Corn Exchange:

archaeobotanical evidence for the impact of social and economic change on agricultural production and consumption in Roman, Saxon and Medieval Britain.

Volume 1

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Abstract

This thesis investigates the influence of socio-economic conditions on crop cultivation and consumption practices in Britain during the Roman, Saxon, and Medieval periods. The archaeobotanical remains of staple field crops (cereals, pulses, and flax) are used as evidence for the decision-making of farmers and the consumers of their produce. The introduction, expansion, contraction, and discontinuation of crops consumed and under cultivation are considered against the backdrop of their environmental and political context, in order to identify the impacts of changing economic and social structures on agricultural practice and staple crop consumption.

During the Romano-British period, changes in farming strategies were primarily aimed at increasing total cereal output, rather than meeting specific consumer preferences. Distinctive patterns of crop consumption were found at consumer sites (such as military sites, London and other large towns) that reflect the prioritisation of pragmatic concerns with the logistics and cost of food provisioning over Romanised ideals of cuisine. Decision-making in the Saxon period was, in contrast, demand-led. Each new introduction represented an improvement on spelt when utilised for a specific purpose. Instead of two general purpose crops (spelt and barley), the Saxon and Medieval crop spectrum comprised the “best” bread-making grain (free-threshing wheat), the most nutritious animal feed supplement (oat), the longest and strongest straw for construction and craft-working (rye), and the preferred brewing grain (barley). The demands of farmers, rather than urban consumers, were the catalysts for innovation, although the new introductions were subsequently adopted as cash crops as opportunities for market sale increased. The dietary variety seen in late Saxon and High Medieval towns is less an expression of consumer choice, and more a reflection of the stratification of wealth within these communities as a greater variety of culturally inferior foodstuffs was consumed by poorer households.

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Chapter 1. Introduction

This thesis is concerned with the archaeobotanical evidence for the cultivation and consumption of field crops in Britain from the Romano-British to the Medieval periods. By analysing the evidence for changes in the archaeobotanical records within their temporal, spatial, and socio-economic context it aims to improve our understanding of the economic environment within which producers and consumers were acting, the demand and supply side influences on their decision-making, and the differing experiences of elite and non-elite consumers and producers.

1.1 Research rationale

The cultivation of field crops was necessary for human survival throughout the study period: cereals were the mainstay of the diet of all social classes and cultural groups, and pulses are likely to have played a particularly important role in meeting the protein needs of the lower social orders (Hagen, 1992; Zohary, Hopf and Weiss, 2012; Woolgar, 2016). This imperative, however, belies the existence and importance of choice within the agricultural economy. The decision by farmers to focus on crop cultivation represents a choice to invest in a particular location over the medium to long-term; the choice of what crop(s) to cultivate reflects farmers' access to productive resources (land, labour, and capital), their tolerance for risk, whether their aims are focussed on subsistence or surplus production, their own culinary preferences and the non-food uses to which they wish to put their harvest. Socio-political elites throughout the study period derived their power and wealth from their control over the agricultural production of others. The consumption of staple foods was not driven solely by the need to meet basic nutritional requirements. The degree of choice (i.e. the ability to select one crop in preference to another) enjoyed by individual consumers depended upon how their access to foodstuffs was mediated, on their status within a system of socially-embedded redistribution, or on their wealth within a market economy. Within these externally imposed constraints, food choices are a marker of identity: a means by which social status can be displayed, and cultural affiliations reinforced or rejected. "Consumption" of field crops does not always mean culinary use. The grains, chaff, and straw, of some cereal species were widely used for animal fodder, as were pulses. Cereal straw had a range of further uses: in construction, craft-working, and as fuel; while flax was primarily grown for its fibrous stems that were used to produce linen (B. M. S. Campbell, 2000; Dyer, 2002; Zohary, Hopf and Weiss, 2012).

The archaeobotanical remains of field crop plants are therefore direct evidence of decisions made in response to a wide range of environmental, social, and economic influences. Different decisions should produce archaeobotanical assemblages of differing composition. The comparison of archaeobotanical remains derived from different temporal, geographical, and socio-economic contexts, is therefore expected to reveal differences and similarities between samples or assemblages that result from these influences. Interpretation of patterning within the archaeobotanical record has the potential, at least in principle, to illuminate ways in which the development of new economic structures, and the changing identities of farmers and consumers, impacted upon agricultural production and consumption. However, to date, the potential for archaeobotanical analyses to yield insights into socio-economic change between the Romano-British and Medieval periods is largely unrealised, and this is not because the more widely utilised types of archaeological and documentary evidence have answered all our questions.

There is a relative paucity of documentary evidence for the economy of Roman Britain in comparison to the other provinces of Rome. Strabo is often quoted as evidence that the people of late Iron Age southern England exported surplus grain to the continent (e.g. Cunliffe, 2007; Fulford, 2007) and there are records of cereal movements from Britain to the Roman army in the Rhineland in the fourth century AD (Mattingly, 2007). What happened in between is undocumented. We can surmise, from the expansion of Britain's agriculturally unproductive population (soldiers, administrators, and town-dwellers), that there was an expansion of surplus agricultural production, but we know little about how this was accomplished, redistributed, or the influence of each new consumer group on farming practice. Although a number of agricultural treatises were written by Roman landowners (Cato and Varro, 1912; Garnsey, 1999), the authors aimed at a readership comprised of their equally wealthy peers. Their ability to elucidate farming practice in the occupied northern province of Britannia, conducted within different environmental, political, economic, and cultural circumstances is doubtful. We know particularly little about the (possible) relationship between non-elite, native farming and the emergence of consumer groups and markets. The absence on non-villa rural sites, of the coins and portable artefacts found on consumer sites (Taylor, 2001; Potter, 2002; Mattingly, 2007; Brindle, 2017) has been used to infer a lack of participation in exchange by native agriculturalists, but inferences based on an absence of evidence are always insecure. The archaeobotanical remains of staple foods are, however, found at both types of site, and have the potential to reveal connections between them. The recent synthesis of archaeobotanical data conducted as part of the Rural Settlement of Roman Britain project (Smith *et al.*, 2016; Allen, 2017) successfully identified regional variations, and some socio-economic variations, in the cereal crop composition of archaeobotanical samples from rural sites, but in the absence of equivalent analyses of data from urban and military sites, the existence and nature of connections between producers and consumers remains invisible.

The greatest use has been made of archaeobotanical evidence by researchers concerned with Saxon agriculture. Here the focus has been on establishing a chronology of agricultural changes, and particular attention has been paid to the introduction of free-threshing wheat. The recent synthesis of archaeobotanical, zooarchaeological, and architectural evidence by McKerracher (2014a, 2018) refined the chronology of early-mid Saxon agricultural development, demonstrating that the expansion of production pre-dated the development of the *wics*, rather than being stimulated by demand from the new settlements. The identities of those who reorganised production, however, remain obscure.

As the corpus of written evidence for the production of, and demand for, agricultural surplus increases, in the late Saxon and Medieval periods, the utilisation of archaeobotanical evidence by researchers concerned with the agricultural economy decreases. The estate management texts of the Anglo-Saxon period – *Gerefa* (*Bege sceadwisan gerefan*) and the *Rectitudines Singularum Personum* (Harvey, 1993), and the monastic and manorial accounts of the later medieval (Slicher van Bath, 1963; B. M. S. Campbell, 2000) – only document activities on high status sites, and tend towards recording administrative and financial matters rather than practical farming tasks. The more hands-on agriculturalists of small estates and peasant farms had no need to produce documentary accounts of what they grew, and how they disposed of it. Likewise, food renders and rents list the produce transferred from the peasantry to the aristocracy, but not the produce that the peasantry retained to meet their own needs. So, again, we need to turn to the direct evidence of archaeobotanical remains to infer the actions of all socio-economic classes.

Recent large-scale syntheses of Roman to Medieval archaeobotanical data have focussed on the evidence for exotic and introduced food-plants in Britain and central Europe (Bakels and Jacomet, 2003; Livarda, 2008a, 2011; Livarda and van der Veen, 2008; van der Veen, Livarda and Hill, 2008). These researchers successfully identified distinctive consumption practices for discrete consumer groups (thereby demonstrating the potential for comparative analyses of archaeobotanical finds) but, due to their focus on luxury foodstuffs, the bulk of food consumption by a large proportion of the population remains unexplored. By focussing on staple crops, this study aims to address this lacuna. The studies of exotic and introduced taxa, and early large-scale longitudinal studies of remains of staple crops (e.g. Green, 1981; Jones, 1981; Banham, 1990), utilised presence data (records of the presence of each taxon of interest at a site) in order to obtain the largest possible dataset. In the case of staple crops (by definition widely cultivated and consumed), many variations in practice are unlikely to be visible in analyses of presence data, due to their ubiquity. This study therefore aims to advance our understanding of socio-economic variations in crop cultivation and consumption by complementing presence analyses with analyses of sample contents data.

1.2 Research aim and objectives

This thesis aims to identify causes of variation in the field crop content of archaeobotanical assemblages and samples from British sites, and thereby improve our understanding of changes in farmers' and consumers' decision-making associated with the development of a market economy in Roman to Medieval Britain.

To achieve this aim, the contents of archaeobotanical assemblages and samples were recorded; categorised according to various temporal, spatial, social, and economic characteristics of the sites from which they derived; analysed; and interpreted, with the following objectives:

- To find evidence for the introduction of new crops, and the retention or discontinuation of others in cultivation and consumption.
- To determine whether the identified changes in field crop cultivation and consumption are likely to represent responses to environmental, socio-cultural, or economic influences.
- To identify and interpret differences in the consumption practices of members of discrete socio-economic groups.
- To identify farming and marketing strategies implemented in response to the (episodically) increasing physical separation of producer and consumer engendered by urbanisation.
- To identify market-orientated developments in farming practice.

