Romano-British Spelt Malting on the Cambridgeshire Fen Edge: Excavations at Norman Way Industrial Estate, Over

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Illustrations by Gillian Greer

Archaeological investigations at Over have revealed significant evidence for crop processing and spelt malting on the Roman fen edge. Analysis of the archaeobotanical remains demonstrates that these activities were being carried out on an industrial scale, providing further insight into the organisation and development of the fenland landscape and the importance of this area to the wider Roman economy.

Introduction

A small excavation carried out in 2014 by Oxford Archaeology (OA) East at Norman Way Industrial Estate on the southern outskirts of Over village (TL 3790 6930) revealed a fairly dense expanse of features predominantly dating to the Roman period. Of particular note was the significant charred plant assemblage recovered from the large pits, tanks and other features that is indicative of large-scale crop processing and spelt malting. This paper focuses on the research potential of the archaeobotanical evidence, particularly in terms of elucidating the role played by smaller fen-edge settlements within both the local fenland landscape and wider Romano-British economy. The overall results of the excavation are fully detailed in the archive report (Moan 2017), which is available to download from the OA library <https://library.the humanjourney.net/3214>. The project archive will be deposited with Cambridgeshire County Council under the site code OVEINE14/ECB4283.

The Site Within the Roman Fenland Landscape

Over is a large fen-edge village located approximately 14km to the north-west of Cambridge. Flanking the southern bank of the River Great Ouse, much of the western part of the parish is fenland and lies at around 3m OD, with the upland dominating the eastern side rising to 18m OD (Hall 1996, 147). Although Roman settlement in this area was generally concentrated on the high gravel terraces, this industry-focused site was established on lower ground (Pleistocene till overlying Ampthill clay) close to the fen edge (*c.* 11m OD; Fig. 1).

Within the immediate environs of the site are the cropmarks of a rectangular double enclosure located just to the north-east and first identified by the Fenland Survey (site 10; Hall 1996, 150–1; fig. 84; Cambridgeshire Historic Environment Record (CHER) 11133, Fig. 1). Although unexcavated, surface finds of Roman pottery and tile have been recovered from the vicinity (CHER 07724), while traces of Iron Age settlement have been found further to the south-east (MCB 19358). Fieldwalking for the Fenland Survey to the south of Hill Farm to the east of the site recovered large quantities of pottery sherds including samian, colour-coated wares and 'Cold Harbour Ware'. Other finds include box flue tile with plaster still attached, possibly deriving from a building of some quality (sites 8, 9 and 11; Hall 1996, 151; Fig. 1). Evidence of pottery production including fire-bars and kiln wall fragments has been found 1.5km to the east of the site, at Cold Harbour Farm (site 12; Hall 1996, 151; fig. 84). Satellite imagery to the west of the site shows part of a palaeochannel close to the Roman fen edge, adjacent to which are a series of what appear to be large rectangular pits or tanks measuring around 10m long by 3m wide, with further linear features on either side of the channel (Fig. 1; TL 37414 69640). Although undated, these features could represent broadly contemporary Roman fen-edge activity.

The development of the Roman fenland has been the subject of much discussion, particularly since the publication in 1970 of *The Fenland in Roman Times* in which Salway advanced the concept of the Fenland Imperial Estate (Salway 1970, 7; Evans *et al.* 2013, 13). This model has since been reassessed and ultimately challenged, with each of the three main tenets underpinning it (rapid colonisation in the late Hadrianic or Antonine periods; the extensive network of artificial waterways, droveways and roads; and the presence of a large-scale salt industry) being reviewed in light of more recent research (Taylor 2000 and summarised by Evans *et al.* 2013, 13–15). In particular, the growing body of development-led investigation, building on the results of the Fenland Survey Project, is showing that colonisation of the fens began earlier and was a much more complex and piecemeal process than had previously been appreciated.

