Anglo-Saxon Economy and Ecology by a Downland Stream: A Waterlogged Sequence from the Anglo-Saxon Royal Settlement at Lyminge, Kent

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ABSTRACT

Palaeoecological and geoarchaeological investigations which cover the Anglo-Saxon period are rare, particularly in chalk downland landscapes which are considered to have limited palaeoenvironmental potential. The present study explores a sequence which can be directly related to the occupation history of the major Anglo-Saxon settlement at Lyminge, Kent. This work demonstrated a sequence of palaeochannels and organic deposits associated with the latter part of an archaeological sequence which spans the 5th to the 11th centuries AD. A range of evidence for the environment and economic activity is presented which suggests landscape continuity, possibly stretching back as far as the Romano-British period. The sequence revealed worked wood and evidence for livestock management and cereal cultivation, some of which is contemporary with the final phases of occupation of a 7th century ‘great hall complex’ and its subsequent transformation into a royal monastery. Agricultural activity following the abandonment of the pre-monastic settlement area caused this stream margin to become gradually buried by ploughwash which displaced the channel over time and sealed the organic deposits. It is incredibly rare to find such organic preservation in direct association with an Anglo-Saxon downland rural settlement and this is the first time that such a sequence has been analysed in association with the latter phases of a known Anglo-Saxon royal and monastic centre.

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Introduction

Themes

The wider landscape context and economy of early medieval settlements has traditionally been investigated through archaeological survey and historical sources (Hamerow 2002, 121). This has created a need for greater understanding of the relationship between sites and landscapes which presents opportunities for new environmental studies (Arnold 1988, 17). Lyminge, Kent (Figure 1) has been the target of excavations by the University of Reading revealing a continuous sequence of Anglo-Saxon occupation and material evidence spanning the 5th to the 11th centuries AD. In 2014 a waterlogged palaeoenvironmental sequence was uncovered adjacent to a spring-fed stream located between the major focal points of Anglo-Saxon settlement, which provides an opportunity to address major current research themes covering the period. These include environmental continuity or change between the Romano-British to early Anglo-Saxon period which has been previously addressed by both broad syntheses (Bell and Dark 1998; Rippon, Smart, and Pears 2015) and other site-specific studies (e.g. Bell 1977). More locally, the site represents an important case study for the development of patterns of land use (Rippon et al. 2013) and estate centres (Brookes 2010) in early Anglo-Saxon Kent. Finally and most significantly, the site presents a continuum between pre-monastic royal centre and monastery (Thomas 2016), enabling investigation of agricultural intensification and the role of monastic estates within the ‘long eighth century’ (Rippon 2010) which has previously been addressed from both botanical (McKerracher, forthcoming; Van der Veen, Hill, and Livarda 2013) and archaeological evidence (Hamerow 2012).

Lyminge archaeology

Occupation at Lyminge began with a 5th century settlement on the plateau of a low spur known as Tayne Field flanked on two sides by the River Nailbourne. This developed into a ‘great hall complex’, identifiable as a vill, or royal estate centre, during the early to middle 7th century, which was superseded by a monastic foundation during the late 7th/early 8th century (Blair 2005, 186, 277; Thomas 2013, 2016; Thomas and Knox 2012a). The material culture and archaeology of these settlement phases demonstrates the role
of the settlement as an important early Anglo-Saxon ironworking site, with extensive assemblages of high status metalwork and glass (Thomas 2013; Thomas and Knox 2015). Such ‘great hall complexes’ represent the earliest recognisable stratum of royal residence in Anglo-Saxon England, expressed most famously at sites such as Yeavering (Hamerow 2012).

Following the Christian conversion the settlement refocused around the core buildings of a documented monastery established at the tip of a neighbouring hanging promontory. This overlooked the earlier great hall site at Tayne Field which on the basis of radiocarbon dates from the foundations of the final building phases, was finally abandoned at some point in the final third of the 7th century AD (Thomas, forthcoming). After the 9th century AD the monastery itself declined (Blair 2005, 298) and the settlement eventually developed into a medieval village focussed around a parish church. At this time occupation activity resumed on Tayne Field (Thomas and Knox 2012b).

A range of palaeobotanical investigations previously conducted on material from the occupation contexts have demonstrated a variety of agricultural activity at the site, with wheat, barley, oats and rye all being grown (Campbell 2012; McKerracher 2012, 2015). Other significant indicators of agricultural economy recovered from the site have included the discovery of an exceptionally rare 7th century plough coulter (Thomas et al. 2016).