1.3 Structure of the thesis

Chapter 2 presents the research context in more detail: outlining relevant current debates in the economic history of the study period; then summarising the archaeological evidence for key aspects of the Romano-British, Saxon, and Medieval agricultural economy, the contribution that archaeobotany has made to our understanding of them, and its potential to provide further insights. Chapter 3 describes the methods of data collection, standardisation, and analysis utilised in this study. Chapters 4 and 5 describe the two datasets analysed, and present the results of their analysis: Chapter 4 is concerned with the analysis of the crop taxa present in each temporal period, at each site (the "site-phase presence" dataset), and Chapter 5 with the analysis of the quantified contents of individual archaeobotanical samples (the "sample contents" dataset). Chapter 6 synthesises and interprets the results of these analyses, discussing the implications of temporal, spatial, and socio-economic variations within the archaeobotanical data. Finally, in Chapter 7, key findings are discussed in relation to each research objective, and future research directions are considered.

Chapter 2. The Research Context

Agriculture was the mainstay of production and employment in Britain throughout the study period (Dyer, 2002; Bowman and Wilson, 2009; Banham and Faith, 2014), and in this respect the late Medieval economy differed little from that of the Late Iron Age on the eve of Roman occupation. Large-scale mobilisation of surplus food was already a feature of the late Iron Age economy (van der Veen, 1992; Cunliffe, 1995, 2004; van der Veen and Jones, 2006; Haselgrove *et al.*, 2016; Garland, 2020), but its distribution was organised along socio-political lines rather than by socially-disembedded markets: in feasts that reinforced familial and/or social relationships (Ralph, 2005a, 2005b; Garland, 2020) , or appropriated and redistributed by elite individuals wishing to mark and maintain their social position (Cunliffe, 2004, 2007; Haselgrove *et al.*, 2016; Moore, 2017). From the Roman to the Medieval periods, food did not lose its social significance, remaining a marker of various social and cultural affiliations, but rather it acquired an additional, commercial, value. The production of agricultural surplus was not new, but the quantity produced changed, as did the identities of the groups who produced and acquired the surplus, and the means by which they did so.

As is discussed in greater detail below, none of these changes was unilinear. Levels of surplus production fluctuated with demand (as society became more or less stratified, and with changing levels of urbanisation) and when different resources (e.g. land in the High Medieval, labour in the late Medieval period) became limiting factors on production. The identities of those consuming the agricultural surplus produced by others varied: although elite consumption was a feature of nearly all periods (except perhaps for the very early Saxon), non-elite consumers also emerged (episodically) with urbanisation, the division of High Medieval peasant landholdings into units which were sometimes too small for self-sufficiency and eventually with the increasing affluence and economic specialisation of many peasant farmers and artisans. The transition from the redistribution of produce via a socially embedded economy to redistribution via trade was unevenly paced and discontinuous, and it is likely that several alternative economic mechanisms for the reallocation of goods (including gift-exchange, tribute, taxation and trade) co-existed at various times and places. By the end of the Medieval period, commercial considerations influenced all aspects of agriculturalists' decision-making: regional specialisation in particular plant or animal species was consistent with decision-making based (at least in part) upon considerations of comparative advantage in production (Fisher, 1935; Thirsk, 1984); distance and difficulty of transporting produce to the London market seems to have been an important consideration in determining many regional specialities (Fisher, 1935; Campbell *et al.*, 1993); levels of peasant by-employment (for example in textile production) were high (Thirsk, 1984; Dyer, 2002); and early Tudor period agrarian writers made explicit mention of prices and profitability when recommending agricultural strategies (Fitzherbert, 1523; Tawney and Power, 1924). Whether or not, and the extent to which, farmers adapted their practices in order to participate in trade would have depended on a combination of factors. Practical considerations would have included the physical accessibility of markets (distance, the ease of transporting goods, the fragility and perishability of the latter), the legal and political environment (which may or may not have facilitated transactions and predictable returns from exchange), and the availability of productive resources (land, labour, and other capital) to invest in increasing or diversifying output beyond the levels of local auto-consumption. Different groups (and individuals) are more or less motivated by the potential rewards from trade compared to the rewards from other activities, and more or less willing to take risks in the hope of rewards (Ellis, 1993, pp. 105–122). Ethnographic and empirical studies of peasant risk aversion have produced variable results which suggest that attitudes to risk vary between cultures, income levels, and of course between individuals (Binswanger, 1980; Binswanger and Sillers, 1983; Grisley and Kellog, 1987; Parikh and Bernard, 1988; Ellis, 1993; Mendola, 2007).

Any economy more complex than purely subsistence based has several essential features. They support a (variable) number of agriculturally unproductive individuals, whether these are members of socio-political elite groups, or specialists in other forms of production (e.g., craft-workers). Once a significant proportion of the population are consumers only (i.e. agriculturally unproductive), the remaining farmers must increase their production above the level required for their own subsistence. This surplus must then be physically moved from producer to consumer. The reallocation of this surplus may be achieved by various means: tribute and command redistribution, taxation, exchange (which may or may not be monetised). No one method of data analysis will provide evidence for all aspects of the economy: different analyses will give better (or poorer) insights into the existence and identities of consumer groups, the production of agricultural surplus, the movement of that surplus, and the mechanism by which it was reallocated. The mechanism of reallocation is probably the most difficult to reconstruct using archaeological evidence; the most we can hope to find is evidence of behaviours by farmers or consumers consistent with the pursuit of particular aims (e.g. food security or profit-seeking). Several alternative methods may be utilised to explore the same aspect of the economy. Different methods of analysis are suitable for charred, and for waterlogged and mineralised, datasets and different analyses will be required to investigate the production and consumption of staple and luxury foodstuffs. Because of the limitations of archaeobotanical (and more generally of archaeological) evidence, the more lines of evidence that are consistent with each other, the better. Two alternative approaches have been taken to achieving this: Matterne (2001) applied a variety of statistical analyses to one dataset, whilst Bakels (1996,

2014) used a series of case studies to illustrate each aspect of the economy (surplus production, specialisation, etc.) under discussion. The former approach gives more opportunities to identify agricultural and consumption strategies common to regions, socio-economic groups, and temporal periods, and does not leave researchers open to accusations of cherry-picking.

This chapter begins with a brief discussion of the economic systems believed to have been operating within Britain at various times during the study period. Following sections summarise the archaeological (and for later periods, some aspects of the documentary) evidence relating to aspects of the economy: the existence of discrete consumer groups, and the interactions between these consumers and agricultural producers (i.e. between demand and supply). These sections conclude by reviewing the ways in which archaeobotanical studies have added to, and have the potential to add to, our understanding of change in the agricultural and wider economy. The archaeobotanical analyses discussed are those involving the interpretation of secondary data (i.e. the information commonly included in archaeobotanical reports).

There have been a number of recent developments in the analysis of primary archaeobotanical data, including: morphometric analysis, which improves identification confidence and precision (e.g. Jacquat and Martinoli, 1999; Burger *et al.*, 2011; Ros *et al.*, 2014); ancient DNA extraction and analysis, which has been used to investigate plant domestication histories (e.g. Harris, Robinson and Juniper, 2002; Schlumbaum, Tensen and Jaenicke-Després, 2008; Schlumbaum and Vandorpe, 2012; Pető *et al.*, 2017); and stable carbon and nitrogen isotope analysis to reconstruct aspects of past growing environments (e.g. Fraser *et al.*, 2011, 2013; Wallace *et al.*, 2013, 2015; Bogaard *et al.*, 2016). These methods are not yet routine aspects of archaeobotanical analysis and reporting, however, and in the absence of a corpus of published results from British sites, they largely lie outside the scope of this study and are not analysed systematically in the following discussion, but occasional references are made to findings that illuminate particular aspects of the discussion.

2.1 The economic context

2.1.1 The Romano-British period

The debates concerning the nature of the Roman economy occur within the context of a dearth of written evidence for its operation (especially for the role of government) and this lack of evidence is particularly acute for the province of Britannia (Garnsey and Saller, 2014); raising questions about the extent to which the Romano-British economy was integrated into that of the wider empire. The archaeobotanical evidence for agricultural activity must therefore be considered against a backdrop of uncertainty.

One overarching debate relates to the question of whether economic growth occurred in the empire, and the duration of any such period of growth. Whilst some writers contend that *per capita* economic growth (i.e. an increase in agricultural, manufacturing, and service output per head of population) occurred during the principate, their assessment of its causes differs. Hopkins' (1980) "taxes and trade" model posits that the imposition of money taxes compelled Roman subjects to participate in market exchange (usually by marketing agricultural surplus) in order to obtain cash to pay their dues. Erdkamp's (2012a, 2016) model privileges other factors as incentives to growth: improvements in long-distance communication and political stability engendered by the integration of provinces into the empire reduced barriers to trade, whilst markets developed in the newly established or expanding towns. Most contrary arguments, that *per capita* growth was not achieved, focus on the factors that inhibited growth: technology remained backwards (with particularly little evidence for improvements in agricultural production and processing technologies in Britain); long distance transport remained slow, seasonal, and risky; and financial institutions remained primitive (Duncan-Jones, 1982, 1990; Bang, 2007; Garnsey and Saller, 2014). Whilst Temin (2001, 2004) argues that relatively sophisticated financial structures facilitating money lending did in fact develop (his evidence comes from documentary sources, mostly from Rome and Egypt), and that increases in total economic output occurred, such gains were outstripped by subsequent population growth (see also Scheidel, 2007, 2009), i.e. the Roman economy was caught in a Malthusian trap.

Temin (2001, 2012) views markets as key drivers of economic growth, and the Roman economy as an agglomeration of interdependent markets across the provinces. Most of the documentary evidence for this, again, comes from Rome and Egypt, with evidence largely lacking for the connectedness of other provinces. Bang's (2008) competing view sees individual provinces, and the markets within them, as largely economically isolated. Local markets operated in isolation, and largely in ignorance of each other. Effectively they functioned as local "bazaars" with volatile prices, based on local, short-term, circumstances.

Those arguing for the importance, and inter-connectedness, of markets across the empire (e.g. Temin, 2001; Kessler and Temin, 2007; Wilson, 2012) assert that the sheer volume of staple foods required to provision Rome was beyond the capacity of the government to transport, so that free-market trade must have been the main means of provisioning. Other researchers suggest tributary exploitation was the most important mechanism for supplying the cities and (crucially in Britain) the army and that the redistribution of this tribute could have been accomplished by a system of "administered trade" whereby wealthy individuals were contracted to move goods on behalf of the state (Duncan-Jones, 1982, 1990; Bang, 2007; Garnsey and Saller, 2014).