Although the fenland landscape was clearly

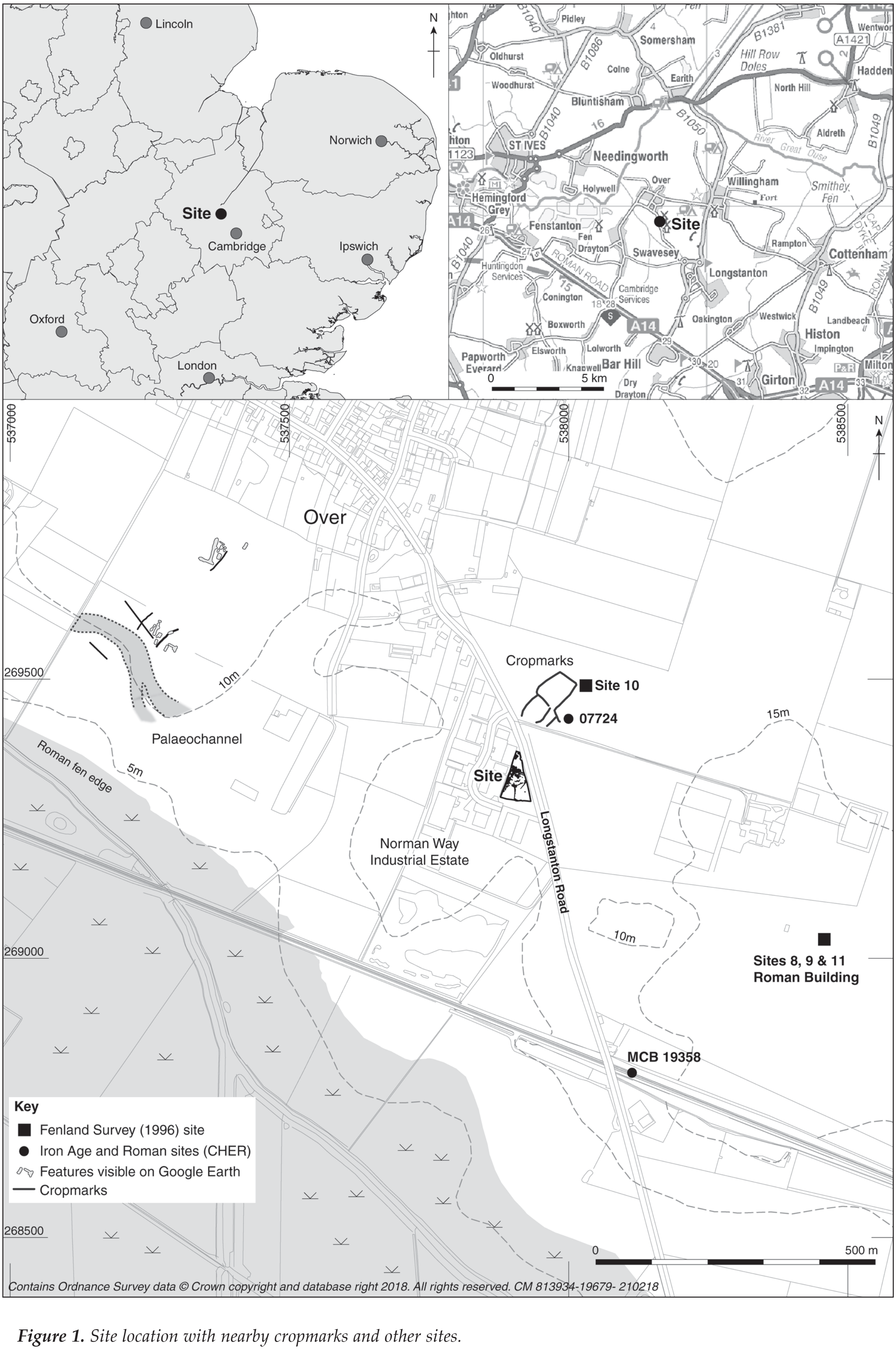

Figure 1. *Site location with nearby cropmarks and other sites.*

served by a well-developed infrastructure (Fig. 2), Taylor argues that there is little evidence that the canal network had been designed as a coherent entity but rather appears to have been constructed in more localised sections linked to the existing natural waterways (2000, 654–5). The canals, notably the Old Tillage (formerly known as the Car Dyke) which passes just a few kilometres to the east of Over, facilitated communication between the developing towns, fen-edge communities and the Wash (CHER 05405; Evans *et al.* 2017). The Roman road network in the area included part of Margary's Route 24 (also known as the *Via Devana*) between *Duroliponte* (Cambridge) and *Durovigutum* (Godmanchester), which lies 13km to the west of the site. To the east Margary's Route 23b (Akeman Street) extended from *Duroliponte* to-

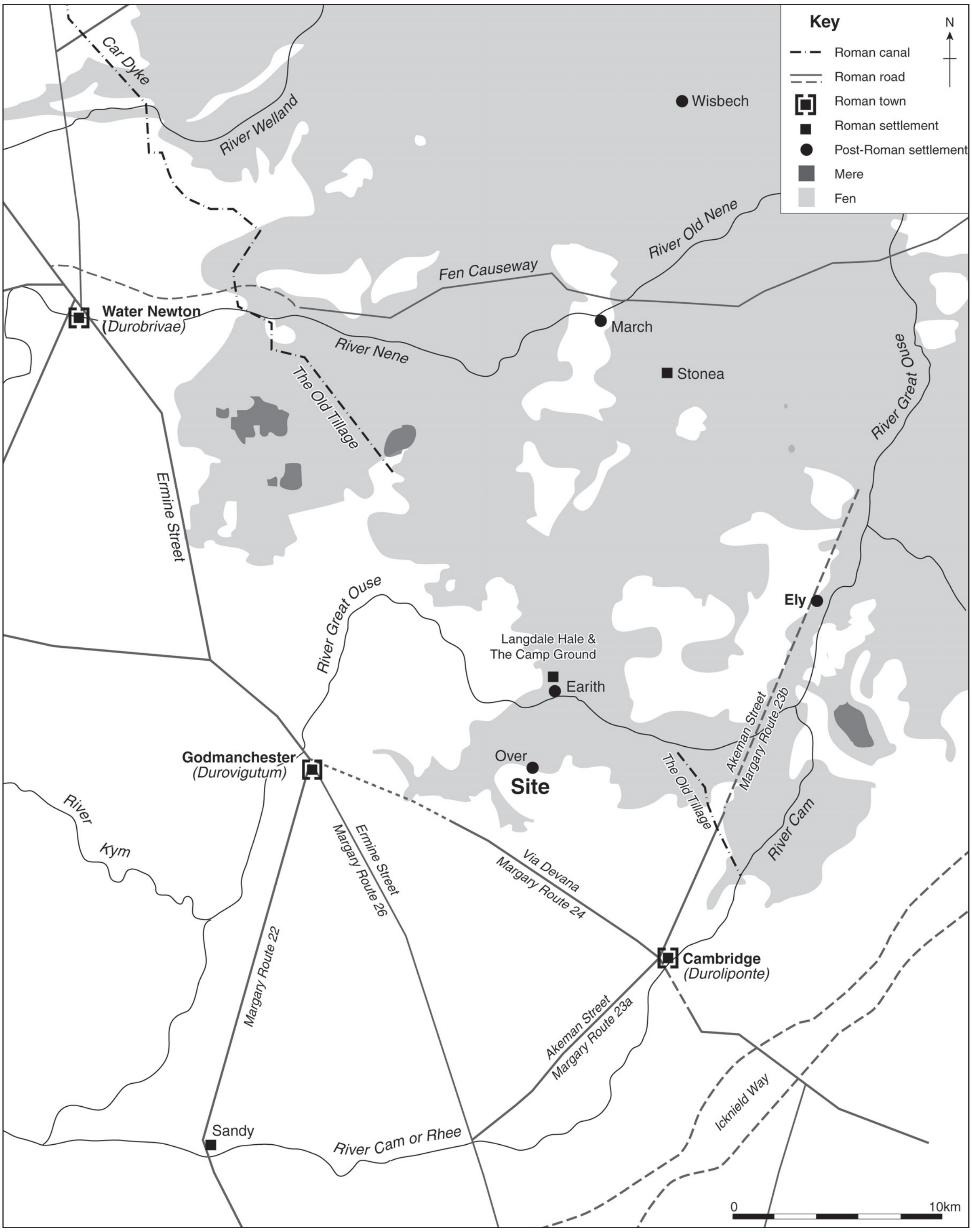

Figure 2. *The site situated within the broader Roman landscape.*

wards Ely and from there presumably northwards to the east-to-west route known as the Fen Causeway. Although there is extensive evidence for saltworking, excavated fenland examples show a great variety in methods of production, while historically saltworks were often run by private individuals; a picture that is inconsistent with an Imperial Estate model (Taylor 2000, 655; Evans *et al*. 2013, 15).

Key to understanding the role of the state and issues of Romanisation in the Fens are the investigations at Colne Fen, on the Earith fen edge. Located some 8km to the north of Over, this area was initially investigated during the early 20th century (Tebbutt 1929) and more recently prior to mineral extraction, when two major sites were subject to intensive fieldwork and sampling (Evans *et al*. 2013; MCB16969). At The Camp Ground a major inland barge-port settlement linked to the Car Dyke/Old Tillage was identified while a mass-production supply farm was revealed at Langdale Hale, where spelt wheat appears to have been the major export.

The Excavation

The 0.3ha excavation uncovered archaeological features spanning the latest Iron Age to the Romano-British periods (Figs 3 and 4), with the main phase of activity being of Middle to Late Roman date (mid 2nd to 4th century AD). Late pre-Roman Iron Age settlement is hinted at by the presence of a pair of parallel north-to-south aligned intercutting ditches and three pits, all located in the southern half of the excavation area and cut by later features. Few finds were recovered, comprising a small amount of 'transitional' late Iron Age to Early Roman pottery from one of the ditches (270) and a fragmented horse skull from one of the pits (289).

Early Roman (c. *AD43–150)*

Early Roman activity was initially represented by a small number of poorly-dated pits located in the central northern part of the site, along with a circular fire-pit (160) found close to the western baulk that produced a few fragments of metalworking slag. A further group of eight intercutting pits or clay quarries (Pit Group 1) of varying size and shape was located outside the enclosure in the northernmost part of the site.

