roman London, *Archaeologia* 60, 169–250

OA, 2006 *South Thames-side Development Route 4 (STDR4 01), Ebbsfleet Valley, Northfleet Kent, Post excavation Assessment Report and Updated Project Design*. Unpubl client rep

O'Connor, T P, 1988 *Bones from the General Accident Site, Tanner Row.* Archaeol of York: The Animal Bones 15/2, London

OAU, 1997 *Proposed Ebbsfleet Development, Northfleet Rise Area, Kent. Archaeological Evaluation Report.* Unpubl client rep

OAU, 2000b *South Thames-Side Development Route 4 (STDR 4), Ebbsfleet Valley, Northfleet, Kent. Archaeological and Geological Evaluation Report.* Unpubl client rep

Ogden, A R, 2005 *Identifying and Scoring Periodontal Disease in Skeletal Material*, unpublished paper, University of Bradford, Bradford

Oliver, M, 1993. The Iron Age Romano-British settlement at Oakridge, *Proc Hampshire Fld Club Archaeol Soc* 48, 55–94

Ortner, D J and Putscher, W G J, 1985 *Identification of Pathological Conditions in Human Skeletal Remains.* Smithsonian Institution Press, Washington

Osborne, P J, 1969 An insect fauna of late Bronze Age date from Wilsford, Wiltshire, *J Animal Ecol* 38, 555–566

Osborne, P J, 1977 Stored product beetles from a Roman site at Droitwich, England. *J Stored Products Res* 13, 203–204

Panagiotakopulu, E, 2004 Dipterous remains and archaeological interpretation, *J Archaeol Sci* 31, 1675–1684

Pattinson, I, 1958 *Insect Infestation in Edinburgh Maltings.* Dept Agriculture and Fisheries, Edinburgh

Payne, S, 1973 Kill off patterns in sheep and goats: the mandibles from Asvan Kale, *Anatolian Stud* 23, 281–303

Pearson, E and Robinson, M, 1994 Environmental evidence from the villa, in *Bancroft: a late Bronze Age/Iron Age settlement, Roman villa and temple-mausoleum. Volume 2: finds and environmental evidence* (R J Williams and R J Zeepvat), 565–584. Buckinghamshire Archaeol Soc Monogr 7, Aylesbury

Pelling, R, 2000 Charred plant remains, 53–56, in Site of the former Hockley Chemical Works, Stratford Road, Alcester: excavations 1994 (A Mudd and P M Booth), *Trans Birmingham Warwickshire Archaeol Soc* 104, 1–74

Pelling, R, 2008 Charred and waterlogged plant remains, in *The Roman Roadside Settlement at Westhawk Farm, Ashford, Kent, Excavations 1998–9* (P M Booth, A Bingham and S Lawrence), 349–57. Oxford Archaeology Monogr 2, Oxford

Penn, W S, 1960 Springhead: Temples III and IV, *Archaeol Cantiana* 74, 113–140

Peters, J, 1997 Zum Stand der Hühnerhaltung in der Antike, in *Beiträge zur Archäozoologie und Prähistorischen Anthropologie 1* (ed M Kokabi), 42–58. Gesellschaft für Archäozoologie und Prähistorische Anthropologie, Konstanz

Phillips, R, 1978 *Trees in Britain, Europe and North America*. Pan, London

Philp, B and Chenery, M, 1997 *A Roman Site at Vagniacae (Springhead), near Gravesend.* Kent Archaeol Rescue Unit, Kent Spec Subj Ser 9, Canterbury

Philpott, R, 1991 *Burial Practices in Roman Britain.* Brit Archaeol Rep Brit Ser 219, Oxford

Piercy Fox, N, 1967 The ritual shaft at Warbank, Keston, *Archaeol Cantiana* 82, 184–190