It is agreed that towns were centres of consumption, but their wider economic impact (i.e. on the rural economy) is debated. Whilst Erdkamp (2012b, 2013, 2016) posits that urban markets encourage the cultivation of cash crops for reciprocal trade between town and country, and Hopkins (1980) argues that trade between local agriculturalists and towns was necessary for the acquisition of cash to pay taxes and money rents, the "consumer city" model (Finley, 1985) posits that cities were maintained by their legal claims (in the form of taxes and rents) on the produce of their rural hinterlands (which may have been paid in kind rather than in cash), not by reciprocal exchange. The other consumer group who may have exerted a great influence over regional economies was the army. Echoing the debates around towns, whilst forts and *vici* are acknowledged to have been foci of consumer demand their wider economic impact is debated. Cash purchases by quartermasters and by individual soldiers may have contributed to the monetisation of local economies (Erdkamp, 2016), but the bulk of supplies may have been acquired by requisition or long-distance administered trade rather than from local markets (Garnsey and Saller, 2014). The relatively high military presence in Britain (compared to other provinces) may have left its economy highly dependent on state expenditure rather than on private trade. The relatively early withdrawal of the army and state administration may have precipitated an early return to a more subsistence based economy in Britain, in comparison to provinces to the east (Erdkamp, 2016).

2.1.2 The Saxon period

Although some documentary evidence pertaining to the operation of the Saxon economy exists, it is scarce and biased in several ways: towards the Midlands and south of England, towards the late Saxon period, towards the entitlements and activities of the landed elite, and towards monetised exchange in urban markets (Harvey, 1993; Faith, 2009; Fleming, 2011; Baker, 2013; Banham and Faith, 2014). Recent research developments in the field of the Saxon economy have been facilitated by an expanding corpus of archaeological evidence which, although still somewhat biased towards the Midlands and south, and towards the end of the period, gives far more evidence for life in rural, non-elite settlements, than is provided in the documentary record (Dyer, 2002; Perring and Whyman, 2002; Wickham, 2005; Banham and Faith, 2014). This expansion of the evidence base has produced a shift in the focus of much research: away from explanations of change focussed on the impact of elite individuals (e.g. Hodges, 1982, 1989) towards greater consideration of the experience and economic role of the peasantry and the inter-relationships between peasant farmers and the aristocracy (e.g. Faith, 1997, 2009; Dyer, 2002; Wickham, 2005).

In the absence of documentary evidence, economic growth, in particular the expansion of agricultural production, over the course of the Saxon period has been inferred from assorted strands of evidence: the expansion of settlement evidence suggestive of a rising population that must have been fed (Dyer, 2002); the reorganisation of rural settlements and field systems in ways consistent with intensification of agricultural production (Faith, 1997; Lewis, Mitchell-Fox and Dyer, 2001; Dyer, 2002; Jones and Page, 2003; Faith, 2009); and an increase the number of agriculturally unproductive consumers dependent upon the surplus produced by others. Various such consumers have been proposed as major stimuli to the production of surplus: kings (Hodges, 1982, 1989); the aristocracy (Hinton, 1990; Boserup, 1993; Wickham, 2005); ecclesiastical communities (Blair, 2005b; Maddicott, 2005); the inhabitants of the *wics* (*emporia* in Hodges' preferred terminology) (Hinton, 1990; Whyman, 2002); and later, the inhabitants of market towns (Britnell, 2000; Richards, 2000b; Britnell, 2011; Griffiths, 2011; Loveluck, 2013). Recent research (Moreland, 2000; Rippon, 2010; McKerracher, 2014a, 2018) concludes that the onset of manufacturing and agricultural expansion pre-dates (from the late seventh century) the development of the *wics* and that therefore we should look to consumers in the countryside for the initial demand stimulus to growth. Transformation of the countryside of central England continued, however, throughout the Saxon period (Lewis, Mitchell-Fox and Dyer, 2001; Roberts and Wrathmell, 2002; Williamson, 2003; Oosthuizen, 2005, 2010; Hamerow, 2012). The mainstream view of mid and late Saxon agricultural intensification is that it was top-down, i.e. directed by landlords (Dyer, 2002; Blair, 2005b; Rippon, 2010; Wright, 2015), although Hamerow (2012) and Faith (2009) argue that some peasants could have made their own productivity-enhancing investments if they were particularly affluent, or by pooling resources.

The evidence base for analyses of the structure of the Saxon economy has expanded from the documentary record to encompass anthropological observations (Hodges, 1982, 1989), excavated evidence for manufactured goods (e.g. Wickham, 2005), and metal detected finds (e.g. Blackburn, 2019). With each additional source of evidence considered, the mid-Saxon economy is revealed to have been more complex than previously thought.

Hodges (Hodges, 1982, 1989) confined his, highly influential, analysis of goods redistribution to the reciprocal gifting of prestige goods between early-to mid Saxon period English regional kings and their continental counterparts, and posited that these exchanges constituted almost the totality of exchange (describing briefly, but drawing no conclusions from, the presence of Mayern lava querns imported to England in the mid-Saxon period) and giving no consideration to the sources of wealth that allowed for the acquisition of the prestige goods. Addressing these criticisms of Hodges' model, Wickham (2005) argued that any elite prestige exchange must have been underpinned by the commodification and redistribution of bulk goods (agricultural and manufactured) within each regional polity, and that local landowning elites (not just kings) must have been involved in this activity. From the distribution of ceramics as a proxy for regional commodity exchange, Wickham argues for the development of bulk commodity exchange in East Anglia in the early eighth century, and from the distribution of coins throughout that region that this exchange was monetised. Wickham contends that this commercialisation of the economy occurs a century earlier in East Anglia than in other kingdoms, but Moreland (2011) counters that the perceived exceptionalism of East Anglia may be an artefact of a reliance on ceramic evidence. If archaeological evidence for the production of other manufactured goods (e.g. metalwork, textiles, and salt) (Maddicott, 2005; Moreland, 2011), and for the distribution of coins across England (Blackburn, 2005, 2019; Moreland, 2011), is considered, bulk commodity exchange and money use are evidenced across large swathes of eighth century England. This is not to say that the mid, or even the late, Saxon economy was fully marketised; the broad consensus of current opinion is that redistribution via barter exchange and via monetised transactions co-existed, with varying views (amongst those prepared to take a position) on the balance between the two mechanisms (e.g. Bolton, 2012 takes a minimalist position on the degree of monetisation of the late Saxon economy; whilst Fairbairn, 2019 is more bullish).

2.1.3 The Medieval period

In contrast to earlier periods, the evidence base for discussions of High and later Medieval Britain's economy is dominated by documentary sources (Daniell, 2003), especially in relation to agricultural production during the twelfth and thirteenth century heyday of demesne farming (Campbell, 2000). The High Medieval period was, overall, one of growth: of population, urbanisation, international and domestic trade, and of monetarisation. The High Medieval rural economy was able to produce enough surplus to provide for the growing urban consumer population of England and Scotland, the consumption (and the wars) of the ruling class, and a growing export trade (Faith, 1997; Dyer, 2002). Most of the documentary evidence for the export of surplus agricultural produce, however, relates to wool rather than to arable produce (Dyer, 2002).

Many of the economic and political systems that supported market exchange in the High Medieval period, including effective central governance (Langdon and Masschaele, 2006; Routt, 2013), state backed coinage (Dyer, 2002; Ten Harkel, 2017; Kelleher, 2018), and regulated trade in towns (Dyer, 2002; Woolgar, 2016), had been in place in Late Saxon England, but expanded during the High Medieval – particularly across northern England and Scotland. A political and legal environment conducive to trade was not, however, constant across all times and places: the Harrying of the North, the Anarchy period, and the Scottish Wars of Independence all disrupted regional economies

(Daniell, 2003; Creighton and Rippon, 2017). Whilst the impacts of the earlier conflicts on agricultural productivity are more hypothesised than evidenced, the importance of internal peace may be inferred from the late twelfth/thirteenth century synchronicity of political stability and economic growth (Dyer, 2002).

Investments that facilitated the High Medieval expansion of marketised trade were made by private individuals rather than the state. The construction of new towns, funded by aristocratic and ecclesiastical landowners, brought urbanism to previously rural areas of Wales and northern England, at the frontiers of Norman control (Griffiths, 2000; Kermode, 2000; Lilley, 2017). In Scotland the burghs introduced by David I as part of a package of policies imitating the Norman state infrastructure were concentrated in the southern and eastern coastal lowlands (Dennison and Simpson, 2000; Lilley, 2002), the most productive arable region but also facing the markets of continental Europe. Towns were a market for surplus demesne production, but this was not the only way in which they generated revenue for their founders who received rents from inhabitants and market stallholders, tolls from visiting traders, and court fines (many are documented for failures to conform to weights and measures legislation) (Beresford, 1967; Dyer, 2002). If, as Beresford (1967) suggests, diminishing marginal returns had set in for agricultural production, towns may have been a higher yielding alternative investment. Access to major trading routes (roads or waterways) appears to have been a deciding factor in determining whether or not an existing settlement expanded and in the siting of new towns (Beresford, 1967). The increasing importance of commercial exchange in the late twelfth and thirteenth centuries may also be inferred from the proliferation of market charters and the addition of marketplaces to existing villages and towns (Lewis, Mitchell-Fox and Dyer, 2001; Lilley, 2017).

By 1300, at least in the east Midlands and south-east England, many farmers had the choice of two or three commercial centres within a day's ride (Lewis, Mitchell-Fox and Dyer, 2001). The use of horses instead of oxen for haulage reduced journey times from producer to market and Langdon (1986) proposed horse haulage as a causal factor in the growth of the market economy. However, where available, riverine and coastal transport was perhaps 1/3 of the cost of road haulage (Dyer, 2002; Blair, 2007). Port and purveyance accounts record that the river ports of East Anglia and the Thames Valley, and the coastal ports of the eastern seaboard, were entrepôts for London's grain supplies (Campbell, 1995; Gutiérrez, 2018). The investment in port facilities that began in the late Anglo-Saxon period continued with the construction of waterfront revetments, docks, and cranes (Dyer, 2002). Investment in warehousing seems to have been a largely private sector concern, and closely connected with the wool trade (Dyer, 2002), whilst government purveyance provisioning of grain made use of temporary, repurposed storage facilities on an ad hoc basis (Claridge and

Landgon, 2011; Woolgar, 2016). The thirteenth century increase in the use of horses rather than oxen for haulage reduced journey times from producer to market. Langdon (1986) identified the adoption of the horse as a causal factor in the growth of the market economy, but, where available, riverine and coastal transport was perhaps one third of the cost (Dyer, 2002; Blair, 2007) and so still more suited to bulky, low value commodities.