A subsequent reorganisation of the site was indicated by the creation of an enclosure (Enclosure 1) that cut the earlier pits and within and around which were designated areas for (quarry) pitting and craft/industrial activities. Aligned north-east to south-west, the enclosure was laid out on a similar axis to the cropmark settlement identified directly to the north-east of the site (Fig. 1). The ditch enclosed an area of at least 0.18ha and measured a maximum of 1.5m wide and 0.6m deep. The north-western corner of the enclosure was subdivided by a number of linear and slightly curving ditches, creating two separate working areas. To the south (Industrial Area 1) this comprised thirteen pits, including a possible oven or corn drier (132), a sub-circular steeping tank or vat (268; 2m wide and nearly 0.6m deep), along with several postholes perhaps representing part of a structure. The sub-rectangular possible corn drier (3.27m long, 0.84m wide and 0.8m deep) contained charcoal-rich fills within which were moderate quantities of fired clay that may represent remnants of a superstructure. The charred plant remains from this group of features largely represent cereal processing waste in the form of spelt wheat chaff that is likely to have been used as fuel.

Located a few metres to the north was another working area (Industrial Area 2), represented by two pits and a second possible corn drier (153). Relatively few finds were recovered from the backfills of these features, comprising small quantities of fired clay, slag, animal bone and pottery; the latter predominantly early to mid-2nd century AD in date. Preserved plant remains were scarce, although germinated grains were noted. It is possible that the waste from the corn drier was placed in the adjacent western arm of the enclosure ditch which produced substantial quantities of charred germinated grain along with charcoal and fired clay. Other finds were few, although pottery evidence indicates that the enclosure ditches were infilled by the end of the Early Roman period, when a group of large amorphous pits (Pit Group 2) was cut into the northern arm. These were backfilled with large quantities of charred cereal processing waste that included evidence of germination.

*Mid to Late Roman (AD150–*c. *400)*

This phase was characterised by the cutting of several large extraction pits and possible watering holes (Pit Group 3), a large tank and associated intercutting pits (Pit Group 4) and a collection of features including two possible corn driers (Industrial Area 3). These followed the same broad north-east to south-west axis as the disused Enclosure 1 and were notable for their distinctive fill sequences. The latter comprised deposits incorporating significant quantities of burnt crop-processing waste interspersed with layers of redeposited pale yellow or grey clay, with the uppermost fills being very mixed.

The large probable extraction pits generally measured between 1.8m and 6m long on their longest axis and between 0.3m and 1m deep, while the possible watering holes (118 and 321/182) were between 9.4m and 15m long, 5.6m and 6.4m wide and a maximum of 2.2m deep, with steeply sloping sides. The lower fills of the deeper features had remained waterlogged resulting in the preservation of brushwood fragments and seeds indicative of the local flora. One of the upper backfills in watering hole 118 produced Middle to Late Roman pottery along with a complete dog skull and a late 3rd century coin. An extensive and thick 'black spread' (*e.g.* 349) was identified infilling the middle and upper parts of several of the

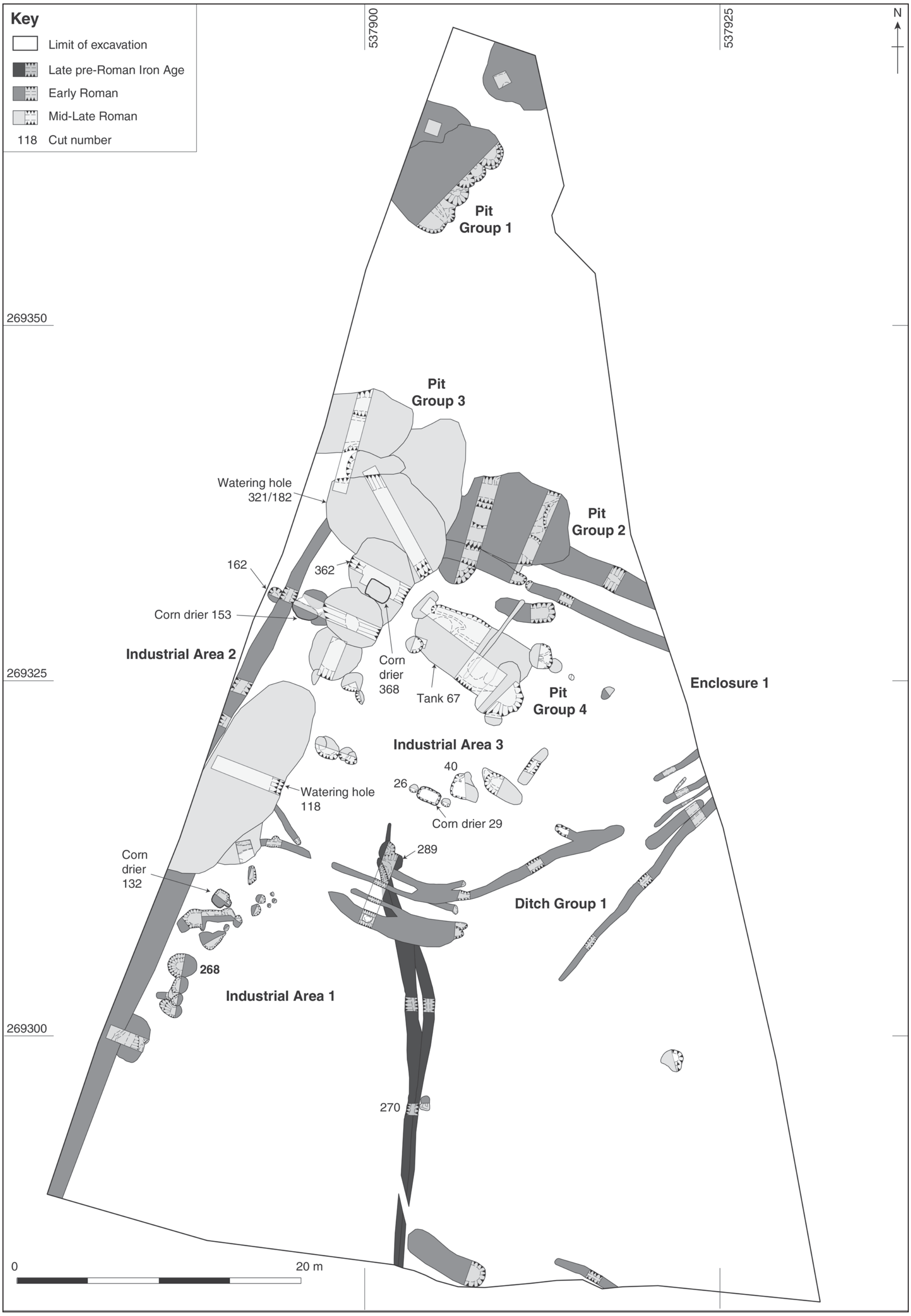

Figure 3. Phase plan of Late pre-Roman Iron Age and Roman features.

Figure 4. General working shot, looking south.

larger pits (such as 321, Fig. 5), indicating that they had been open and partially infilled at the same time. This distinctive deposit, or series of deposits, was largely composed of burnt crop-processing (including malting) waste and had an average thickness of 0.4m, being noticeably thicker (0.8m) within pit 362. Spatial sampling and analysis within the features forming Pit Group 3 demonstrated that the distribution of charred remains within this layer was not uniform and as such represents an accumulation of material from different burning events. It has been estimated that combined these environmentally-rich fills totalled around 180 cubic metres in volume.