The present work has undertaken environmental and geoarchaeological survey at the Tayne Field site uncovering a sequence of palaeochannels associated with the spring-fed source of the River Nailbourne now known as St. Ethelburga’s well. The best preserved portion of this sequence is located 30 m from this spring, 50 m from the nucleus of the 7th century great hall complex and 100 m NE of the Anglo-Saxon monastic church (Figure 1). Excavations in 2014 demonstrated the presence of waterlogged sediments and organic materials which have now been demonstrated to be synchronous to parts of the Anglo-Saxon occupation sequence.

**Research aim**

This work intends to reconstruct the environment of the stream area and interpret evidence for activities relating to the Anglo-Saxon occupation or use following abandonment of the great hall complex and monastery (Thomas 2013, 2016). The identification of processes of land use and economy essentially invisible to conventional excavation methodologies will provide new interpretations of the role and environmental character of both the stream margin and, to some extent, the wider settlement area during the archaeological phases (Bell and Dark 1998, 187). The value of Lyminge for such investigations lies in the location of the archaeology within an undeveloped area of the modern settlement (Thomas 2013, 115) in association with a watercourse providing opportunities for this palaeoenvironmental investigation.

**Investigations**

**Geoarchaeological survey, excavation and stratigraphy**

An auger survey of the site demonstrated a stratigraphy of Grey Chalk Marl overlain by colluvial clay, silty clay subsoil and silty topsoil (Figure 2). The distribution of colluvium was concentrated around the toeslopes of the plateau; other localised variations in the general sequence were encountered around the margins of the stream where lenses of organic and alluvial sediments overlying sandy gravels were encountered. A keyhole excavation of 4 m by 2 m (site code LTF14
TP4, Figure 1) was undertaken in summer 2014 to further examine these sediments. The excavated sequence demonstrated a stratigraphy of grey chalk marl overlain by silty gravel channel deposits and a sequence of calcareous and pelo-calcareous alluvial gley sediments lying below the present water table. These contained lenses of alluvial marl, interleaved with more substantial deposits of organic silt, all of which demonstrated excellent organic preservation, with some demonstrating organic matter content in excess of 50%. These lenses were not horizontally bedded and comprised an irregular sequence of channel deposits dipping north to south (Figures 2 and 5). Overlying this waterlogged sequence was a substantial deposit (up to 1.5 m) of silty clay colluvium capped with subsoil and topsoil, which corresponded to the sequence encountered upslope.

Archaeology

Evidence for *in situ* human activity at the margins of these stream channels was uncovered in the form of two pits of no clear use, waterlogged worked wood and a spread of stones (Figure 4). These occurred exclusively within the waterlogged layers and were sealed beneath colluvium containing re-worked Anglo-Saxon, medieval and post-medieval occupation material. Pottery assessment (Ben Jervis, personal communication) characterised the potsherds within the waterlogged sequence into a broadly dateable distribution demonstrating a southwards progression from mostly middle Anglo-Saxon (context (14071), (14083), (14084)) to mostly later Anglo-Saxon material (context (14082)).

Round wooden stakes of between 3 and 15 cm diameter with cut marks and likely relating to structures at the stream edge were found embedded into channel bed and alluvial deposits (14083)/(14084) sealed beneath units of waterlogged organic sediment (14071)/(14081). Other worked wood included a small flat fragment that was possibly part of a box and two assemblages of *Corylus avellana* (Hazel) and *Acer campestre* (Field Maple) wands, cut at around 4–5 years old which appeared to be interwoven (Figure 3(c)). Further taxonomic work on the waterlogged wood was prevented by time and budget constraints however two samples subsequently provided radiocarbon dates contemporary to the later...
monastic phase and Saxo-Norman settlement (section 'Dating'). Large numbers of wood chips were found in association with wattles and stakes within the organic silt contexts (14083) and (14084) (Figure 4) suggesting either working at this location or a collection of dumped woodworking debris.