The majority of recorded transactions at High Medieval fairs were between merchants, not between merchants and end consumers, whilst the accounts of ecclesiastical estates and of institutional purchasers (such as those of King's College, Cambridge) show agricultural produce moving from producer to merchant via private sale arrangements rather than via open market sale (Dyer, 2002). This evidence implies that town and village markets were mostly places of small-scale transactions for household provisioning. Zooarchaeological evidence for the urban butchery of meat into small joints suggests regular household scale purchases of small quantities, and the emergence of the role of "cater" or "caterer" responsible for purchasing food for great households also suggests the increasing importance of procurement from the market (Woolgar, 2016, pp. 206–7).

The fourteenth century saw a combination of shocks to the economy. Across England government demands for tax to fund war with France as well as with Scotland deprived farmers of working and investment capital (Campbell, 1995; Dyer, 2002), whilst purveyance demands for grain (purchased, at best, well below market price) increased (Campbell, 1997b). Heavy rainfall caused harvest failures, cattle murrain killed plough animals, and the bubonic plague ravaged the human population (Lamb, 1977, 1995; Flohn and Fantechi, 1984; Campbell, 1995, 2011; Epstein, 2009; Woolgar, 2016). Britain's population halved (Lewis, Mitchell-Fox and Dyer, 2001; Dyer, 2002) causing lasting change in the market for foodstuffs. On the supply side labour shortages increased wage rates (Faith, 1997; Campbell, 2016), increasing costs of production on demesne farms dependent on hired labour. On the demand side, the dramatic reduction in consumer numbers, and the increased purchasing power of those remaining gave the lower status members of society the ability to diversify their diet and increase their consumption of previously "elite" foods (Woolgar, 2016; Gidney, 2018; Pluskowski, 2018). As labour shortages brought about higher rural wages and improved working conditions, the incentives for peasants to migrate from country to town reduced. International trade became increasingly concentrated in the capital cities London and Edinburgh (Dyer, 2002).

2.2 Emerging consumer groups

Throughout the study period, the rate of urbanisation was discontinuous and new social elites (the Roman military, and the Saxon and Medieval aristocrats and clerics) emerged. Common to all these groups is their demand for the surplus produce of others. Overall, increasing consumer demand for food may have stimulated increased production, particularly in the immediate hinterlands of consumer settlements (Simon, 1981; Boserup, 1983, 1993; Perring, 2002; Salway, 2002a), and consumers' preferences for specific products may have influenced the agricultural strategies (such as crop choices) implemented by farmers (Oosthuizen, 2010; Blockmans, 2014; McKerracher, 2014a).

Food is a necessity, but it is also an expression of identity. Following Goody's (1982) seminal work exploring foodways as signifiers and reinforcers of socio-cultural status and affiliations, many researchers have focussed on the cultural significance of food preparation and consumption in pre-modern societies. Studies have aimed to identify artefactual and ecofactual (zooarchaeological and archaeobotanical) signifiers of group diets (e.g. King, 1984; Allason-Jones, 2001; Cool, 2006; Woolgar, 2006; Livarda, 2008). However, it is increasingly being recognised that abstention from the consumption of particular foods may also be an expression of an individual or group's values and status (Potter, 2002; Jotischky, 2011) and the interpretation of the absence of archaeological material is far more problematic than the interpretation of its presence.

2.2.1 Archaeological and historical context

2.2.1.1 The Romano-British period

The Roman occupation introduced two new consumer groups to Britain: the military and town dwellers. The mobilisation of large numbers of soldiers and administrators to impose Roman rule brought migrants with a variety of dietary traditions from across the Roman Empire to the new province. Changing patterns of consumption also occur in the countryside with the development of villas: these architecturally distinctive and highly archaeologically visible settlements are associated with elite consumption (e.g. Taylor, 2001; Esmonde Cleary, 2007) as well as with large-scale agricultural production (e.g. Branigan, 1977; Starr, 1982; Branigan, 1989; Branigan and Miles, 1989; Huskinson, 2002; Bowman and Wilson, 2013a).

Estimates of the military population range from 0.5% (Millett, 1992) to 3.4% (Potter and Johns, 1997) of the total population of Britain, and to the number of soldiers would have been added their families and their retinues of servants, slaves, and other camp followers (James, 2001). Moreover, their impact may have been disproportionate to their number, as they arrived suddenly in the previously sparsely settled countryside of north and west Britain. Synthetic studies of several artefact types have identified commonalities between assemblages at different Romano-British sites with military influence, and differences between assemblages from military and civilian settlements, that suggest a common, distinctive, military food culture. Compared to other categories of site (civilian urban and rural) forts yield zooarchaeological evidence for the consumption of more beef and pork, and for the consumption of less lamb/mutton (King, 1984, 1999; Dobney, 2001; James, 2001; Cool, 2006; Maltby, 2016). They also yield more amphorae sherds and archaeobotanical remains suggesting the consumption of imported foodstuffs: wine, olives, olive oil and *garum* (Cool, 2006; Stallibrass and Thomas, 2008), and exotic food plants (Livarda, 2008, 2011; Livarda and van der Veen, 2008; van der Veen, Livarda and Hill, 2008). Although Roman authors described barley as an inferior food grain to wheat – in the military context it was described as punishment rations and food for those unproven in battle (Clough, 1865; Shuckburgh, 1889; Milner, 1993) – archaeobotanical assemblages from military granaries containing large quantities of cleaned barley grain indicate its consumption by the soldiers of infantry regiments, not just by cavalry horses (Cool, 2006). Tableware suggests that the way in which food was consumed also differed between military sites and civilian rural settlements: individual dining at the forts is suggested by a high proportion of bowls and dishes (i.e. vessels associated with individual place settings) within ceramic assemblages, whereas jars suggestive of communal service predominate on rural sites (Evans, 2001; Cool, 2006).

The staple and the luxury aspects of soldiers diets seem to derive from different food traditions: the staples of beef and cereals are similar to the dietary traditions of Gaul and Germany (King, 1984, 1999); the consumption of imported fruits, herbs, and spices evokes tastes of the Mediterranean (van der Veen, Livarda and Hill, 2008). Although there are dietary communalities between forts, there is not homogeneity. Some variations have been proposed as status based: pork, the meat of choice in Roman food culture (Apicius, 1958; King, 1999), is better represented in zooarchaeological assemblages from legionary forts than in assemblages from auxiliary forts (King, 1984), whilst others may have been cultural: variations in the proportions of barley and wheat recovered from military stores may reflect the different culinary preferences of each unit, with barley preferred by soldiers originating from northern European provinces (Alcock, 2001; Cool, 2006).

The late Iron Age saw the development of *oppida* but the Romano-British period of urbanism was unprecedented (Cunliffe, 2004; Pitts and Perring, 2006; Jones, 2007). The variety of settlement forms included the "public" towns (*coloniae*, *municipia*, and *civitas* capitals) with legally defined roles in the devolved administration of the Roman state, the *vici* adjacent to forts, and the "small town" nucleated settlements established along the new road network (Jones and Mattingly, 1990; Wacher, 1995; Ordnance Survey, 2016). Estimates of the urban population range from 6% to 13% of the total population (Millett, 1992; Potter and Johns, 1997; Hingley and Miles, 2002), with the upper end of these estimates representing a level of urbanisation unsurpassed until the Industrial Revolution (Jones, 2007). Romano-British urban dining was similar in several ways to that in the forts: levels of beef and pork consumption may have been even higher; amphorae sherds evidence the consumption of imported processed foods and archaeobotanical remains evidence the presence of some imported food plants, albeit at lower levels than in the forts and most often in towns with military connections (Cool, 2006; van der Veen, Livarda and Hill, 2008). Tableware finds again suggest individual place settings rather than communal service (Evans, 2001; Cool, 2006). Skeletal evidence from urban cemeteries reminds us of the socio-economic variations within towns: with individuals exhibiting skeletal changes associated with diabetes and obesity tending to be associated with elite burial styles in cemeteries at Cirencester and London, whilst others from non-elite burials show evidence of vitamin C deficiency (Cool, 2006).

Most evidence for dietary change connected to immigration relates to imported luxury foodstuffs. Whilst migrants with connections to the military or access to large towns may have been able to maintain a sense of their original foodways using imported condiments and fruits (van der Veen, Livarda and Hill, 2008), isotopic analyses of their bone collagen and dentine suggest they adapted their staple cereal diets to consume the species long-established in British food culture. Individuals raised on childhood diets rich in C_4 plants (suggesting an Eastern European origin, with significant consumption of millet) were consuming diets rich in C_3 plants (which include wheat, barley, oats, and rye) at the end of their lives (Eckardt *et al.*, 2009; Chenery, Eckardt and Müldner, 2011; Müldner, Chenery and Eckardt, 2011).

Perhaps the most striking evidence for dietary differences between the nucleated urban and military settlements and the native rural sites of Roman Britain comes in the form of zooarchaeological evidence. Animal bone assemblages from native rural sites associate this site category with the lowest levels of beef and pork consumption, and the highest levels of lamb/mutton consumption. These meat preferences suggest a continuation of Iron Age patterns of consumption (King, 1999; Cool, 2006). Another continuation of Iron Age traditions can be seen in tableware assemblages, with no transition towards the use of individual bowls and dishes. A further difference between ceramic assemblages from native rural and urban/military sites is the rarity of amphorae sherds at the former sites, suggesting the (usually imported) foodstuffs contained within them did not often reach the countryside (although it is possible that some small quantities did, in re-packaged form) (Evans, 2001; Cool, 2006). Some changes did occur, however, in the archaeobotanical remains found in the countryside over the course of the Romano-British period: with finds of new herbs, fruits, and (most often) vegetables appearing on rural sites in south-eastern England, suggesting they were taken into local cultivation (van der Veen, Livarda and Hill, 2008). Villas are (by definition) associated with distinctive architectural and decorative material culture, but there is less bioarchaeological evidence for the consumption of a distinctive diet: van der Veen, Livarda, and Hill (2008) found no distinction between villas and native rural settlements in the frequency of finds of new food plant introductions. At individual villa sites there is zooarchaeological evidence for the consumption of pork and chicken (as at urban and military sites), as well as for fish, leading Cool (2006) to posit these meats as potential indicators of high status.