Poole, C, 1984 The woodlands and their use, in *Danebury: an Iron Age hillfort in Hampshire. Vol 2 The excavations 1969–1978: The finds* (B Cunliffe), 481–483. Counc Brit Archaeol Res Rep 52, London

Powell, A B, Booth, P, Fitzpatrick, A P and Crockett, A D, 2008 *The Archaeology of the M6 Toll 2000–2003.* Oxford Wessex Archaeol Monogr 2, Salisbury and Oxford

Preece, R C and Bridgland, D R, 1998 *Late Quaternary Environmental Change in North-west Europe: excavations at Holywell Coombe, south-east England.* Chapman & Hall, London

Preece, R C and Bridgland, D R, 1999 Holywell Coombe, Folkestone: A 13,000-year history of an English chalkland valley, *Quat Sci Rev* 18, 1075–1125

Prilloff, R-J, 1994 Archäologische Hinweise auf die Gewinnung von Seeadlerfedern im Mittelalter, in *Beiträge zur Archäozoologie und Prähistorischen Anthopologie* (eds M Kokabi and J Wahl), 429–435. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 53, Stuttgart

Prior, J and Alvin, K L, 1983 Structural changes on charring woods of *Dictostachys* and *Salix* from southern Africa, *Int Assoc Wood Anat Bull* 4(4), 197–206

Pugsley, P, 2003 *Roman Domestic Wood.* Brit Archaeol Rep S1118, Oxford

Reichstein, H, 1994 Über Knochen von Rinder-, Schaf- und Schweinefeten aus Kloaken und Abfallschächten spätmittelalterlicher bis frühneuzeitlicher Städte in *Norddeutschland, in Beiträge zur Archäozoologie und Prähistorischen Anthopologie* (eds M Kokabi and J Wahl), 445–448. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 53, Stuttgart

Reid, C and Lyell, A H, 1911 Seeds from the mud at the bottom of the well, 448 in Excavations at Caerwent, Monmouthshire, in the years 1909 and 1910 (T Ashby, A E Hudd and F Hing), *Archaeologia* 62(2) 405–48

Roberts, C and Manchester K, 1997 *The Archaeology of Disease*. Sutton, Stroud

Roberts, C and Cox, M, 2003 *Health and Disease in Britain from Prehistory to the Present Day (2nd edn)*. Sutton, Stroud

Robinson, M A, 1976 Appendix 2. The environment of the Roman defences at Alchester, 161–70 in The defences of Roman Alchester (C J Young), *Oxoniensia* 40, 136–170

Robinson, M A, 1979 The biological evidence, in *Iron Age and Roman Riverside Settlements at Farmoor, Oxfordshire* (G Lambrick, and M A Robinson), 77–133. Counc Brit Archaeol Res Rep 32, London

Robinson, M A, 1981 The Iron Age to early Saxon environment of the Upper Thames terraces, in Jones and Dimbleby (ed) 1981, 251–286

Robinson, M, 1999 Charred plant remains, 147–50 in Excavations at the Mount Roman Villa, Maidstone, 1994 (M Houliston), *Archaeol Cantiana* 119, 71–172

Robinson, M A, 2002 Domestic burnt offerings and sacrifices at Roman and pre-Roman Pompeii, Italy, *Vegetation Hist Archaeobot* 11, 93–99

Robinson, M A, 2007 The environmental archaeology of the Cotswold Water Park, in *Iron Age and Roman Settlement in the Upper Thames Valley* (D Miles, S Palmer, A Smith, and G P Jones), 355–64. Thames Valley Landscapes Monogr 26, Oxford

Robinson, M A and Wilson, R, 1987 A survey of environmental archaeology in the South Midlands, in *Environmental Archaeology: a regional review, vol 2* (ed H C M Keeley), 16–100. HBMC Occas Pap 1, London

Rodwell, J S (ed), 1991a *British Plant Communities, volume 1: woodlands and scrub*. Cambridge Univ Press, Cambridge