Large stones comprising flat greensand slabs together with irregular or rounded nodules of flint or chalk up to 40 cm in diameter were found within the same horizon (14084) as the majority of the worked wood and do not occur in the overlying sequence. No clusters indicative of dumping were observed; the linear arrangements appeared perpendicular to the channel suggesting an interpretation as stepping stones, placed to allow access across a marshy margin area. No examples were found to be worked or shaped in

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**Figure 4.** Simplified plan of early medieval features within trench showing: locations of environmental and C14 samples discussed in text with laboratory codes (black dots/ellipses), worked wood (black silhouette), stones (light grey silhouette), wood chips within contexts (14083) and (14084) (dark grey triangles).

**Figure 5.** West facing profile of trench LTF14 TP4 with simplified stratigraphic interpretation and sample locations; dotted lines indicate suggestions for identifiable former channel margins based upon distribution of organic lenses in section.
any way which could suggest other functions (Salisbury 1992, 159).

**Sampling and methods**

A range of sampling was undertaken as detailed in Table 1. Six sub-samples were taken from each of three monoliths and processed by heavy-liquid separation and acetylation for analysis of pollen and non-pollen palynomorphs (NPP) indicative of vegetation history and land use. Pollen grain identifications were conducted with reference to Moore, Webb, and Collinson (1991) using nomenclature after Bennett (1994); spore identifications and nomenclature follow Reille (1992), Van Geel, Bohmcke, and Dee (1980), Van Geel and Aptroot (2006) and Cugny, Mazier, and Galop (2010).

Bulk samples of 1 litre were wet sieved and analysed for plant macrofossils (seeds), Mollusca and ostracods. Seed identifications were made with reference to the Digital Seed Atlas of the Netherlands (www.seedatlas.nl) (Cappers, Bekker, and Jans 2006) with plant nomenclature after Stace (2010). Mollusc identifications were made with reference to Kerney (1999), Kerney and Cameron (1979) and Evans (1972) with taxonomic nomenclature after Anderson (2005). Ostracod identifications are from Griffiths, Rouse, and Evans (1993).

A micromorphological sample was taken using a Kubiena tin with the aim of analysing site formation processes relating to the sequence. The thin-section was ground and polished to 30 µm, using Brot and Logitech lapping machines (Goldberg and Macphail 2006, 354). Analysis was conducted using a Leica DM EP polarising microscope and a Leica DML microscope equipped with a 50 w Hg discharge UV lamp for fluorescence microscopy (Courty, Goldberg, and Macphail 1989, 48–49). Taxonomic identifications of charred wood fragments in thin section follows Schweingruber (1990).

Ten samples extracted during the environmental sampling were submitted for radiocarbon dating at the Oxford Radiocarbon Accelerator Unit (ORAU) (www.c14.arch.ox.ac.uk) (Table 2). These comprised fragments of worked roundwood with cut ends and macrofossils of nut shells and fruit stones which were represented throughout the sequence. Selection of the latter was based upon specimens which displayed excellent preservation with minimal evidence of abrasion from redeposition and which were taxonomically identifiable. Calibration and Bayesian modelling was undertaken in OxCal 4.2 (Bronk Ramsey 2016) using the IntCal13 calibration curve.

**Results**

The stratigraphies of the monoliths are detailed in Supplemental Material Table 1. Pollen diagrams from two of these monoliths (<4> and <5>) are presented (as % total pollen sum including aquatics) in Figures 8 and 10. Associated NPP are presented (as % standardised to total pollen sum for each sample) in Figures 9 and 11. Monolith <24> demonstrated poor preservation with low grain and spore counts and analysis was not completed. Environmental assessment data and counts for plant macrofossils (seeds) and ostracods from bulk sequence <3> are presented in Supplemental Material Table 2 with a summary diagram for plant macrofossils by habitat group presented in Figure 13. Molluscan data from the same bulk samples is presented in Figure 14. All counts are standardised to 1 litre bulk sample volumes. Micromorphological evaluation revealed five distinct microstratigraphic units in the single block sample; descriptions, inclusions and post-depositional textual pedofeatures are detailed in Supplemental Material Table 3.

**Dating**

Radiocarbon dating results relating to the sample scheme in Table 1 are detailed in Table 2. All of these samples present potential taphonomic problems of re-deposition within the colluvially and fluvially mixed sediments encountered in this sequence. These complicating is widely encountered when attempting to date fluvial sequences, especially when using plant macrofossils, as highlighted in some recent studies (e.g. Howard et al. 2009). Consequently an attempt was made to refine and correlate these dates to compensate for taphonomic distortion and residuality using a Bayesian phasing model for the total sample set, as presented in Figure 6 and Table 3.