2.2.1.2 The Saxon period

In the fifth century, following Roman military and administrative withdrawal, archaeological evidence for social complexity disappears (Wickham, 2005; Esmonde Cleary, 2012). Occupation by reduced numbers of people, living in much reduced circumstances, continued in some of the former public towns. These now functioned as ecclesiastical centres for Christian bishoprics (Astill, 2012; Henig, 2012; Blockmans, 2014). Although there is no evidence that these settlements retained consumer economies or control over the agricultural produce of their rural hinterland, zooarchaeological evidence shows that some of their inhabitants were eating fairly large quantities of venison and pork (Holmes, 2014), both meats associated with elite consumption in the mid and later Saxon period (Hagen, 1992; Albarella, 2006; Sykes, 2006; Banham and Faith, 2014).

Demonstrable social stratification re-emerged gradually after the Roman departure. Sixth century grave goods suggest some minor variations in wealth between individuals in rural communities (Bassett, 1989; Scull, 1993; Faith, 2009), but it was not until the early seventh century that law codes and land charters record the existence of a new secular landed aristocracy. Food renders record payments in kind from peasant farmers to their landlords and give evidence for aristocratic food preferences: wheaten was preferred to oat or barley bread, loaves and ale preferred to grains for pottage, and pork and (to a lesser extent) beef preferred to sheep meat (Faith, 1997; Dyer, 2002; Stone, 2006; Banham and Faith, 2014). Zooarchaeological syntheses describe greater dietary diversity at aristocratic sites (in comparison to non-elite sites) with the consumption of freshwater fish, fowl (domestic and wild), venison and wild boar (Sykes, 2006; Holmes, 2014).

The seventh century also saw the first monastic foundations. The high-ranking ecclesiastics were drawn from the ranks of the aristocracy and monasteries were endowed with land to provide a variety of resources (Hagen, 1992; Dyer, 2002; Jotischky, 2011), so similarities in food consumption at secular and religious elite sites are to be expected. Wheaten loaves were, again, preferred, not just for eucharistic bread but for meals, whilst loaves made from other grains (often barley) were considered fit only for penitents and ascetics (Jotischky, 2011; Banham and Faith, 2014; Woolgar, 2016). With the Church’s links to Rome, senior clerics were especially well-travelled for the period, and their correspondence reveals they often brought back exotic spices which they exchanged amongst themselves (Crawford, 2009). Differences between religious and secular diets increased in the late Saxon period following the implementation of the Benedictine *Regularis Concordia*, which (amongst many other things) forbade the consumption of “flesh meats” (the meat, but not the fat, of quadrupeds). Thus the “ideal” monastic diet relied more heavily on bread, vegetables, fish, and dairy produce than the typical aristocratic diet (Wilson, 1976; Hagen, 1992; Jotischky, 2011; Holmes, 2014). Ideal and reality, are of course, different: deviations from the rule are documented and, over time, many houses returned to meat consumption (Wilson, 1976; Hagen, 1992; Jotischky, 2011). The greatest impact of religious communities on diet may have been indirect: several writers (Hagen, 1992; Cool, 2006; Banham and Faith, 2014) have proposed that the Anglo-Saxon popularity of bread wheat amongst the laity may have been encouraged by clerical culinary preferences.

The *wics* established in the eighth century were the first new “urban” settlements of the Anglo-Saxon period, with known sites distributed one per kingdom in England: Lundenwic (London) in Mercia, Hamwic (Southampton) in Wessex, Eoforwic (York) in Northumbria, and Gipeswic (Ipswich) in East Anglia (Wickham, 2005). There are however several putative sites in Kent, and a second East Anglian emporium may have been located at Norwich (Wickham, 2005; Griffiths, 2011). Following the decline of the wics, the first burhs were constructed in Mercia in the late eighth / early ninth century (Haslam, 1987; Hall, 2012) and in Wessex by King Alfred in the later ninth century (Baker, 2013). The five boroughs of the East Midlands may have been modelled on the Wessex burhs (Hall, 1989, 2012). The urban population of England increased from perhaps 2% to 10% of the total between 850 and the Domesday survey (Dyer, 2002). Zooarchaeological studies consistently associate Anglo-Saxon urban settlements (of all types) with high levels of beef consumption (Bourdillon, 1988, 1994; O’Connor, 1994; Crabtree, 1996; Holmes, 2014), and low levels of lamb/mutton consumption (Hagen, 1992; Holmes, 2014) in comparison to rural sites. Whether or not pork was particularly associated with urban sites (e.g. Crawford, 2009; and Holmes, 2014 argue for relatively high levels of pig meat consumption in towns; contrary to Albarella, 2006; and Sykes, 2006) remains debated. Later in the Saxon period, as the bone evidence for fish consumption increases, this is better evidenced at urban than at rural sites (Sykes, 2006) . The most commonly proposed difference in cereal consumption between urban and rural sites relates not to the cereal species consumed, but to the manner in which they were eaten: whilst bread and ale were staples for all, pottages are often associated with rural rather than urban diets (Hagen, 1992; Faith, 1997; Dyer, 2002). Whilst many researchers have observed evidence for relatively homogenous diets within the mid Saxon *wics* (Bourdillon, 1988, 1994; O’Connor, 1994; Crabtree, 1996), Serjeantson (2006) observed status based differences within the later Saxon burhs and boroughs: with evidence for the consumption of more fowl, and younger, more palatable quadrupeds, in more affluent suburbs.

2.2.1.3 The Medieval period

England's population increased sharply (possibly threefold) between the late eleventh and early fourteenth centuries. Peasants continued to comprise the majority of the population but there was also an increase in urbanism, monasticism, and the number of minor aristocrats (Faith, 1997; Dyer, 2002).

The Norman conquest effected the almost total replacement of the Anglo-Saxon aristocracy. The need of the new Norman earls and barons to reward their knights for military service increased the numbers of lesser aristocrats with rural landholdings (Faith, 1997). The new Norman elite brought their patterns of consumption with them: their foodways were characterised by preferences for game meats (Woolgar, 2016; Gidney, 2018; Pluskowski, 2018) and (like the Saxons before them) bread wheat (Kapelle, 1979; Stone, 2006). Although the aristocrats themselves preferred wheaten bread, at the household level a range of cereals was demanded for different purposes and consumers: barley was usually the preferred brewing grain (Lewis, Mitchell-Fox and Dyer, 2001; Dyer, 2002), bread made from barley or from mixed grains (and sometimes pulses) was deemed adequate for feeding servants and paupers (Woolgar, 2016), and oats were needed for fodder (Dyer, 2002; Stone, 2006).

There were broad similarities but subtle differences between monastic and secular aristocratic diets. Wheat consumption was characteristic of both groups: hagiographers may describe penitent saints subsisting on barley bread, but monastic accounts record monks eating wheaten loaves while giving barley bread as alms (Woolgar, 2006; Jotischky, 2011). Meat consumption varied with the order and the gender of houses. The consumption of game was more common in male houses, although zooarchaeological assemblages (containing greater proportions of hare, and roe rather than fallow deer) suggest monasteries held lesser hunting rights than secular aristocratic households (Jotischky, 2011; Gidney, 2018; Pluskowski, 2018).

Urban expansion ended in the fourteenth century. The depopulation wrought by the plague was significant, and not all towns recovered: labour shortages brought about higher agricultural wages and better working conditions, incentivising a return to rural employment (Hoskins, 1984; Dyer, 2000). Increased wages and lower demand for food translated into increased purchasing power for the peasantry, who diversified their diet and increased their consumption of previously "elite" foods such as meat and wheaten bread (Faith, 1997; Woolgar, 2016; Gidney, 2018; Pluskowski, 2018). To maintain a sense of social differentiation the aristocracy further diversified their meat diet; zooarchaeological assemblages evidence the consumption of a wider range of game birds

(Pluskowski, 2018) and high status cookbooks reveal elite preferences for dishes made with imported spices rather than locally grown herbs (Woolgar, 2016, p. 12).

2.2.2 Archaeobotanical studies and potential

The emergence of distinct consumer groups raises two questions that may be addressed by the analysis of archaeobotanical remains: whether the sites of production of arable produce can be distinguished from sites where only consumption took place, and whether socio-economically distinct consumer groups can be distinguished from each other on the basis of their food choices.

The question of whether consumer sites can be distinguished from sites of agricultural production on the basis of archaeobotanical evidence was considered by M. Jones (1985). Cereal grain is a valuable commodity in its own right and especially compared to cereal chaff. Consequently it is expected that care would be taken to avoid wasting it. Archaeobotanical assemblages rich in grain should therefore be relatively uncommon, and when they are found they require explanation (van der Veen and Jones, 2006). M. Jones (1985) devised a model that interpreted grain-rich, or chaff- and weed-rich, assemblages as deriving from sites with different economic functions. He hypothesised that since grain accrues value as it moves from farmer to consumer, most care would be taken to avoid wastage at consumer sites; here only contaminants (chaff and weed seeds) would be deliberately discarded. Grain would be most likely to be discarded at producer sites when cereals were being processed in bulk, for example in the floor sweepings produced after threshing or winnowing. On these grounds he interpreted assemblages containing high percentages of grain as characteristic of producer sites, and assemblages containing high percentages of chaff and weed seeds as characteristic of consumer sites. However, van der Veen's (1992) application of this model to Iron Age and Romano-British data produced classifications contradicted by other types of archaeological evidence, leading to the critique produced by van der Veen and G. Jones (2006) which sets out the reasons why the conclusions drawn from M. Jones' (1985) model are unreliable.