One of the more intriguing features was the large feature (tank 67) which may have been used for steeping grain prior to germination. Sub-rectangular in plan, it measured 7.5m long, 4.68m wide and 1m deep with steep sides and a flat base. The primary fills comprised puddling clays containing duckweed seeds, suggesting that this feature had contained water, while the presence of iron nails may relate to a timber lining or cover. Vast quantities of cereal processing waste and lesser amounts of grain were recovered from the tank and associated pits, with individual assemblages being quite variable in composition. The 0.42m-thick layer of clay that sealed this group of features produced an assemblage of baked clay, many fragments of which retain impressions of straw and spelt grain (Fig. 6).

Another possible corn drier (29) was represented by a sub-rectangular pit (1.65m long, 1m wide and 0.2m deep) and two associated postholes. One of the postholes (26) and an adjacent pit (40) each contained large quernstone fragments in millstone grit (SFs 1 and 2), with the example from the pit retaining traces of a hopper or spindle hole. A further possible sub-rectangular corn drier (368) measuring 1.68m long, 1.22m wide and 0.4m deep lay to the north-west (Pit Group 3). This corn drier was cut into the burnt grain-rich fills of pit 362 and is notable for a large dump of Horningsea pottery in its backfill. The charred plant remains from these features are poorly preserved and predominantly comprise cereal processing waste and grain with only occasional evidence of germination, suggesting that they were not primarily associated with malting.

Finds

Overview

Finds from the excavation are generally typical of a low-status rural Romano-British settlement, although one with a clearly specialised function. Apart from the pottery (below), the assemblage includes two Roman coins (a *sestertius* of Faustina the younger, struck under Marcus Aurelius, dated broadly AD 161–175; and a later 3rd century radiate), eight iron objects (mostly nails and a single iron blade) and a fragment of worked bone pin. Also recovered was a small assemblage of iron smithing debris (2.28kg) including a possible hearth bottom, pieces of vitrified hearth lining and hammerscale, perhaps indicative of the repair of agricultural tools on or near to the site. A contemporary assemblage of comparable size found at Langdale Hale, Earith from similarly redeposited contexts comprised undiagnostic iron working slag and hearth base fragments along with fuel ash slag

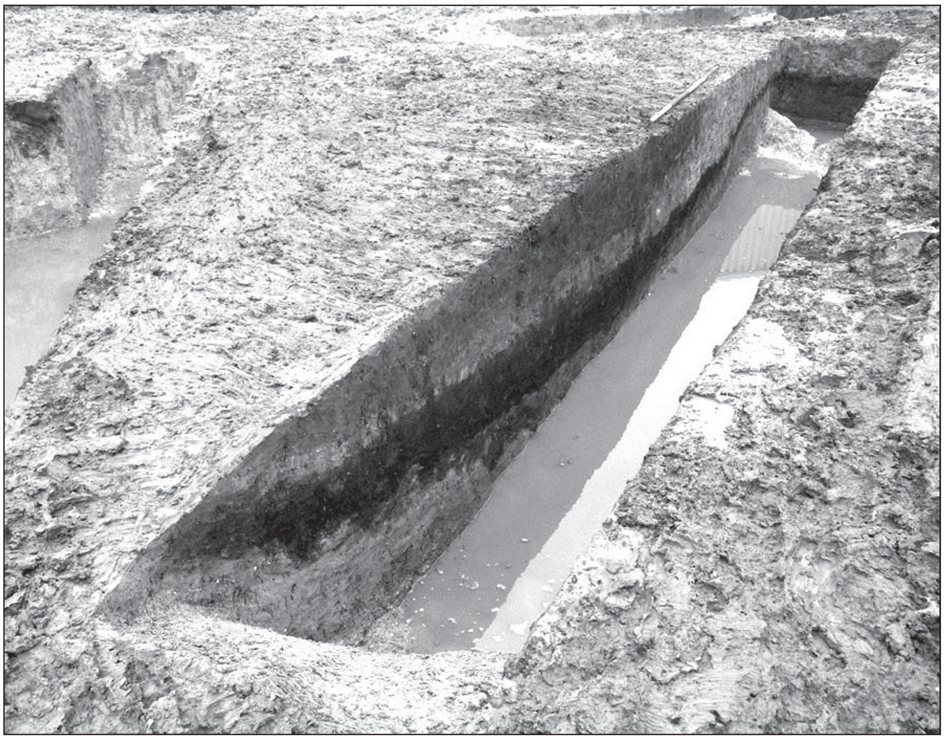

Figure 5. *Pit Group 3, watering hole 321, looking north-west.*

Figure 6. *Baked clay with charred cereal straw impression, from Tank 67.*

(Clogg 2013, 115).

Other finds include a small and abraded collection of predominantly Roman tile and roof tile fragments (28 pieces weighing 4.4kg) and a moderately large group of baked clay (661 pieces weighing 18.7kg). The latter comprises fragments of daub and lining, much of which probably derived from the superstructures of the various ovens or corn driers present on the site. Impressions of straw, cereal grains and chaff elements were recorded on several of the baked clay pieces, including an example with particularly well-preserved stem fragments and a spikelet of spelt wheat from watering hole 321 (Fig. 7). Forty-six quern and millstone fragments were found, with the majority being small undiagnostic pieces of lava quern imported from the Rhineland. Of note are two large fragments of Derbyshire millstone grit measuring 98mm and 110mm thick, each with one smooth and one opposing pecked surface, and a third smaller piece that is 25mm thick with one surviving smoothed surface. Millstone grit and lava quern fragments were both also found at Langdale Hale near Earith (Appleby 2013, fig.2.56) and are present at several other contemporary sites in the area.

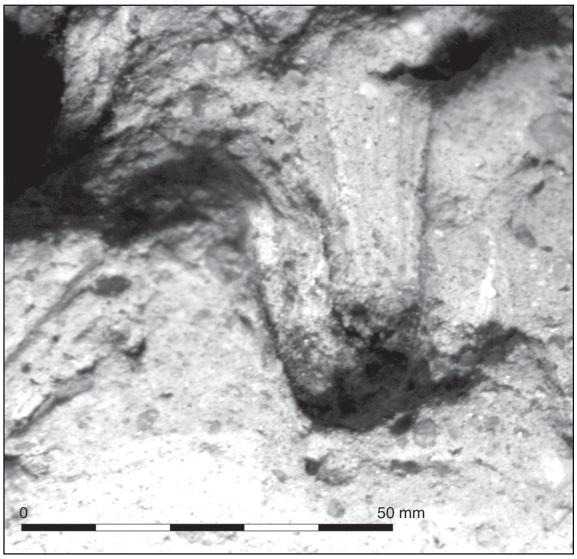

Figure 7. *Spikelet preserved within baked clay, from watering hole 321.*

Roman Pottery
Alice Lyons

Collectively the evaluation and excavation phases of investigation produced 761 sherds weighing 17.9kg (6.20 Estimated vessel equivalent (EVE)) of latest Iron Age and Romano British pottery, representing a minimum of 213 fragmentary vessels. A total of thirteen fabric families were identified, with the bulk of the assemblage dating to the early to mid 2nd and 3rd centuries AD. The assemblage is utilitarian in character, dominated by locally produced Horningsea and unsourced Sandy grey and Shelly ware jars and storage jars, although a few imported finewares were also recovered. The large number of substantial (but fragmentary) vessels (notably Horningsea) has resulted in the assemblage having a relatively large sherd size of *c*. 24g. Pottery was predominantly recovered from large pits and a possible watering hole, with the largest single group comprising a dump of fragmented Horningsea vessels (140 sherds weighing 5.83kg) in the top of a possible Mid to Late Roman corn drier (368).