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**Table 1. Sample scheme.**

| Sample type/code | Type of analysis | Location description |
|------------------|------------------|----------------------|
| Monolith <4>     | Pollen and non-pollen palynomorphs | Contexts (14068)(14070)/(14071)/(14076) |
| Monolith <5>     | Pollen and non-pollen palynomorphs | Discrete organic lens (14081) overlying stones in context (14084) |
| Monolith <24>    | Pollen and non-pollen palynomorphs | Sediments overlying and infilling pit [14079] |
| Bulk sample sequence <3> | Plant macrofossils and Mollusca | Sequence of 15 bulk samples from limit of excavation to topsoil, at intervals of between 5 and 20 cm dependent on context boundaries |
| Micromorphology sample <28> | Micromorphology | Contexts (14068)(14070)/(14071) |
| Bulk sample <7>  | Plant macrofossils and Mollusca | Channel fill (14077) |
| Bulk sample <8>  | Plant macrofossils and Mollusca | Channel fill (14082) |
| Bulk sample <9>  | Plant macrofossils and Mollusca | Organic primary fill (14080) of pit [14079] |
| Bulk sample <10> | Plant macrofossils and Mollusca | Organic lens (14081) associated with monolith <5> |
| Bulk sample <17> | Plant macrofossils and Mollusca | Channel fill (14082) (additional sample) |
| Bulk sample <18> | Plant macrofossils and Mollusca | Organic alluvial silt lens (14083) |
The stratigraphic evidence demonstrates a palimpsest of dipping channels and laterally constrained sediment lenses which are not horizontally bedded; consequentially it cannot be assumed that accumulation was consistent. This being the case an age-depth model of mutually exclusive sequential phases will be unrepresentative except for the units which are stratigraphically secure (Units 1–4, contexts (14076) to (14070)). The remaining spot samples (Units 5–7) are less well correlated, therefore a degree of phase overlap is assumed.

This model illustrates a problem introduced by the two samples (OxA-33564 and OxA-33697) from the lowest phase in the sequence which shows the high degree of lateral variation in the age of this otherwise stratigraphically and compositionally homogenous basal sediment unit. This reflects the unit’s composition from an undifferentiated mix of channel deposits chronologically progressing from north to south which could not be differentiated in the field.

Despite these caveats, this model provides a chronology corresponding well to the on-site archaeological phasing (section ‘Lyminge archaeology’). The main environmental sample sequence is bounded between the date of onset of organic accumulation between 382 and 535 AD (Unit 2) and the upper limit of alluvial accumulation at this location (14070) between 773 and 947 AD (Unit 4). The final fill from the excavated channel sequence at the southern limit of the trench (14082) which marks the cessation of fluvial processes across the entire span of the excavated area, is modelled at 894–984 AD.

**Interpretations**

**Micromorphology**

The sequence base comprised intermixed colluvial and alluvial sediments containing weakly orientated plant remains deposited in relatively slow moving water. This was overlain by a compacted organic layer (Figure 7(a)) resembling a relict stable crust and potentially demonstrating *in situ* trampling by livestock (Macphail et al. 2004, 179). Overlying this were finer organic silts and a discrete calcareous marl lens. The

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**Table 2. Radiocarbon samples and individual results.**

| Lab Ref       | Material                        | Depth/context | Uncalibrated C14 BP ±BP | Calibrated AD (IntCal13) (2σ/95.4%) |
|---------------|---------------------------------|---------------|-------------------------|-------------------------------------|
| OxA-33561     | Corylus avellana shell          | 134–137 cm (14070) | 1169 ±31               | 771–967 (−27.0)                     |
| OxA-33523     | Corylus avellana shell          | 137–142 cm (14071) | 1264 ±24               | 669–797 (−26.1)                     |
| OxA-33562     | Corylus avellana shell          | 142–147 cm (14071) | 1275 ±31               | 661–855 (−26.5)                     |
| OxA-33563     | Prunus sp. cf. avium stones     | 147–152 cm (14071)/(14076) | 1628 ±30               | 349–536 (−26.3)                     |
| OxA-33564     | Prunus sp. cf. spinosa stones   | 152–157 cm (14076) | 1139 ±28               | 777–982 (−29.8)                     |
| OxA-33565     | Corylus avellana shell          | (14082)       | 1140 ±28               | 777–981 (−30.3)                     |
| OxA-33566     | Worked Corylus avellana roundwood (5 years old) | (14082) | 1051 ±31               | 899–1027 (−27.0)                    |
| OxA-33567     | Worked Acer campestre roundwood (5 years old) | (14082) | 1091 ±29               | 892–1014 (−23.4)                    |
| OxA-33568     | Prunus domestica stone          | (14081)       | 2447 ±33               | −754–410 (−27.2)                    |
| OxA-33697     | Prunus sp. cf. spinosa stones   | (14077)       | 1209 ±28               | 777–982 (−27.2)                     |