Van der Veen and Jones (2006) point out that Jones' (1985) underlying hypothesis is contrary to ethnographic observations of traditional cereal processing in Turkey (Hillman, 1981): here producer-site assemblages were characterised by large proportions of cereal culms and rachis (the waste products of early-stage crop processing), and consumer-site assemblages were grain rich. Jones' model also fails to allow for the biases introduced by the handling of differing proportions of glume wheats and free-threshing cereals at different sites. Glume wheat chaff is removed at a later stage of processing (and more often within household contexts) compared to free-threshing cereal chaff. Consequently, glume wheat chaff is more likely to be exposed to fire. Sites where larger proportions of glume wheats were handled are therefore more likely to produce chaff-rich charred assemblages (irrespective of the site's economic function). Furthermore, Jones' (1981) analysis of data at the assemblage rather than the sample level also means that no account can be taken of the crop processing stages or contexts represented (further factors that influence the relative proportions of cereal grains, chaff, and weed seeds present). The alternative hypothesis proposed by van der Veen and G. Jones (2006) is that differences in the proportion of grain and chaff in samples from different sites reflect differences in the scale of grain handling at these sites (Section 2.3.4 below).

Recent research attention has focussed on the distribution of luxurious, probably expensive, exotic and novel food plants across north-western Europe (e.g. Bakels and Jacomet, 2003; Livarda, 2008; Livarda and van der Veen, 2008). During Roman occupation, military sites are distinguished from civilian sites (of all social statuses) by an association with exotic food plants. In central Europe, Bakels and Jacomet (2003) found that military sites enjoyed earlier access to new (imported and potentially introduced) foods, whilst van der Veen, Livarda, and Hill (2008) found that military sites in Britain and on the Rhine frontier were distinguished by the frequency of finds of imported food plants, although at British sites the diversity of species present was lower and there appeared to be less spread of these new foods to the local civilian population. The other distinctive consumer sites of Roman Britain (van der Veen, Livarda and Hill, 2008) were the major towns; again these were characterised by finds of exotic taxa. Villas were not distinguished from non-elite rural sites in such a manner (both categories of site were relatively unlikely to yield finds of new food plants), suggesting that, rather than reflecting social status, cultural affiliations, or affluence, the main determinant of consumption of new foods was accessibility. The siting of the few minor settlements yielding exotic taxa, along major transport routes or at likely trading hubs supports this interpretation. The difference apparent within the rural dataset was between sites (of any status) in the south east of England and those elsewhere: south eastern sites yielding a greater variety of species (including herbs, vegetables, and fruits), a difference attributed not to socio-cultural differences in diet on rural sites in the south east, but to the presence of urban demand and good transport infrastructure in the south east incentivising local rural cultivation (i.e. horticulture and orcharding) for trade. In the Medieval period (Livarda, 2008) a clearer distinction between urban and rural sites emerges. Urban sites now have the greatest variety of food plants, and are characterised by the presence of herbs, fruits, and rare imported taxa, whilst rural (peasant) sites are associated with vegetables and lentils. That herbs and fruits are now associated with towns rather than the countryside suggests not just distinctive urban dietary patterns, but distinctive means of provisioning the towns: by urban gardening and orcharding, rather than by trade with the countryside. Socio-economic differences emerge in the countryside for the first time, with a much greater variety of species found at rural elite (secular and religious) sites compared to peasant sites. Dietary variety (in horticultural and orchard produce) is now a hallmark of elite sites regardless of settlement type (urban or rural) and monastic or secular status.

The consumption of different cereal species also has status connotations, and the prospect that analysis of cereal taxa present and abundant at different types of consumer site could yield insights into the food consumption of particular socio-economic groups is raised by Britton and Huntley's (2011) analysis of the cereal bran content of faecal deposits from three Romano-British sites in north-west England. This revealed the expected inverse relationship between social status and barley consumption: at the legionary fort in Carlisle (garrisoned by Roman citizens) hardly any barley consumption was evidenced, whilst at Birdoswald (a minor fort garrisoned by provincial auxiliaries) much more barley was consumed. Still higher were the levels of barley consumption at the civilian settlement studied: the *vicus* at Carlisle. These results must be interpreted cautiously, however, as status is not the only difference between the two forts: the Birdoswald samples are of a much later date and it is possible that the cereal component of the military diet adapted over time to take account of local foodways and resource availability.

There is, however, a dearth of studies comparing charred cereal assemblages from sites of different status or settlement type. De Hingh and Bakels' (1996) comparison of cereal remains from the seventh to eighth century manor house and peasant village at Serris-les Rouelles, France illustrates some of the difficulties that could be encountered. Differences in architecture, consumer goods, and animal bone assemblages suggested status differences between the two communities, but no such distinction was apparent in the archaeobotanical data. An expected contrast between the frequency of presence of bread wheat (associated with elite consumption) and rye (associated with peasant consumption) in contexts from the two sites did not appear: the same five cereals were identified, and bread wheat was the most frequently present species in samples from both sites. De Hingh and Bakels propose two possible explanations: that archaeobotanical evidence may not be a sensitive indicator of socio-economic status, and that communal food preparation had obscured signs of social differentiation. At Serris-les Rouelles there was very little spatial separation between the manor house and peasant dwellings. This is not a unique problem, and even when manor houses are clearly spatially separate from peasant dwellings, the obligations of elite households to provide alms and to feed servants and other employees make them places of both high- and low-status food consumption. The consumption of cereals by animals can also confound inferences of status made on the basis of archaeobotanical assemblages: barley is both (an inferior) human food and fodder; and oats may have been regarded as an inferior food grain associated with Medieval peasant cooking (Stone, 2006; Woolgar, 2016), but they were also fed to horses, luxury animals owned by the rich (Langdon, 1986; Moffett, 1994). The quantification methodology used by De Hingh and Bakels (1996), recording the presence but not the abundance of taxa within samples, may also have obscured differences between the high and low status sites. Instead of looking for different species, variations in the relative importance of the established species must be identified.

2.3 Demand and supply in the agricultural economy

Once (some) consumers live apart from agricultural producers, goods must move between the two groups. Although surplus agricultural production (i.e. levels of production above household needs) is a prerequisite for any economic system more complex than pure subsistence farming, it is not sufficient evidence of economic complexity. Even within subsistence economies some level of deliberate overproduction to create a "normal surplus" that buffers against the risk of poor harvests is common (Allan, 1977; Forbes, 1989, 2016; Halstead, 1989). The identification of surplus agricultural production alone cannot, therefore, be considered sufficient proof of the existence of a market economy.

Most of the archaeological evidence for the movement of crops relates to imports, and therefore to luxuries. During the study period the distance over which agricultural produce moved varied; the broad trends are well known (international exchange increased during the Roman period, contracted in the early Saxon, and expanded again in the Medieval) but in each temporal period there were disruptions caused by political instability. The distance over which goods were moved also varied according to the consumers they were destined for. The international connections of the Roman military and state administrators facilitated long-distance trade, but the emergence of the landed aristocracy in the Saxon and Medieval periods would have resulted in relatively little movement of produce, with the lesser gentry living on or near the estates on which their food was grown. The ability of farmers to connect with consumers would have varied according to the density and distribution of urban, or other consumer, settlements, their access to (and the state of) road or water transport networks, and the suitability of their particular crops for transport.

The reallocation of surplus to consumers may be achieved by several non-market mechanisms. Even at the end of the study period the more "primitive" methods of redistribution remained features of the British economy: many Saxon and Medieval contracts record renders and tithes payable in kind not cash (Faith, 1997; Dyer, 2002), and the gifting of food in acts of commensality, hospitality, and charity was a feature of social life and relationship building into the late Medieval period (Woolgar, 2011, 2016). The relative importance of these re-allocative mechanisms fluctuated during the study period; although the overall trend was towards an increasingly marketised economy, episodic environmental changes and political events precipitated reversions to subsistence farming. Subsistence and market-orientated farmers have different aims and make their decisions in response to different incentives. Ethnographers and economists associate subsistence farming with satisficing rather than maximising aims, and with risk-reducing strategies (Wolf, 1966; Forbes, 1976; Ellis, 1993). Market-orientated farmers are more motivated by profit-seeking, resulting in the selection of strategies to reduce costs of production and/or increase revenues from sales (Ellis, 1993; Parkin, 2010). Whilst some peasant farmers may have been partially profit-motivated, they are unlikely to have been profit maximisers. Their limited resources (of land, labour, and capital) would have prevented the implementation of costly changes and given farmers little or no buffer against their failure. In a changing economy, where any markets were likely to be imperfect, unpredictable, or difficult to access (Ellis, 1993), famers would still have needed to produce for their own needs so we might expect a combination of subsistence and trade-orientated behaviours. If farmers were able to choose whether or not, what, and how much, to produce for exchange, this decision would have a partially economic basis (i.e. based upon the resources available to them, and the expected rewards), but also a socio-cultural basis (i.e. upon group and individual attitudes to trade-offs between risk and reward, and, in the Romano-British period, on their willingness to participate in an economic system imposed by an occupying culture).

2.3.1 Archaeological and historical context

2.3.1.1 The Romano-British period

In addition to the emergence of new consumer groups in the form of the Imperial Roman Army (Fulford, 1992; Breeze, 2002; Bowman, 2003; Hanson, 2007; Carrington, 2008) and town-dwellers (Simon, 1981; Boserup, 1983, 1993; Condron, Perring and Whyman, 2002), Roman rule brought about further changes to the economy within which British farmers (within or proximate to the occupied area) were operating. State investment in the road network and the *cursus publicus* (imperial courier service) facilitated the movement of personnel, resources, and information for the military and state administration (Brodersen, 2001; Kolb, 2001; Laurence, 2001; Foubert and Breeze, 2014) but would also have facilitated the movement of goods, whether directed by the state or private entrepreneurs. International trade, in particular, may have been encouraged by the introduction of internationally standardised laws, currencies, and political institutions (Scheidel, 2012; Silver, 2012). Whilst the potential for an increase in commercial exchange is clear, the evidence that this potential was realised is patchy. The majority of archaeological evidence for increased trade in the Romano-British period relates to imported products (Cunliffe, 2004, 2007, 2013; Lodwick, 2014b). The economy within Britain is less well evidenced. No documentary evidence describing the provisioning of the British public towns survives, but in other provinces the administrators of similar settlements received rents and tribute from farmers in their rural hinterlands (Breeze, 2002). Although patterns of consumption common to military sites have been identified, individual forts may have been free to organise their own procurement, potentially employing purchase, requisition, taxation in kind, and direct production, and combining local sourcing and importation (Breeze, 2002; Fulford, 2002; Bowman, 2003).