Horningsea is located just 16km to the south-east of Over, where pottery production was undertaken from the late 1st century AD. The large number of Horningsea storage jars found at Over is mirrored by the pottery assemblage found at a contemporary Roman maltings site at Beck Row, Mildenhall – located *c*. 33km to the east (Tester with Willet 2004). The role of these storage jars and how they were used in the malting process, particularly if their internally coarse-combed surfaces had any practical purpose, is a subject of ongoing research. A recent publication on the wares (Evans *et al*. 2017, 57) summarises the theories on why internal combing was present, although the reason still isn't fully resolved. One theory is that the combing increased surface area, helping to keep the jar's contents cooler, particularly liquids. However, the crevices in the combs would have been areas where bacteria and insects could have easily multiplied, perhaps causing any foodstuffs to degrade faster. At Over the coarse ware jars and storage jars appear to have been used in their original form and were not adapted in any way as has been seen on brewing sites in the region (Abrams and Ingham 2008, 63; Tester with Willet 2004, 38; fig 23. 19).

Despite being a much smaller assemblage than those collected from nearby sites (Langdale Hale and the Camp Grounds; Evans *et al*. 2013), the range of fabrics and vessel types found at Over are similar and appear to be typical of the region for this period.

Faunal Remains
Angelos Hadjikoumis

A small faunal assemblage (137 identifiable specimens) was recovered by both hand collection and from the residues of bulk samples, the majority of which derived from Early-Mid Roman contexts (NISP= 129). The latter total includes primarily macromammalian remains (NISP= 118), but also small quantities of amphibian (NISP= 5), avian (NISP= 4), micromammal (NISP= 1) and fish remains (NISP= 1).

Concerning macromammal remains, the Roman sample is characterised by high cattle (45.6%; NISP= 36) and sheep/goat (34.2%; NISP= 27) percentages, with equids (all identifiable remains being horse) also forming an important component of the assemblage (11.4%; NISP= 9). The overall composition suggests that the animal economy of the site was heavily domestic, with little interaction with wild animals. Animal husbandry was mainly based on cattle and sheep/goat and within the sheep/goat taxonomic category, only sheep remains were identified, which can be viewed as an indication that goat was either absent or scarce at the site. When body weight is taken into account, it is clear that cattle provided most of the animal-derived food to the site's inhabitants. The presence of some neonatal and immature cattle and sheep/goat remains raises the possibility of milk exploitation for both taxa. Interestingly, the recovered equid remains have evidence of butchery, suggesting equid meat was consumed at least occasionally.

Charred and Waterlogged Plant Remains

Introduction

In total 95 environmental samples were taken during the excavation, including spatial sampling of the clearly ecofact-rich dark deposits including layer/fill 349. Spelt wheat (*Triticum spelta*) predominates throughout both Roman phases, with frequent germination. Chaff, mainly glume bases, was recovered in enormous quantities. Emmer (*T. dicoccum*) wheat chaff was also identified as a minor component within most of the assemblages. Barley (*Hordeum vulgare*), oats (*Avena* sp.) and crop-associated weeds such as bromes (*Bromus* sp.) were recorded as rare contaminants. Charred weed seeds are notably low in density and diversity. The general paucity of these seed contaminants is interesting and may be an indication of the methods of harvesting and processing the cereal crop.

Initial assessment of the flots revealed that germinated grain and/or detached sprouts were found spread over the entire site and it is only through detailed analysis and further examination of the material that subtle variations are discernible in the distribution of this material. Evidence of germination of cereal grains has been determined by the characteristic effects that this process has on the grain. The development of a sprout (also known as coleoptile, acrospire or 'shoot') in hulled wheat (with the outer husk still in place) forms a groove in the dorsal surface of the grain which is very distinctive. The germinated grain often has shrunken sides, a missing end (where the sprout has broken off) and sometimes displays a glossy sheen. The sprouts may still be attached to the grain but are frequently found detached. Many of the grains were poorly preserved in that they were abraded and missing the dorsal surface, possibly as a result of having germinated. The individual components of the assemblages are grains (germinated and non-germinated), chaff (glume bases, spikelets, spikelet forks, basal rachis segments) and detached sprouts (up to 7mm in length and often retaining the trident-shaped end).

These distinctive assemblages that include evidence of germination have become increasingly recognised on Romano-British sites. A recent synthesis of the rural economy of Roman Britain reviews the structural and archaeobotanical evidence for malting (Lodwick 2017, 62–66) and includes criteria for interpreting the components of each stage of the malting process (Fig. 8):

Type A: Glume bases and sprouts that have been removed by de-husking and sieving after germination and used as fuel. The ratio of grain:glume bases is 0:1.

Type B: Germinated grains in spikelets that represent accidentally charred malted grain prior to de-husking. The ratio of grain:glume bases is 1:1.

Type C: Germinated grains that have been accidentally charred as a product of the malting process. The ratio of grain:glume bases is 1:0.

An attempt has been made to apply these criteria to the Over assemblages. This can only be tentative due to the obvious mixing of material and repeated depositional events. It is also likely that Type A deposits have been used as fuel for successive malting processes. Quantification of the proportion of germinated grain has proved difficult due to the level of preservation of the grain (which was frequently fragmented) and the variability of the evidence which is often in the form of detached sprouts. The results indicate the spelt grains germinated whilst still in the spikelet which were then subjected to roasting to halt the malting process. It would then have been necessary to release the germinated grain (wort) from the spikelets by pounding which could explain why so many of the sprouts have become detached from the grain (although flotation could have caused some damage) and could also explain why so many of the grains have broken transversely. The by-products of this process (Type A) would have been made brittle by heating rendering the material as excellent tinder for use in corn driers.

Results

The charred plant assemblages from the earlier Roman phase of activity relate to two industrial areas and a pit cluster. Industrial Area 1 comprised several pits and a possible corn drier. Assemblages from these features produced similar results in which spelt chaff is abundant with occasional germinated cereal grains and a moderate component of bromes (*Bromus* cf. *secalinus*) and dock (*Rumex* sp.) seeds. Some of the pit assemblages are more grain dominant but evidence of germination was generally very low and most likely represents accidental rather than deliberate germination. Industrial Area 2 was relatively unproductive, the contents of the corn drier in this area appears to have been dumped in the adjacent section of the enclosure ditch. The latter produced a large deposit of grain without chaff with an average grain concentration of 30 grains per litre of soil and approximately 70% germination; representing Type C – malted grain. Within a large group of inter-cutting pits (Pit Group 2) an assemblage composed of abundant spelt chaff (approximately 3375 glume bases per litre of soil) with several detached sprouts, occasional charred germinated spelt grains and weed seeds is representative of Type A – the waste or 'comings'. Preservation is poor with most of the glume bases being indeterminate to species level although there are occasional items that are clearly identifiable as emmer wheat glume bases through the prominence of both the main keel and secondary nerve (after Jacomet 2006). Of the 77 grains present, 34% could be identified as germinated grains, whilst the remainder were too poorly preserved for identification but are likely to have germinated – possibly representing Type B or C. This assemblage also contains a significant weed seed component in which rye-grass (*Lolium* sp.) and bromes predominate along with occasional specimens of dock and goosefoots (*Chenopodium* sp.) (Table 1).