Rodwell, J S (ed), 1991b *British Plant Communities, volume 2: mires and heaths*. Cambridge Univ Press, Cambridge

Rodwell, J S (ed), 1992 *British Plant Communities, volume 3: grasslands and montane communities*. Cambridge Univ Press, Cambridge

Rodwell, J S (ed), 1995 *British Plant Communities, volume 4: aquatic communities, swamps and tall-herb fens*. Cambridge Univ Press, Cambridge

Rodwell, J S (ed), 2000 *British Plant Communities, volume 5: maritime communities and vegetation of open habitats*. Cambridge Univ Press, Cambridge

Rogers, J and Waldron, T, 1995 *A Field Guide to Joint Disease in Archaeology*. Wiley, Chichester

Ross, A, 1975 Appendix: a wooden statuette from *Venta Belgarum*, 335–6 in Excavations at Winchester 1971: tenth and final interim report: part II (M Biddle), *Antiq J* 55, 295–337

Ross-Mackenzie, J, 1934 *Brewing and Malting* (3 edn). Pitman, New York

Ruscillo, D, 2006 The table test: a simple technique for sexing canid humeri, in *Recent Advances in Ageing and Sexing Animal Bones* (ed D Ruscillo), 62–67. Oxbow, Oxford

Ryves, D B, Juggins, S, Fritz, S C and Battarbee, R W, 2001 Experimental diatom dissolution and the quantification of microfossil preservation in sediments, *Palaeogeog, Palaeoclimat, Palaeoecol* 172, 99–113

Samuel, D, 2000 Brewing and baking, in *Ancient Egyptian Materials and Technology* (eds P T Nicholson and I Shaw), 537–576. Cambridge Univ Press, Cambridge

Sanden, W B van der, 1996 *Through Nature to Eternity: the bog bodies of northwest Europe*. Batavian Lion International, Amsterdam

Scaife, R G, 1980 *Late Devensian and Flandrian vegetation palaeoecological studies in the Isle of Wight.* Unpubl PhD thesis, King's College, Univ London

Scaife, R G, 1987 The Late Devensian and Flandrian vegetation of the Isle of Wight, in *Wessex and the Isle of Wight: field guide* (ed K E Barber), 156–180. Quaternary Research Association, London

Scaife, R G, 2000a Holocene vegetation development in London, in *The Holocene Evolution of the London Thames: archaeological excavations, 1991–1998* (J Sidell, K Wilkinson, R Scaife and N Cameron), 111–117. Mus London Archaeol Service Monogr 5, London

Scaife, R G, 2000b Palynology and palaeoenvironment, in *The Passage of the Thames: Holocene environment and settlement at Runnymede* (S P Needham), 168–187. Runnymede Bridge Research Excavations 1, London

Scaife, R G, 2006 Pollen analysis of the sediment fills from well 11010 at Thurnham Roman villa (ARC THM 98), in Giorgi and Stafford 2006

Scheuer, L and Black, S, 2000 *Developmental Juvenile Osteology.* Academic Press, London

Schmid, E, 1972 *Atlas of Animal Bones for Prehistorians, Archaeologists and Quaternary Geologists.* Elsevier, New York

Schuster, T, 2001 *Bösselkatrien heet mien Swien: Das Tier in der ostfriesischen Kulturgeschichte und Sprache*, Leer

Schweingruber, F H, 1990 *Microscopic Wood Anatomy* (3 edn). Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf

Scott, E, 1999 *The Archaeology of Infancy and Infant Death.* Brit Archaeol Rep S819, Oxford

Siegel, J, 1976 Animal pathology: possibilities and problems, *J Archaeol Sci* 3, 349–384

Simoons, F J, 1994 *Eat Not This Flesh: food avoidances from prehistory to the present* (2 edn). Univ Wisconsin Press, Madison

Simpson, T, 2000 The Roman well at Piddington, Northamptonshire, England: the investigation of the coleopterous fauna, *Environ Archaeol* 6, 91–96