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**Figure 6.** Stream sequence phasing model showing major depositional units and dates.
sharp boundary between this marl lens and the organic silt units above and below it suggests a localised flood event.

Throughout the organic units post-depositional humification in a waterlogged environment was indicated by phosphatised residues, hypocoatings (Babel 1975, 418; Polo Diaz and Fernández Eraso 2010, 91) and neoformed pyrite crystals (FitzPatrick 1984, 96–97). The organic remains comprised wood and plant fragments, cellular residues and amorphous material. The majority of wood fragments comprised Corylus (hazel), Salix (willow) and Quercus (oak), some of which demonstrated evidence of combustion in low temperature domestic fires (Braadbaart and Poole 2008, 2443; Matthews 2010, 103). Intrusive material was indicated throughout this sequence by poorly sorted inclusions washed down from the settlement area similar in form to material previously recorded in the micromorphology of on-site midden deposits (Maslin 2015). Coprolite fragments in the upper unit, comparable to those produced by omnivores (i.e. human or pig) (Shillito et al. 2011), demonstrate dung deposited or dumped at the stream edge (Figure 7 (b)) which also correlate to parasite eggs in associated samples (section 'Parasite eggs').

Evidence for partial decay and redeposition is noted from the high proportion of crumpled and broken grains (Brown 1997, 136) as well as disproportionately high concentration of more robust types such as Lactu ceae (Dumayne-Peaty 2001, 383; Scaife 1987, 148), particularly in the uppermost layers most exposed to colluvial input and fluctuating water levels. The representation of cereals, particularly in monolith <5> (Figure 10), is potentially distorted by concentration within dung as indicated by association with fungal coprophilous Sordariaceous ascospores categorised by Van Geel as 'Non-pollen palynomorphs', Figure 11) and coprolite fragments (section 'Micromorphology') (Grieg 1982, 54; Macphail et al. 2004, 181). The presence of wild Bromus type grasses in the macrofossil record (Supplemental Material Table 3) raises the possibility that some of these larger pollen grains may also relate to wild oat or other closely related uncultivated varieties, as has been seen in other wetland palynological studies (e.g. Waller and Grant 2012).

**Non-pollen palynomorphs**

**Fungal spores**

Fungal spores were present in all samples, but most notably those from monoliths <24> and <4> (Figure 9). In all samples obligate coprophilous types associated with grazing were present, such as Sporormiella (Cugny, Mazier, and Galop 2010, 397). The group of Sordariaaceous ascospores categorised by Van Geel as Hdv type 55 represent a more diverse range of types associated with human influence (Van Geel, Bohncke, and Dee 1980, 418–419) and some are species-specific to domesticated animals (López-Sáez and López-Merino 2007, 105). Other forms of coprophilous Sordariaceae present include Podospora type, which has also been strongly associated with the presence of domestic animals on archaeological sites (Van Geel and Aptroot 2006, 323). These grazing indicators were found in association with Glomus, a potential indicator of soil

| Phase unit | Description | Modern finds | Dating evidence | Modelled date range (95.4%) | Modelled interval (95.4%) |
|------------|-------------|--------------|----------------|---------------------------|--------------------------|
| 9 | Topsoil | Medieval and post-medieval colluvial sequence, (14068) and overlying deposits | | | |
| 8 | Medieval and post-medieval colluvial sequence, (14068) and overlying deposits | | | | |
| 7 | Medieval and post-medieval colluvial sequence | Late Anglo-Saxon/medieval pottery; OxA-33567; OxA-33565 | | 894–984 AD | 0–625 years |
| 6 | Late Anglo-Saxon/medieval pottery; OxA-33568 | | 892–1006 AD | 0–923 years |
| 5 | Late Anglo-Saxon/medieval pottery; OxA-33566 | | 779–980 AD | 0–883 years |
| 4 | Early Middle Ages 4 | OxA-33561 | | 773–947 AD | 0–269 years |
| 3 | Middle Ages 5 | OxA-33563 | | 684–768 AD | 0–188 years |
| 2 | Middle Ages 6 | OxA-33697; OxA-33564* (assumed to be intrusive/ outlier on the basis of superposition of four earlier samples) | | 104–336 AD | 671–1468 years |
Figure 7. Micromorphological features and inclusions. (a) Orientation and layering from compression; (b) Coprolite (PPL).