Deposits within Middle to Late Roman features were extensively sampled due to the presence of the distinctive black charcoal-rich material within the larger pits in particular. Industrial Area 3 was located centrally within the excavation area, focused around a corn drier (29). The main fill of this feature produced a large flot volume (115ml from a 7l sample) that is primarily composed of fine abraded chaff fragments that are the lighter chaff elements surrounding the grain (palea and lemma), along with brome seeds and occasional grains, most of which have germinated. Preservation of the cereal grains is poor – perhaps a reflection of the germination process – and which consequently hampered the calculation of percentage germination. A conservative estimate of at least 50% is consistent with conclusive evidence of deliberate germination (Parks 2012, 129–37). A nearby pit (38) produced an assemblage that is comprised almost entirely of charred grain (115 grains per litre soil) with only occasional chaff contaminants. The grains are extremely abraded and most have lost their embryo end but, as such, the grains do not display evidence of germination that is characteristic in most of the other assemblages from this site. Other pits in this area (e.g. 13, 19 & 20) produced assemblages of abundant spelt glume bases, and sprouts noted in all of the samples are indicative of germination but in general are mostly in low quantities. The charred plant remains recovered from the features within Industrial Area 3 most likely represent the burnt remains raked from corn driers or hearths. Hammerscale and metalworking debris were also retrieved from these features and it is possible that their function was in part related to metalworking, for which this type of fuel would have made excellent tinder.

A large watering hole (321) located in the west of the site had waterlogged lower deposits containing seeds of plants that would be expected to be growing on scrub-land or in hedgerows. These include burdock (*Arctium lappa*), elderberry (*Sambucus nigra*), bramble (*Rubus* sp.) and nettles (*Urtica dioica* and *U. urens*) in addition to seeds of hemlock (*Conium maculatum*) and sedges (*Carex sp.*) which were most likely growing in the wet margins of the watering hole. Further watering holes and/or extraction pits were cut into the corner of the earlier enclosure ditches (Pit Group 3). The lower fills of the deeper features contained waterlogged roots and stems and preserved seeds including sainfoin (*Onobrychis viciifolia*), buttercup (*Ranunculus acris/repens/bulbosus*), stinging nettles, docks and sedges. Obligate aquatics such as pond weed (*Potamogeton* spp.), duckweed (*Lemna* sp.) and water crowfoot (*Ranunculus* subgenus *Batrachium*) represent plants that would have been growing in the water within the feature. It is evident that only robust seeds have survived and the fragile taxa have been lost through degradation.

Samples from the thick black spread of material (349) infilling this watering hole show considerable spatial variation; with both Type A and Type B assemblages present. In addition, there are assemblages in which sprouts are notably absent, although there

Table 1. *Summary of key samples (ER = Early Roman; MLR = Mid-Late Roman; Ind. Area = Industrial Area).*

Sample No.	**40**	**91**	**45**	**4**	**23**	**94**	**34**	**62**	**76**	**69**	**11**	**47**
Context No.	200	390	294	27	107	396	163	366	178	349	65	337
Cut No.	198	233	268	22	109	394	137	362	174	321	67	338
Phase	ER	ER	ER	MLR	ER	MLR	MLR	MLR	MLR	MLR	MLR	-
Feature Type	Pit	Ditch	Pit	Pit	Pit	Pit	Pit	Pit	Pit	Pit	Pit	Pit
Feature group	Ind. Area 2	Ind. Area 2	Ind. Area 1	Ind. Area 3	PG 2	Waterhole	PG 3	PG 3	PG 3	PG 3	PG 4	-
Volume processed (L)	7	8	8	7	10	7	6	7	1	1	1	7
Flot volume (millilitres)	15	40	18	115	75	50	350	300	30	35	15	48
% flot sorted	100	100	100	100	100	100	25	10	100	100	100	100
Grain:chaff:weed	103:1:2.5	251:2:1	1:450:13	1:3:2.5	1:27450:1	1:3:1	2:1521:1	1:1610:5	1:8:3	1:13:1	3:38:1	1:249:8
Grains per litre	29	31	1	4	7	6	5	3	53	95	112	14
Estimated chaff per litre	0.2	0.25	394	14	3375	18	12425	4371	450	1260	660	747
No. of coleoptiles	0	0	3	28	7	10	147	46	38	107	6	124
% non-germinated grain	35	7	86	14	0	7	70	5	7	10	20	13
% germinated grain	29	51	0	43	34	83	18	58	66	47	57	4
% possible germinated grain	36	42	14	43	66	10	12	37	27	43	23	83

are occasional germinated grains present possibly representing Type C. In the most extreme case of Type A results, an estimated density of 12,500 chaff elements was recovered per litre of soil. There is some evidence of germination of bromes and wild oats (identified by the presence of a floret base of *A. fatua*). Also notable within the samples from this area is the vast quantities of siliceous remains of cereal awns. Well-preserved spikelets of spelt in which the grains can be seen to have germinated whilst still in the glumes are evident and sprouts are also frequent. Pit Group 4 was located centrally within the excavation area focusing on a large tank (67). The lower fills of the tank consisted of puddling clays that contain duckweed seeds and occasional charred grains. Samples from subsequent fills showed spatial variation within each fill with Type A and B assemblages in each. A dark spread of burnt material (69) overlying the puddling clays contained moderate assemblages of chaff. Sprouts are notably absent, although there are occasional germinated grains present.

Discussion

Despite the small area investigated, analysis has demonstrated that this was predominantly a production site focused on crop processing with increasing specialisation in the malting of spelt wheat in the Mid to Late Roman period. This interpretation is underscored by the range of features present, including a number of possible corn driers, tanks, extraction pits and watering holes, combined with the seemingly utilitarian nature of the finds assemblage (pottery, quern and millstones, baked clay/daub and metalworking debris). However, it is the preserved plant remains that are key to understanding the function of the site and its context within the broader Roman economy.

Extensive environmental sampling has shown that crop-processing waste was present in such large quantities that the scale of production, and the subsequent burning and disposal of this material, has to have been related to an industrial activity of some importance. The abundance of evidence of germination on this site indicates deliberate malting for brewing. Applying Lodwick's criteria for evidence of the different components of malting waste has not been totally successful due to the mixed nature of the deposits but, as Lodwick (2017, 63) concludes, 'the evidence of malting in multiple samples across one site provides stronger evidence of large-scale malting'.

Spelt was extensively cultivated in this region in the Roman period (Moulins & Murphy 2001; Greig 1991) gradually replacing emmer wheat and continuing to be the favoured wheat variety despite the gradual introduction of bread wheat. As signified by its name, bread wheat produces a flour that has a higher gluten content that produces better bread. This raises the question of why spelt was still being mass produced, with the possibility being that it was favoured because of its use for brewing ale. Both spelt and emmer are hulled wheats in which the grain is tightly enclosed in spikelets that each contain (normally) two grains. A number of processing stages are required to release the grain from the tough outer chaff of the spikelet. This is best described by Hillman (1981) and Wilkinson and Stevens (2003, 195) and involves stages including harvesting, fine sieving, parching and pounding, threshing, winnowing and finally coarse-sieving to produce clean grain suitable for grinding/milling into flour. Each of these stages produces characteristic plant product and waste assemblages with different ratios of grain:chaff:weed seeds.