The production of large quantities of agricultural surplus did not occur for the first time in Roman Britain: on Iron Age sites, surplus cereal production is often inferred from the presence of large scale storage features (e.g. Bakels, 1996; Groot *et al.*, 2009; Groot and Lentjes, 2013). From the Romano-British period onwards grain storage on rural sites actually becomes less archaeologically visible: with a shift away from the use of pits, towards above ground storage in multi-purpose barns. Bulk grain storage facilities are associated with consumer demand: their numbers peak in the second and third centuries, and are most densely concentrated in central England, around London, and in the north-western military zone (Taylor, 2001; Fowler, 2002; Smith, 2016a), mirroring the distribution of the civilian towns and the military forts and *vici* (i.e. the consumer settlements).

A new, archaeologically distinctive, structure associated with cereal processing appears for the first time during the Roman period: the corn dryer. Corn dryers vary stylistically but all consist of three parts: a fire-stoking area, connected by a flue to a grain-heating chamber (Reynolds and Langley, 1979; Monk and Kelleher, 2005; McKerracher, 2014b). Various functions have been proposed for corn dryers, some of which can be linked to the scale of agricultural production and processing: parching grain transforms it into a stable product suited to long-term storage (Lacey, 1972; Hillman, 1981; Hill, Lacey and Reynolds, 1983) and may make it easier to process large quantities, whether this involves milling (Bowie, 1979), the dehusking of glume wheats, or the removal of the lemma and paleas of hulled barley (Hagen, 1992; Cool, 2006; contra Samuel, 1993, 1999). Other possible uses, the baking of bread (Moffett, 1994) and malting of grain (Reynolds and Langley, 1979; Jones, 1981; Alcock, 2001; Stone, 2006), are not directly linked to the scale of production, but they do have commercial potential. The drying of under-ripe or damp grain (van der Veen, 1989; Campbell, 2010), however, relates to environmental rather than to economic conditions.

Documentary evidence relating to Romano-British imports and exports of agricultural produce is scant: Strabo (Strabo, 1923, 4.5.2) listed grain and cattle among the exports of late Iron Age Britain, and there are records of cereals being exported to provision the army on the Rhine frontier in the fourth century AD (Mattingly, 2007, p. 505). A trend common to many Roman provinces was for the volume of Italian imports to peak shortly after occupation and then decline as local centres of manufacturing were established (Silver, 2012). In Britain, trends in the abundance of amphora sherds (proxies for the importation of olive oil, wine, and garum) (Fulford, 1992, 2002; Mattingly, 2007, p. 322; Silver, 2012) conform to this pattern. Finds of many exotic (i.e. necessarily imported) food plants also decline within the period of Roman occupation, but the timing of their decline varies: occurring in some localities between the early and mid Romano-British periods, but later (between the mid and late sub-periods) in others (van der Veen, Livarda and Hill, 2008). It is impossible to say on the basis of similar evidence whether or not staple cereals followed this pattern: the most common species (hulled barley, spelt, and emmer) of Roman Britain were cultivated both domestically and on the European mainland, and their movement is not associated with archaeologically durable and distinctive containers. An increase in flightless grain pest species has been interpreted as evidence for the large scale importation of grain to Britain (Buckland, 1981; Smith and Kenward, 2011), and their arrival in northern England at the same time as the Roman army suggests that the garrisons were receiving this imported grain (Smith and Kenward, 2011). The conquest would have been highly disruptive to rural life, and imported supplies might have been needed most during the first century AD. Other imported foods were reaching first and second century military sites (Fulford, 2002; Livarda, 2008, 2011; Livarda and van der Veen, 2008; van der Veen, Livarda and Hill, 2008) and shipwrecks in other provinces show that large cargoes of grain were moving around European waterways (Pals and Hakbijl, 1992; Bakels, 1996).

The first and second centuries were the heyday of the Romano-British public towns, while a decline in urban finds of coins, and in the archaeological evidence for manufacturing (pottery and metalworking) suggests a contraction of urban economic activity in the third century (Reece, 1991, 1992, 1993; Pitts and Perring, 2006; Jones, 2007). Although there is a general consensus that the public towns were dependent upon the agricultural surplus of others, their means of acquiring this remain obscure (Condron, Perring and Whyman, 2002; Cunliffe, 2004, 2013; Jones, 2007; Moore, 2012, 2017). Evidence from other provinces shows the dependence of these towns on rents and tribute from rural agriculturalists, payable in cash or kind (Breeze, 2002). The later fourth century repurposing of urban public and domestic buildings into granaries and corn dryers suggests the re-engagement of the urban populace with the processing and storage of arable surplus (Barker, 1975, 1997; Wacher, 1995; Esmonde Cleary, 2007), perhaps reflecting increased need for private citizens to ensure the security of their food supplies. Late Romano-British period changes in the distribution of exotic food plants (spices, fruits, and nuts) also suggest changes in the mechanism by which towns were provisioned with foodstuffs – increasingly regionalised variation in their distribution suggests a decentralisation of provisioning consistent with a transition from state-directed importation to private enterprise (Orengo and Livarda, 2016).

The "small towns" sited alongside roads and rivers are the most poorly understood type of Romano-British settlement. It is still unclear whether they were centres of distribution, trade, consumption, or agricultural production. A few sites were obviously centred on industries, such as pottery at Bainesse Farm (Busby *et al.*, 1996) and Redcliff (Lyne, 2002), and salt extraction at Stanford Wharf (Allison, Biddulph and Collins, 2012), Nantwich (Arrowsmith and Power, 2012), and Middlewich (Williams and Reid, 2008); but at most small towns there is an absence of evidence for any kind of economic activity (Burnham and Wacher, 1990; Reece, 1992; Burnham, 1995; Millett, 1995; Burnham *et al.*, 2001; Hingley and Miles, 2002; Mattingly, 2007). Their situation on transport routes has inspired suggestions that they were centres for the aggregation and onward distribution of agricultural surplus (Perring, 2002; Pitts and Perring, 2006) but, although corn dryers are frequent, granaries and market places are not (Smith, 1987; Burnham and Wacher, 1990; Rust, 2006). An alternative suggestion is that the inhabitants of small towns did not directly involve themselves in the distribution of produce, but profited from it by charging tolls at river crossings, or by providing services to travellers (Burnham and Wacher, 1990; Allen and Smith, 2016).

The spatial coincidence in southern and eastern England of most of the public towns, with a concentration of archaeological evidence for agricultural change offers some support for the contention that the demands of larger towns stimulated agricultural production (e.g. Hopkins, 1980; Simon, 1981; Boserup, 1983, 1993; Condron, Perring and Whyman, 2002; Salway, 2002a). This is the region where the earliest architecturally Romanised farmsteads and villas were built, and where most of the rural sites with evidence for the cultivation of new fruits and vegetables occur, and where there is most evidence for Roman period livestock improvement (Albarella, Johnstone and Vickers, 2008; van der Veen, Livarda and Hill, 2008; Allen, 2014, 2016b; Maltby, 2016; Smith, 2016c, 2016b). Patterns of coin loss suggest the operation of monetised markets within the public towns (Reece, 1991, 1993; Condron, Perring and Whyman, 2002), forts (Bowman, 2003, pp. 34–41), and between forts and their *vici* (Allason-Jones, 2001, 2016). In contrast, coins and consumer goods are very rarely recovered from native rural settlements (Taylor, 2001; Potter, 2002; Mattingly, 2007; Brindle, 2017) although they are often found at villas (Allen, 2016a, 2016b; Smith, 2016b, 2016c).

The villas of central and southern England have long been interpreted as centres for the production and processing of agricultural surplus for market sale on the basis of their spatial association with towns; the quantities of capital invested in their construction, decoration, and large scale crop processing and storage facilities; and the assemblages of consumer goods and coins commonly found (e.g. Applebaum, 1972; Branigan, 1977, 1989; Branigan and Miles, 1989; Huskinson, 2002; Bowman and Wilson, 2013b). The association of villas with farming for private profit is so strong that their absence from the East Anglian fenlands inspired suggestions that the area must have been an Imperial estate and not an area of private enterprise (Potter *et al.*, 1981; Frere, 1991), although in fact villas have been found on Imperial estates in other provinces (Mattingly, 2007; Bowman, 2013).

Because they are so distinctive and archaeologically rich, villas have been subject to a level of academic interest that belies their relative scarcity (Hingley and Miles, 2002; Salway, 2002b). Most farming will have been conducted outside the villa system, where there were other innovations in rural settlement. A style of farmstead that increased in frequency across Britain during the later first and second centuries had yard and enclosure complexes suited to livestock handling (Allen, 2016a; Allen and Smith, 2016; Smith, 2016a, 2016c). Such facilities may suggest an increase in the number of animals reared, or alternatively an increased intensity of livestock management necessitated by the expansion of arable cultivation onto land previously used as pasture. Whilst the absence of archaeological evidence for the returns from trade on native rural sites has been used as an argument against the involvement of native Britons in the sale of surplus agricultural produce (Pitts and Perring, 2006), a counter argument can be made that rather than spending on culturally “Roman” goods, investment in increasingly substantial farm buildings, in livestock, or in the expansion and improvement of arable land may have been the preference of those who rejected Roman cultural norms (Taylor, 2001, 2013; Potter, 2002; Mattingly, 2007; Brindle, 2016). Allen and Smith (Allen, 2016a; Smith, 2016c, 2016b) found a spatial correlation between the new road network and the siting of new rural settlements in central, east, and north-east England during the late first and second centuries. The new complex farmsteads (associated with more intensive livestock, and possibly arable, farming) were often closer to the major road network than were villas (Allen, 2016b), suggesting native farmers were in fact concerned with access to consumers. Although water transport has been suggested as more suitable (i.e. cheaper) for bulky products such as grain (Ellis Jones, 2012), no correlation was found between the locations of new rural settlements and navigable rivers (Allen and Smith, 2016).

We still cannot assume all native farmers were equally willing or able to participate in market exchange: those close to urban markets in the civilian administered south may have found trade more profitable than those in the militarised north and west where the monopsonistic purchasing power of the military might have made markets neither free nor fair. Tacitus (1967) describes native farmers being compelled to oversupply the garrisons, and then to buy back produce at inflated prices to meet their own subsistence needs.