Smith, D, 1997a Insect remains, 41–43 in A prehistoric and Roman occupation and burial site at Heybridge: Excavations at Langford Road, 1994 (B Langton and N Holbrook), *Essex Archaeology and History* 28, 12–46

Smith, D, 1997b *The insect remains from Mancetter Mill Lane, Roman well.* Unpubl Rep

Smith, D N, 1999 *The insect remains from Covert Farm (DIRFT East), Crick, Northamptonshire*. Unpubl Rep

Smith, D N, 2001 *The Insect Remains from Invereskgate,* University of Birmingham Environmental Archaeology Services Report 30. Unpubl Rep

Smith D N, 2002 The insect remains, in *Prehistoric and Romano-British landscape: excavations at Whitemoor Haye Quarry, Staffordshire, 1997–1999* (G A Coates), 67–72. Brit Archaeol Rep 340, Oxford,

Smith, D N, 2003a *The insects from Little Paxton, Cambridgeshire,* University of Birmingham Environmental Archaeology Services Report 40. Unpubl Rep

Smith, D N, 2003b *The insect remains from 20–30 Gresham Street (Blossom's Inn), City of London EC2 (GHT00),* University of Birmingham Environmental Archaeology Services Report 136. Unpubl Rep

Smith, D N, 2006 *The insect remains from the Ikea site at Glover Drive, Edmington, Enfield (GVV 04),* University of Birmingham Environmental Archaeology Services Report 133. Unpubl Rep

Smith, D N, 2010 The insect remains, in *The Carlisle Millennium Project: excavations in Carlisle 1998–2001; Vol 2: the finds* (C Howard-Davis), 921–5, 1481–9. Lancaster Imprints 15, Lancaster

Smith, D N, In press 2011a The insect remains, in *Roman London and the Walbrook Stream Crossing: excavations at 1 Poultry and vicinity, City of London* (J Hill and P Rowsome), 559–63. MoLAS Monograph Series 37, London

Smith, D N, 2011b Roman grain pests in Britain: implications for grain supply and agricultural production, *Britannia* 42, 1–20

Smith, D N, Roseff, R, and Butler, S, 2001 The sediments, pollen, plant macro-fossils and insects from a Bronze Age channel fill at Yoxall Bridge, Staffordshire, *Environ Archaeol* 6, 1–12

Smith, W, and Davies, A, 2006 The charred plant remains from Thurnham villa, Thurnham, Kent (ARC THM 98), in Giorgi and Stafford (eds) 2006

Snyder, L M and Moore, E A (eds), 2006 *Dogs and People in Social, Working, Economic or Symbolic Interaction*. Oxbow, Oxford

Stace, C, 1991/1997 *New Flora of the British Isles* (1st/2nd edn). Cambridge Univ Press, Cambridge

Stevens, C J, 2003b Agricultural processing: an overview, in *Power and Island communities: excavations at the Wardy Hill Ringwork, Coveney, Ely* (C Evans), 138–144. E Anglian Archaeol 103, Cambridge

Stevens, C J with Robinson, M, 2004 Production and consumption: Plant cultivation, 81–82, in *Yarnton: Saxon and Medieval Settlement and Landscape* (ed G Hey). Thames Valley Landscape 20, Oxford

Stevens, C J, 2006a Charred plant remains, in *Iron Age and Romano-British settlements and landscapes of Salisbury Plain* (M G Fulford, A B Powell, R Entwistle, and F Raymond), 152–158. Wessex Archaeol Rep 20, Salisbury

Stevens, C J, 2006b The charred plant remains from North of Saltwood Tunnel, Saltwood, Kent, in Giorgi and Stafford (ed) 2006

Stevens, C J, 2006c The charred plant remains from Bower road, Smeet, Kent (ARC 440/99), in Giorgi and Stafford (ed) 2006