Figure 8. Pollen (% total pollen including aquatics, Pteridophytes and Sphagnum) diagram for monolith <4> with sample descriptions, context numbers and sample height above monolith base.

Figure 9. NPP counts (expressed as standardised % based on total pollen sum for the sample) for monolith <4>.

Figure 10. Pollen (% total pollen including aquatics, Pteridophytes and Sphagnum) diagram for monolith <5> with sample descriptions, context numbers and sample height above monolith base.
erosion (Van Geel et al. 2003, 881), suggesting runoff from a grazed land surface around the stream (Figure 9). These types were largely absent from the organic unit in monolith <5> (14081), Figure 11, suggesting a different origin for this sediment from the otherwise stratigraphically comparable organic unit in monolith <4> (14071).

**Parasite eggs**

Eggs of intestinal parasite Helminth worms (*Trichuris* (whipworm) and *Ascaris* (mawworm)) (Figure 12) were identified together in all three monoliths, most notably in monolith <5> (14081), in a co-occurrence typical for occupation deposits (Fernandes et al. 2005, 330). Measurements taken using an ocular micrometer of the *Trichuris* eggs (in relation to Brinkkemper and van Haaster 2012), produced a distribution broader than what would be expected for a sample consisting solely of *T. trichiura* (human) eggs, suggesting that part of this assemblage comprises *T. suis* (pig). Comparison to urban sites such as Coppergate, York (Jones 1985) allow the organic material from monolith <5> which demonstrated egg counts of nearly 55,000 per gram, to be interpreted as dung. This intense concentration, together with the very different spore and pollen signature from this context (14081) suggests dumped organic waste.

**Waterlogged plant remains**

These samples contain evidence for tree and shrub cover (e.g. *Salix*, *Alnus*, *Crataegus*) along the banks of the stream channel, along with a wide range of ruderal and arable weeds. A number of potential food plants are represented (hazelnut, blackberry, elderberry, sloe, apple, cherry, plum) including charred hazelnuts. A high number of blackberry seeds in sample <10> (14081) and elderberry seeds in the lower part of the sequence (14071) may represent concentration in dung deposits from local livestock or dumped wastes from the settlement (e.g. Dennell 1976, 231). The lowest part of the sequence contains both an aquatic and riparian component, suggesting disturbed bankside areas subject to occasional clearance alongside a watercourse with relatively clean, unpolluted water (Smith 2013, 8, 64). The sequence demonstrates a change from riparian or aquatic to dry-ground species over

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**Figure 11.** NPP counts (expressed as standardised % based on total pollen sum for the sample) for monolith <5>.

**Figure 12.** Parasite egg types from monolith samples. (a) *Trichuris* sp.; (b) *Ascaris* sp.
time (Figure 13), comparing closely with the molluscan evidence (section ‘Mollusca’) (Figure 14). In contrast the uppermost colluvial sediments demonstrate weed species associated with heavily grazed or arable areas and disturbed ground around agricultural settlements (Grime, Hodgson, and Hunt 1988; Hey 2004, 367; Robinson 1992, 203; Smith 2013).

Charred plant remains

A range of charred cereal grains was recovered (Supplemental Material Table 3). A high degree in variation of preservation was apparent with a proportion of grains being abraded and damaged by redeposition, particularly in the case of specimens from the uppermost colluvial units which incorporate material from reworked upslope occupation contexts. The micromorphological evidence for sediment mixing throughout the sequence (section ‘Micromorphology’) indicates that a proportion of grains within the waterlogged alluvial units also represent inwashed material. The high concentrations of grains within organic lenses containing parasite eggs (e.g. context (14071)) likely indicate the presence of dumped occupation wastes.