Recovery of cereal processing waste from archaeological deposits is dependent on preservation. This is usually through the waste products being carbonised through accidental or deliberate burning. Grain was frequently exposed to fire (after Van der Veen 1989; Hillman 1982; 1984) within corn driers for a number of reasons; these include parching of hulled wheat spikelets prior to processing (de-husking) so that the outer chaff becomes brittle and easier to remove, drying of whole spikelets that have been harvested wet, drying and hardening of fully processed grain prior to storage and milling, parching to kill any insect infestation and, finally, exposure to heat to halt germination of grain that has sprouted either accidentally due to spoilage or deliberately as part of the malting process. The possible corn driers at Over were all small in size which would have necessitated scrupulous cleaning (without which a catastrophic fire is likely). The spent fuel (which was likely to have been cereal processing waste and Type A material) would have been disposed of nearby which would explain the accumulation of charred deposits within the pits and other features, although the enormous quantities recovered seem disproportionately large.

There is increasing evidence for the presence of germinated grain from all periods of Roman occupation in Britain. In a study by Parks (2013, 129) germinated spelt grains occur often within large assemblages of burnt spelt processing waste giving rise to the theory that these deposits represent the by-products of the cleaning of malt. Germinated grain is not generally considered sufficient evidence of spelt brewing unless there are associated features such as corn driers and malting floors. Studies by Van der Veen (1989, 305) have suggested that assemblages produced by the roasting of germinated grain for malting would consist of grains that show morphological evidence of germination and numerous sprouts. A key measure of whether germination is accidental or deliberate is agreed as greater than 75% for deliberate germination and less that 15% for accidental germination (Van der Veen 1989, 314). Furthermore, if the grains had been allowed to germinate in their spikelets, chaff consisting of glume bases and spikelet forks would also be present in the assemblage. Most of the germinated grains at Over display the dorsal groove as evidence of in-spikelet malting, but much of the evidence of germination is through the presence of well-developed, detached sprouts.

Experiments in Germination

An alternative explanation for the presence of germinated grain is through natural spoilage of the crop as a result of exposure to moisture. Experiments by the author have shown that freshly harvested spelt spikelets can germinate extremely quickly when exposed to moisture. If the crop had started to germinate due to, for example, wet weather, it is likely that it would have been immediately harvested and dried followed by threshing and sieving. It has been assumed that accidental germination would result in assemblages in which germination of individual grains was variable and without conformity of sprout length whereas deliberate germination should result in even rates of germination. For the first experiment some of the grain was dehusked and the rest left as hulled grain. After steeping both batches in water overnight, germination started almost immediately, with the sprout emerging after 24 hours. There proved to be very little difference in germination rates between the hulled and clean grain, which was surprising, as it is usually assumed that storage of hulled grain would prevent, or at least delay, accidental germination. The second surprise was the different germination rates within each sample. Again, it has been presumed that deliberately germinated grain would produce sprouts of roughly equal length, whereas the opposite seems to be true, with some sprouts developing much more quickly than others (Fig. 8). This may be of particular relevance as historic cereal landraces would have been more genetically diverse than modern varieties due to selective breeding (after Briggs 1978, cited in Van der Veen 1989, 314). Of particular significance, the experiment confirmed the hypothesis that the dorsal groove only develops in grain germinated whilst still hulled in a spikelet. This was clearly the case as, in the clean dehusked grain, the sprout grew up away from the grain whereas in the hulled grain the shoot was constricted and grew along the back of the grain to escape from the spikelet, causing the groove.

The experiments carried out with ears of modern spelt indicate that it is not necessary to dehusk spelt wheat when malting and that the rate of germination varies considerably along the length of the ear and even within the two grains in a spikelet. Uniformity of sprout length cannot therefore be used to distinguish between accidental and deliberate germination.

Most of the charred, germinated spikelets at Over contain just one grain rather than the usual pair of grains. This phenomenon was also noted at Langdale Hale (Ballantyne 2013, 151) where single-grained spikelets, immature spikelets and lower rachis internodes were interpreted as the cereal crop having been harvested whilst 'still green' or possibly related to a period of physiological stress during growth. Modern spelt wheat grown by the author was attacked by rabbits early in the season with much of the green foliage consumed. The crop recovered and produced a late harvest in which the ears were greatly reduced in length and all of the spikelets were single-grained. This supports the theory of physiological stress, although a traditional cultivar/landrace variety of spelt wheat obtained from the John Innes Centre in August 2015 (*Triticum spelta* T1220017 'Grey Spelt') is an awned variety that typically has single-grained spikelets on the lowest part of the ear. Several of the Over assemblages contain the lower rachis internodes of the cereal ear and it is plausible that the single-grained spikelets are also from the lower stem fragments and, being smaller than the two-grained spikelets, would pass through a sieve. Single-grain spelt spikelets have also been recorded from sites as far away as Northamptonshire and Somerset (by the author) and from the Thames Estuary (Hunter 2012, 9) to name just a few.

Spelt Malting within the Local and Regional Economy

Evidence of spelt malting in this region has hitherto been scant, mainly due to the rarity of archaeological features that can be positively identified as related to malting through associated charred plant remains. Excavations at Stebbing Green, Essex (Murphy 1989) produced spelt malt (Type C) combined with large quantities of 'fine-sieving by-products' (Type A). At this site a building was interpreted as a 'malt-house' due to the presence of oven flues containing sprouted grain, while an adjacent rectangular pit may have been used to steep the grain. Within Cambridgeshire, evidence of spelt malting was seen at Lower Cambourne (approximately 16km away) which produced Type A samples (Lodwick 2017, 65) from a Late Roman oven and an Early Roman ditch. Sites at Haddon (Fryer 2003) and Itter Crescent (Fosberry forthcoming), both in Peterborough, and Tunbridge Lane, Bottisham (Nicholson 2014, 171) produced putative evidence of spelt malting. Further afield in Northamptonshire, assessment of recently excavated sites to the east of Kettering indicates extensive spelt malting in the form of Type A and B deposits, with an associated barn, T-shaped corn driers and an extensive drainage system (Gilmour 2017 and 2018). Well-preserved malting buildings have also been discovered at Towcester (M. Muldowney pers. comm.). To the east, on the Norfolk/Suffolk border, a grain steeping tank, malting floor and corn driers with evidence of germinated spelt and sprouts were identified at Scole (Fryer and Murphy 2014). A Roman maltings was also excavated at Beck Row, Mildenhall, although here the sprouted grains were mainly wheat and barley (Bales 2004).