Stevens, C J, 2006d The charred plant remains from Little Stock Farm, Mersham, Kent, in Giorgi and Stafford (ed) 2006

Stevens, C J, 2009, Charred plant remains, in K Ritchie, Environment and landuse in the lower Lea valley c 12,500 BC – 600 AD: Innova Park and the Former Royal Ordnance Factory, Enfield, Trans *London Middlesex Archaeol Soc* 59, 1–38

Stevens, C J, 2010a Charred plant remains, in *Living and Working in Roman and Later London: Excavations at 60–63 Fenchurch Street* (V Birbeck and J Schuster), 103–110. Wessex Archaeology, Salisbury

Stevens, C J, 2010b The charred plant remains, 145–47 in An archaeological investigation of land at Kingsborough, Farm and Kingsborough Manor, Eastchurch, Isle of Sheppey (S Stevens), *Archaeol Cantiana* 129, 129–54

Stevens, C J, Wyles, S F and Huckerby, E, 2005 *CTRL Section 2 Post-Excavation Archaeological Works Springhead and Northfleet: Assessment of Charred Plant Remains*. Unpubl Rep

Straker, V, 1984 First and second century carbonised cereal grain from Roman London, in van Zeist and Casparie (ed) 1984, 323–330

Straker, V, 2006 Macroscospic plant remains, in *Roman Droitwich: Dodderhill Fort, Bays Meadow Villa, and Roadside Settlement* (L Barfield, J Hughes and F McAvoy), 221–3. Counc Brit Archaeol Res Rep 146, York

Struck, M, 1993 Kinderbestattungen in romano-britischen Siedlungen – der archäologische Befund, in *Römerzeitliche Gräber als Quellen zu Religion, Bevölkerungsstruktur und Sozialgeschichte* (ed M Struck), 313–318. Archäologische Schriften des Instituts für Vor-und Frühgeschichte der Johannes Gutenberg-Universität, Mainz

Stuiver, M, Reimer P J, Bard, E, Beck, J W, Burr, G S, Hughen, K A, Kromer, B, McCormac, G, Plicht, J van der and Spurk, M, 1998 INTCAL98 Radiocarbon Age Calibration, 24000–0 cal BP, *Radiocarbon* 40(3), 1041–1083

Taylor, M, 1981 *Wood in Archaeology*. Shire, Princes Risborough

Tebb, G, 1968 A survey of infestations in maltings and breweries, *J Inst Brewers* 74, 207–219

Tetlow, E, 2010 The insect remains (Section 17), in *Landscape Evolution in the Middle Thames Valley. Heathrow, Terminal 5 Excavations Volume 2* (Framework Archaeology), 1-39. Framework Archaeol Monog 3, Salisbury

Tomek, T and Bochenski, Z M, 2000 *The Comparative Osteology of European Corvids (Aves: Corvidae), with a Key to the Identification of their Skeletal Element.* Polish Academy of Sciences, Institute of Systemics and Evolution of Animals, Warsaw

Tomlinson, P, 1987 Plant remains, 291–5 in A plank tank from Nantwich (R McNeil, and A F Roberts), *Britannia* 18, 287–97

Toynbee, J M C, 1973 *Animals in Roman Life and Art*. Phaidon, London

Trantalidou, K, 2006 Companions from the oldest times: dogs in ancient Greek literature, iconography and osteological testimony, in Snyder and Moore (ed) 2006, 96–120

Trotter, M and Gleser, G C, 1952 Estimation of stature from long bones of American whites and Negroes, *Amer J Physical Anthrop* 10(4), 463–514

Trotter, M and Gleser, G C, 1958 A re-evaluation of estimation of stature bases on measurements of stature taken during life and of long bones after death, *Amer J Physical Anthrop* 16(1), 79–123