The better preserved cereal grains largely consist of Hordeum (barley) along with a smaller proportion of Triticum (wheat) and considerable quantities of Avena (oat) which likely represent both wild and cultivated (Avena sativa) varieties. A high degree of variation in the forms of the Triticum grains suggests a proportion of glume wheat (spelt) present alongside more prevalent types of free-threshing bread wheat. These results compare well to those from the on-site assemblages, particularly to the 8th/9th century monastic contexts which contained evidence for all four major cereal types as well as both spelt and free-threshing wheat varieties (Campbell 2012; McKerracher 2012, 2015).

Mollusca

The molluscan assemblage comprises taxa washed in from dry-ground environments along with autochthonous bankside and aquatic types (Davies 1992, 67). The diagram for this sequence is displayed in Figure 14; samples skewed by very low shell counts (n < 10), due to taphonomic variations within the sediments, have been removed to ensure comparability between the more representative samples. The base of the sequence contains a diverse assemblage of types demonstrating a high degree of taphonomic mixing consistent with the interleaving of slope and stream-
side sediments (section ‘Micromorphology’). The aquatic Mollusca indicate the stream hydrology to be characterised by stable perennial flow with infrequent periods of drought (Davies 2008, 21–22). These are present alongside ostracod types favouring shallow water environments and fine grained substrates (Ruiz et al. 2013).

The terrestrial assemblage is dominated by *Trochulus hispidus* and *Vallonia excentrica*, consistent with origins in eroded arable soils (Bell 1983; Davies 2008, 121) and short-turfed grazed grassland (Evans 1991) both of which are likely washed in from upslope environments. Alongside this were a range of shade-demanding types such as *Carychiom, Discus rotundatus* and *Oxychilus cellarius* which may derive from areas of taller herbaceous vegetation around the stream channel itself. The transition from this mixed assemblage to one dominated by dry-ground and open country types in the overlying Saxo-Norman and medieval colluvium suggests a pronounced transition to an open, probably cultivated, land surface along with a general reduction in shaded environments following the settlement abandonment.

**Discussion**

**Site formation processes and taphonomy**

The Anglo-Saxon occupation sequence at Tayne Field spans the 5th to the latter 7th century AD, following which time the area was apparently abandoned with settlement activity refocusing around the nucleus of the nearby monastic complex. Occupation activity subsequently resumed on Tayne Field during the 10th/11th century when part of the former Anglo-Saxon settlement area became used for domestic waste pits, presumably to the rear of unlocated dwellings along the line of the road bounding the western side of the site (Figure 1(b)). The wider site at this time likely constituted open areas of fields or paddocks defined by linear boundary features.

Agricultural activity and tillage over a prolonged period following the abandonment of the great hall complex generated a process of erosion and colluviation which progressively infilled and displaced the stream channel southwards. This created a dynamic hydrological system characterised by laterally discontinuous deposition of organic and alluvial sediments which accumulated across this transition in land use. A Bayesian model derived from a sequential set of radiocarbon dates from the sequence (Units 2–4 in Figure 6) suggests that organic accumulation alongside the stream channel at the excavated location occurred between 382–535 AD and 773–947 AD, after which time the channel margin at this point became buried by colluvium. This process facilitated the survival of these laminated sediment features, by sealing them in a waterlogged environment which minimised post-depositional bioturbation (Brown 1997, 39), as demonstrated by micromorphological analysis (section ‘Micromorphology’). No evidence was found during the field survey for any similarly waterlogged organic sediments north of and pre-dating the excavated sequence. This absence suggests that the stream channel prior to this period existed in a more stable, less disturbed landscape with any potential contemporary environmental or archaeological deposits likely lost to *in situ* channel bed erosion.

This dynamic geomorphology has led to the exceptionally unusual circumstance of waterlogged organic preservation contemporary to dry-ground Anglo-Saxon settlement archaeology (Hamerow 2012, 2). Recovery of such material has previously been limited to lowland sites like Brandon, Suffolk and Yarnton, Oxon, which occupy the alluvial floodplains of major rivers (Carr, Tester, and Murphy 1988; Hey 2004). The Lyminge site demonstrates the potential for localised conditions of waterlogged preservation in dry downland areas lacking permanent bodies of standing water (French 2003, 64).