The charred plant remains recovered from Over consist of cereal processing waste that has been burnt, probably as fuel for a large-scale industrial process. The inclusion of germinated grain and detached cereal sprouts indicates either the accidental spoilage or deliberate malting of spelt wheat. The abundance of evidence of germination on this site indicates deliberate malting for brewing but, without supporting archaeology, this conclusion can only be tentative. No malting floors or malt-houses were identified at Over, although these could have been located outside

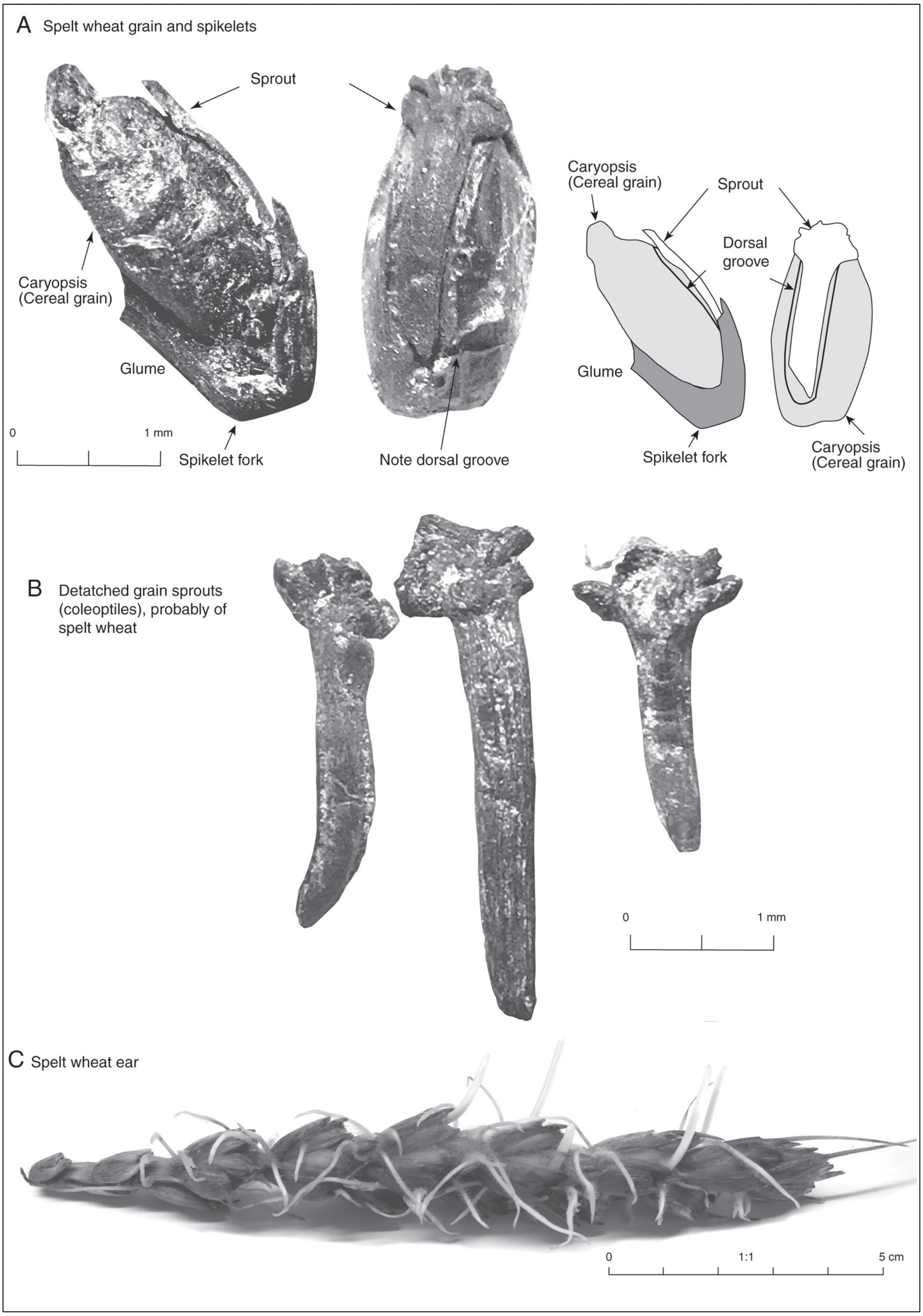

Figure 8. *Charred archaeological and modern experimental evidence of germination:*
A. Charred archaeological spelt wheat grain and spikelets.
B. Charred archaeological detached grain sprouts (coleoptiles), probably of spelt wheat.
C. Modern experimentally germinated spelt wheat ear.

the excavated area. Some of the possible corn driers (albeit small) could have been used to roast the malt, while the presence of at least one probable steeping tank alongside the large watering holes and extraction pits points to industrial activity on a scale that required significant quantities of water, clay and fuel. It is possible that industrial activities continued further to the west where cropmarks indicate the course of a former channel along with adjacent tanks and ditches (Fig. 1).

The limited area of excavation precludes full interpretation of the site but cropmarks in the surrounding fields hint at a possibly extensive fen-edge settlement that formed part of a wider area of Roman occupation and industrial enterprise. The nearby Camp Ground at Earith evolved to become a mercantile centre with a vibrant economic community and extensive trade links (Evans *et al*. 2013) and an in-depth analysis by Ballantyne of the plant remains from the local and contemporary site at Langdale Hale indicated that this was a cereal-rich farmstead with significant agricultural production and processing. Spelt wheat was dominant with a minor emmer component and the abundance of hulled wheat chaff, alongside the very large (animal driven) rotary querns, has been interpreted as an indication that this farmstead was a 'producer site' for the export of grain. The scale of the burning and disposal of cereal processing waste at Over is also indicative of large-scale cereal production in the Fens and the economies of the two sites may well have been linked. If this was the case, who were these cereals being cultivated by, for whom were they intended and what logistics were required for their distribution?

Although predominantly 'utilitarian' in character, the site at Over formed part of a wider settlement, presumably a small farmstead. The faunal assemblage is clearly domestic, mainly based on cattle and sheep/goat, with some suggestion that equid meat was consumed at least occasionally – possibly continuing an Iron Age tradition. This farmstead was presumably one of several positioned in this agriculturally fertile area, with a possible high status Roman building perhaps located to the south-east (Fig. 2). The scale of production at Over might support an interpretation of more centralised organisation, with the cereal crops and other products being transported, possibly through local administrative centres such as Stonea Camp, via the established network of water and road routes. They may have been destined for nearby urban settlements (*Durobrivae*, *Duroliponte* or *Durovigutum*), or for feeding the Roman army. Britain's contribution to the Imperial Roman economy was through the exportation of grain to other areas within the north-western provinces through a system of trade networks. Stallibrass and Thomas (2008, 146–169) discuss the logistics of surplus cereal production for feeding the Roman army, bearing in mind that the 'army' comprised not just the soldiers but also their families, servants and animals. Accounts exist of grain being exported to the Rhineland in the mid 4th-century AD (Taylor 1999 82; Mattingly 2006, 505 cited in Parks 2013, 22), and forts at Brancaster and Caister-on-Sea in Norfolk and Reculver in Kent may have been control posts for this (Michael Fulford, pers comm.).

The Production and Use of Ale in Roman Britain

The processes involved in malting start with the steeping of the grain in water and then the grain is spread onto a malting floor with gentle heat to induce germination. This activates enzymes to convert the stored starches within the grain to sugar and is a stage that needs to be carefully controlled by experienced maltsters. Germination is arrested by gently heating the malted grain in a corn drier (using cereal processing waste as fuel). Once dried, the malt could be stored for several months, possibly in the form of 'malt cakes' in which the malted spikelets are lumped together and dried (Campbell 2016, 141). It seems practical that the malt would have been transported for mashing and brewing, as required, at the destination. Transport of the malt would have been through the established route-ways provided by the network of roads, rivers and the Old Tillage Roman canal.

Conclusion

This evidence of large scale crop processing and spelt malting at Over is of regional significance and has implications for the study of the Roman fenland economy in particular. The process, scale and organisation of malt production in Roman Britain is still poorly understood, although the results from Over clearly add to a growing dataset that demonstrates that this was an important part of the Romano-British economy.

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