Turner, J, 1981 The vegetation, in Jones and Dimbleby (ed) 1981, 67–73

Tyrell, A, 2000 Skeletal non-metric traits and the assessment of inter- and intra-population diversity: past problems and future potential, in *Human Osteology in Archaeology and Forensic Science* (ed M Cox and S Mays), 289–306. Greenwich Medical Media, London

Uerpmann, H-P, 1977 Schlachterei-Technik und Fleischversorgung im römischen Militärlager von Dangstetten (Landkreis Waldshut), *Regio Basilensis* 18, 261–272

Underdown, S J, 2003 *Structures and Processes: an integrated approach to the archaeology of the floor-malting industry.* Unpubl MA Dissert, Univ York

URL 1997b *The Ebbsfleet Valley, Northfleet, Kent (ARC EFT97)*. Unpubl Rep

URN 2002b *Ebbsfleet Sports Ground, Northfleet, Kent (ARC ESG00): Phase II Evaluation Archaeological Works, Fieldwork Report: Final.* Unpubl Rep

Vaughan, M D, 1982 *The Charred Plant Remains from Hanbury Street, Droitwich.* Unpubl MSc thesis, Univ College London

Veen, M van der, 1989 Charred grain assemblages from Roman-period corn driers in Britain, *Archaeol J 146*, 302–319

Veen, M van der, 1991 Consumption or production? Agriculture in the Cambridgeshire fens?, in *New Light on Early Farming: recent developments in palaeoethnobotany* (ed J Renfrew), 349–361. Edinburgh Univ Press, Edinburgh

Veen, M van der, 1992 *Crop husbandry regimes: an archaeobotanical study of farming in northern England 1000 BC–AD 500*. Sheffield Archaeol Monogr 3, Sheffield

Veen, M van der and Fieller, N, 1982 Sampling seeds, *J Archaeol Sci* 9, 287–298

Vitt, V O, 1952 The horses of the kurgans of Pazyryk, *J Soviet Archaeol* 16, 163–206 (in Russian)

WA, 2007a *Archaeological investigations at Weedon Hill, Aylesbury, Buckinghamshire: archaeological assessment report and updated project design.* Unpubl Rep

Watts, L and Leach, P, 1996 Henley Wood. Temples and Cemetery. Counc Brit Archaeol Res Rep 99, York

Wenban-Smith F F, 2002, *Eastern Quarry, Swanscombe: Preliminary Palaeolithic/Pleistocene field Evaluation Report.* Unpublished Rep

Wenban-Smith F F, Allen P, Bates M R, Parfitt S A, Preece R C, Stewart J R, Turner C and Whittaker J E, 2006 The Clactonian elephant butchery site at Southfleet Road, Ebbsfleet, UK, *J Quat Sci* 21(5) 471–483

Wheeler, A, 1978 *Key to the Fishes of Northern Europe*. Warne, London

Wheeler, R E M and Wheeler, T V, 1932 *Report on the Excavation of the Prehistoric, Roman and Post-Roman Site at Lydney Park, Gloucestershire.* Rep Res Comm Soc Antiq London 9, Oxford

White, KD, 1970 *Roman Farming.* Thames and Hudson, London

Wilkens, B, 2006 The sacrifice of dogs in ancient Italy, in Snyder and Moore (ed) 2006, 132–137

Willcox, G H, 1977 Exotic plants from Roman waterlogged sites in London, *J Archaeol Sci* 4, 269–282.