The taphonomy of this sequence, particularly with regards to the pollen evidence, is highly complicated by inwashed colluvial sediments (section ‘Micromorphology’), laterally interleaved organic lenses from different channel phases (section ‘Geoarchaeological survey, excavation and stratigraphy’) and contamination from dung and dumped occupation wastes (section ‘Parasite eggs’). The small size of catchment additionally restricts the source area of any pollen derived from inwash to a few hundred metres, limiting the prospect of interpreting the vegetation cover of a wider area (Hey 2004, 371). In addition to this problem, extensive micromorphological evidence for trampling demonstrates that the movement of livestock generated a churned surface of local vegetation detritus, dung and dumped occupation wastes, incorporating sediments and microfossils imported from the wider area on the hooves of animals (Chadwick 2016, 107). This collectively implies that the data from this sequence will reflect a mixture of both highly localised environments and processes connected with occupation activities which defy easy separation.

**Economic evidence associated with the occupation sequence**

The archaeology within these deposits provides new contextual evidence for the economy of the Anglo-Saxon settlement at Lyminge, particularly during the middle and later Anglo-Saxon phase when the abandoned site of the former great hall complex at Tayne Field was used for grazing and agriculture by the early monastic community. This further demonstrates the intensive exploitation of a small, distinct ecological
area for many of the activities and resources normally associated with larger wetland pays in Kent during the Anglo-Saxon period (Brookes 2010; Everett 1977, 1986).

The presence of in-situ stakes, stones and pits suggest bankside structures and use of the location for activities related to the wider settlement economy. The presence of wooden structures and the dumping of materials related to the manufacture of hurdles and other wooden artefacts are evident within a date interval of 779–980 AD, which corresponds to the monastic and later phases of settlement. This activity may have exploited the damp stream-side environment to maintain flexibility of wands for working, a requirement demonstrated by experimental studies (Grococ, 2010, 28). The presence of commonly coppiced species such as Salix (willow) and Corylus (hazel) within both the pollen record and the identified fragments of worked roundwood further suggest that local, potentially coppiced, stands were being actively exploited.

Associated with this activity is evidence for a subsistence economy of wild food plants (blackberry, elderberry, sloes, plums, apples, hazelnuts) likely demonstrating foraging activities around the settlement (Arnold 1988, 17) or even horticulture, as has been suggested at Yarnton (Hey 2004, 48). This body of evidence matches assemblages derived from on-site occupation contexts (Campbell 2012, 9) which have been highlighted by McKerracher (forthcoming) as being unusually diverse in the monastic phase. This corresponds chronologically to the abundant waterlogged remains recovered from organic lens (14071) which has a modelled date range of 684–768 AD. The presence of these plant types in the underlying unit (14076) further suggests they also represented an important part of the earlier food economy of the great hall complex (6th/7th century AD), offering parallels to contemporary contexts. This period corre-
sponds to the height of monastic activity, characterised in the botanical assemblages by an increased diversity and abundance of cereal types (Campbell 2012; McKerracher, forthcoming). Such increasing production of arable surpluses is a phenomenon of the ‘long eighth century’ as demonstrated more widely in southern England from evidence for new crop types, developments in field systems, settlement layouts and agricultural infrastructure (Rippon 2010). The role of monasteries in driving this process has been debated on archaeological and historical grounds but is likely to have been highly significant (Blair 2005; Faith 1997; Thomas 2016).

Conclusions

The stream margin close to the great hall complex at Lyminge demonstrates evidence for activities such as
livestock management, the collection of wild food plants and possibly wood working during the latter phase of its occupation and, following abandonment in the 8th century AD, across the subsequent monastic and Saxo-Norman phases. This sequence further allows the contextualisation of the Anglo-Saxon occupation into an open landscape with a largely herbaceous flora and limited local tree cover which had likely been continuously present since the earliest period of settlement. The land use around the stream throughout this period comprised a mixture of both grazing and arable cultivation.

Within this record is evidence for a previously archaeologically unknown continuation of use of the former occupation area for these economic activities after the abandonment of the great hall complex. Against this backdrop, suggestions of a general increase in local cereal production in the 8th century may also demonstrate the role of the monastery in driving localised arable intensification. From the Late Saxon period onwards, intensive cultivation around the stream caused the earlier stream channels to become progressively sealed by colluvium, transforming the topography of the former settlement area.

The extensive taphonomic complications revealed by this multi-proxy study amply demonstrate the complexities of interpreting and securely dating such small fluvial sequences. Despite these problems, the demonstrable potential for recovering waterlogged and environmental evidence in otherwise dry-ground situations demonstrates that these types of localised sequences may offer new and valuable sources of contextual data for early medieval downland settlement sites.

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