Willcox, G H, 1978 Seeds from the late 2nd century pit F28, in *Southwark Excavations 1972–1974*, London Middlesex Archaeol Soc/Surrey Archaeol Soc Joint Publ 1, London, 411–414

Willcox G H, 1980 The environmental evidence, in *The Roman Riverside Wall and Monumental Arch in London* (C Hill, M Millet and T Blagg), 78–82. London Middlesex Archaeol Soc Spec Pap 3, London

Wilson, D G, 1979 Horse dung from Roman Lancaster: a botanical report, in *Roman Lancaster: rescue archaeology in an historic city 1970–75* (G Jones and D Shotter), Brigantia Monogr 1, Manchester, 170–178

Wilson, R, 1998 The animal bone, in Boyle and Early 1998, 34–36

Winder, J M, 1985 Oyster culture, in *The Port of Roman London* (G Milne). Batsford, London, 91–95

Winder, J M, 1992 The oysters, in *Excavations in Poole 1973–83* (I P Horsey), 194–200. Dorset Natur Hist Archaeol Soc Monogr 10

Winder, J M, 1993a Oyster and other marine mollusc shells, in *Excavations at the Old Methodist Chapel and Greyhound Yard, Dorchester, 1982–1984* (P J Woodward, S M Davies, and A Graham), 347–348. Dorset Natur Hist Archaeol Soc Monogr 12, Dorset

Winder, J M, 1993b Oyster and other marine mollusc shells, in *The Romano-British Villa at Halstock, Dorset. Excavations 1967–1985* (R M Lucas), 114–116. Dorset Natur Hist Archaeol Soc Monogr 13, Dorset

Yalden, D, 1999 *The History of British Mammals.* T & A D Poyser, London

Yonge, C M, 1960 *Oysters*. Collins, London

Zach, B, 2002 Vegetable offerings on the Roman sacrificial site in Mainz, Germany: short report on the first results, *Veget Hist Archaeobot* 11, 101–106

Zeist, W van and Casparie, W A (eds), 1984 *Plants and Ancient Man: studies in palaeoethnobotany.* Balkema, Rotterdam

Zeiler, J T, 1997 Offers en slachtoffers. Faunaresten uit de Fortunatempel te Nijmegen (2e eeuw n. Chr.), *Paleoaktueel* 8, 105–107

Zohary, D and Hopf, M, 2000 *Domestication of Plants in the Old World: the origin and spread of cultivated plants in West Asia, Europe, and the Nile Valley* (3 edn). Clarendon Press, Oxford

Index

by Susan Vaughan

Illustrations are denoted by page numbers in *italics* or by *illus* where figures are scattered throughout the text. Places are in Kent unless indicated otherwise.

The detailed specialist reports in this volume, the third of four, present analyses of the Late Iron Age and Roman human bone and animal bone assemblages recovered during the reported excavations, as well as environmental remains and dating evidence relating to contemporary landscape, subsistence and economy.

A single cremation burial and at least 48 inhumation burials were recorded at Springhead, with a single inhumation burial of a neonate also recovered from within the Northfleet villa complex. Whole or partial skulls appear to have been both deliberately placed and redeposited in a variety of features, including a 'ritual shaft' at Springhead. Over 68,000 fragments of animal bone were recovered, including many complete animal skeletons. At Springhead the assemblage is dominated by sheep/goat whilst cattle are more important at the Northfleet villa.

The environmental evidence for Roman subsistence and economy is presented in reports on charred plant remains, wood charcoal, and marine shell. Of particular note is the evidence for brewing on an almost industrial scale at the villa, with a malting oven (reconstructed above), a barn and three brewing tanks discovered – the largest of which could hold up to 16,000 pints alone, supplying not only the villa's need but almost certainly also for trade further afield. Environmental sequences and remains relating to the development of the wider Roman landscape of the Ebbsfleet Valley were also recovered from a range of locations.

All four volumes: ISBN 978-0-9545970-7-8

Volume 1: The Sites (ISBN 978-0-9545970-3-0)
Volume 2: Late Iron Age to Roman Finds Reports (ISBN 978-0-9545970-4-7)
Volume 3: Late Iron Age to Roman Human Remains and Environmental Reports (ISBN 978-0-9545970-5-4)
Volume 4: Saxon and Later Finds and Environmental Reports (ISBN 978-0-9545970-6-1)

ISBN 978-0-9545970-5-4

9 780954 597054 >