There is little evidence of the extent to which forts were (or were not) integrated with their local economies. Similarities between coin, ceramic, glass, and plant assemblages evidence economic similarities between forts and their adjacent *vici*, but there is little artefactual evidence for exchange between forts and local native rural settlements or between *vici* and local native rural settlements (Allason-Jones, 2001, 2016; Taylor, 2001; Livarda, 2008, 2011; Livarda and van der Veen, 2008). The collapse of most *vici* following military withdrawal (Davies, 2007; Brindle, 2016) also suggests that they were poorly integrated with their local rural economies.

The Vindolanda tablets itemise soldiers' privately purchased "extras" (Bowman, 1983, 2003) but the means by which staple cereals were acquired remain obscure. The orders of foodstuffs made by individual soldiers were mostly small quantities of luxury items. The importation of very small quantities of fruits and condiments to the northern frontier is unlikely to have been profitable on its own account, leading Fulford (1992, 2002) to propose that they were piggybacking onto bulk movements of staple produce destined for the garrisons. This would have (at least partially) subsidised the cost of their transportation. The shared distribution pattern of amphorae sherds (ceramic containers for bulky goods) and of exotic food plants found by Livarda and Orengo (2016) supports this contention. The quantities, and the security of supply, demanded by the army may have led them to source their grain from further afield, including from overseas (Frere and Fulford, 2001), and particularly so during times of local unrest, and in the early years of occupation before local provisioning was established.

Some writers regard the militarised areas of north and west Britain as having limited potential for the production of arable surplus, leaving local farmers unable to meet the needs of the garrisons (e.g. Davies, 1997, 2007; Breeze, 2002), but, late Iron Age pollen sequences (Dumayne-Peaty, 1998; Dark, 1999), and archaeobotanical (van der Veen 1992) and zooarchaeological remains (van der Veen and O'Connor, 1998; Breeze, 2002) suggest that (in north-east England at least) the army arrived into a landscape that was already highly productive agriculturally. After the initial upheaval of conquest, local provisioning may have been both feasible and cost-effective. A second century increase in farmsteads close to Hadrian's Wall (Brindle, 2016) suggests a local increase in agricultural activity concurrent with the establishment of permanent garrisons. Evidence of more Romano-British period field systems on the south (compared to the north) side of Hadrian's wall also hints at the intensification of agricultural production within the boundaries of Britannia (Brindle, 2016), although there are difficulties in dating field boundaries with sufficient precision to confirm their concurrence with the period of military occupation.

2.3.1.2 The Saxon period

The collapse of Romano-British urbanism and military withdrawal reduced the demand for agricultural surplus, whilst the collapse of the villa system reduced the size of farms (Esmonde Cleary, 2012). Concurrently, several of the agricultural technologies associated with large scale arable production in the Romano-British period appear to have declined in use: evidence for the continued use of Romano-British corn dryers in the fifth and sixth centuries is rare (Hamerow, 2012; Ross *et al.*, 2017), watermills also disappeared from Britain after the Roman departure (Fowler, 2002) and there is no evidence that the construction of either technology resumed until the late seventh/early eighth century (Hagen, 1992; Hamerow, 2012). Although archaeological evidence for Roman and Saxon period ploughs is too scarce to draw secure conclusions about trends in their use, the collapse of the Roman state-supported iron industry is likely to have resulted in a temporary reversion to wooden tools (Fowler, 2002), and there is little evidence for the widespread adoption of the heavy (mouldboard) plough until the tenth century (Fowler, 2002; Banham and Faith, 2014; Blockmans, 2014). Some writers (Hamerow, 1992; Newman, 1992) have suggested that a shift towards pastoralism and less intensive arable cultivation is evidenced by the predominance of early Saxon rural settlement in areas of light soils; but heavy clay soils were not completely abandoned (Hamerow, 1991, 2012), and their utilisation may be underestimated because of a relative lack of fieldwalking in these areas (Lewis, Mitchell-Fox and Dyer, 2001).

From the seventh century onwards royal grants of rural estates, comprising pasture, woodland, arable land, and rivers, that formed a self-sufficient productive unit, to the aristocracy and the Church created new landlords whose demands for rent and tithes may have stimulated increased agricultural production from peasant farmers (Hinton, 1990; Boserup, 1993). However, citing the food renders demanded by the laws of King Ine of Wessex, Fleming (2011; see also Faith, 2009) argued that, with the burden shared between the tenant farmers of an estate, the impact on individual households would have been minimal. Furthermore, since most of the produce demanded was perishable (for example, bread and ale were demanded rather than grain), lords would have had no reason to extract surplus beyond their immediate needs. There is no evidence that the surplus acquired by landowners was moved onwards to other consumers: even the regional kings were dependent on the produce of their own land, their households moving from one royal estate to another and consuming the produce of each in turn (Lewis, Mitchell-Fox and Dyer, 2001; Condron, Perring and Whyman, 2002; Fleming, 2011). The archaeological record of imports to Saxon-period Britain is dominated by high-value, low-bulk items: weapons and other metalwork, jewellery, glass and pottery vessels (Huggett, 1988; Wickham, 2005; Esmonde Cleary, 2012). The rarity of these items (in absolute terms and in comparison to levels of production on the European mainland) is consistent with them arriving in Britain as politically motivated gifts exchanged between elite individuals, rather than as the returns from trade (Sawyer, 1998; Wickham, 2005). Monks may have placed greater demands upon the land than the secular aristocracy. All but the smallest monasteries had more inhabitants than the manor houses and, unlike the royal manors, they were occupied year-round (Blair, 2005b). The rituals of monastic life required specific products: flax cultivation may have been encouraged by demand for liturgical linens, and viticulture by demand for sacramental wine (Oosthuizen, 2010; McKerracher, 2018).

The archaeological evidence for a mid-Saxon resurgence of interest in increasing agricultural productivity includes the renewed construction of technologies associated with bulk grain-processing: watermills and corn dryers; the construction of permanent field boundaries, stock enclosures, and stone-footed buildings; repairs to timber buildings; the establishment of rural settlements with permanent footprints (Hamerow, 1991, 2012; Moreland, 2000; Fleming, 2011; Higham, 2013; McKerracher, 2018); and archaeobotanical evidence for crops cultivated on nutrient-rich soils (Hamerow, 2012; McKerracher, 2018). With a decline in glume wheat cultivation, the new corn dryers were not required to aid de-husking, so functions relating to large-scale grain drying before milling or storage seem more likely (Hamerow, 2012; McKerracher, 2018). The new stock enclosures suggest livestock were brought into closer proximity to settlements. A shortage of pastureland may have resulted from the keeping of sheep and cattle to a greater age to meet increased demand for their secondary products (McKerracher, 2018), or from an expansion of arable cultivation that reduced available grazing land (Blinkhorn, 1999; Hamerow, 2012). An expansion of cultivation onto heavy soils, may also have required the keeping of plough oxen close to settlements (Hamerow, 2012; McKerracher, 2018). Some writers see the hand of landlords directing these improvements (e.g. Blair, 2005a; Wright, 2015), whilst others see no reason why peasants could not have implemented them autonomously (e.g. Hamerow, 2012). Although Hodges (1989, 2012) and Hinton (1990) have suggested that the needs of the *wics* stimulated increased agricultural production, more recent research suggests that agricultural production had been increasing from the late seventh century, pre-dating the heyday of the *wics* (Moreland, 2000; McKerracher, 2014a, 2018). An alternative stimulus to investment in agriculture over the long-term may have been the legal creation of heritable bookland estates (Naismith, 2016).

Consumer settlements (i.e. nucleated settlements not sustained by their own landholdings) first reappeared in the eighth and early ninth centuries in the form of *wics*. These trading and manufacturing centres are widely believed to have been founded and provisioned by royals and aristocrats who wished to control access to prestige manufactured goods; the craft specialists living and working within them depended on redistributed surplus from their patrons' estates (Scull, 1993; Condron, Perring and Whyman, 2002; Whyman, 2002; Astill, 2012; Pestell, 2012; Blockmans, 2014). In the mid Saxon *wics*, finds of coins, imported goods, and sites of craft production (Richards, 2000b; Wickham, 2005; Hadley, 2006; Higham, 2013) show these settlements were part of an international exchange network for luxury goods, but there is little evidence for their more prosaic connections to their local agricultural economies. Most archaeological evidence for the economic relationship between a *wic* and its surrounding countryside comes from East Anglia, where the widespread distribution of *sceattas*, Ipswich ware, and imported lava querns suggests the participation of rural communities in trade with *Gipeswic* (Blinkhorn, 1999, 2012; Wickham, 2005; Astill, 2012; Pestell, 2012). The distribution of Ipswich ware ceramics evidences the existence of commercial networks within rural eastern England from the eighth century onwards. The density of potsherd finds is greatest in close proximity to the coast and inland waterways, but Ipswich ware is also found in areas only accessible overland, so packhorse or cart transport was also being used (Ulmschneider, 2000; Blinkhorn, 2012; Leahy, 2012). Although farming for profit is suggested by Hamerow (2012) on the basis of the archaeological evidence for farmers' investments in enclosures, boundaries, and permanent settlements (Hamerow, 2012), and by Crabtree (1996) on the basis of zooarchaeological evidence for rural communities specialising in the rearing of particular species, most researchers believe that the food renders given by peasant farmers to their landlords were then redistributed to the *wics*' inhabitants (e.g. Hodges, 1989, 2012; Bourdillon, 1994; Whyman, 2002; Astill, 2012; Blockmans, 2014; contra Loveluck, 2013). Zooarchaeological evidence from *Gipeswic* (Ipswich), *Hamwic* (Southampton), and *Eoforwic* (York) suggests the *wics*' residents ate monotonous meat diets dominated by beef from elderly cattle. Such monotony is more consistent with centralised food distribution than with the choices of individuals provisioning themselves from markets (Bourdillon, 1988, 1994; O'Connor, 1994; Crabtree, 1996). It also suggests the absence of the relatively affluent consumers to be expected if the artisans of the *wics* were profiting from their skills in an emerging market economy.

The products of *wics* other than *Gipeswic* are not so widely distributed across their rural hinterlands (Hodges, 1989, 2012; Moreland, 2000; Wickham, 2005). Outside East Anglia a stronger case can be made for minster churches (rather than *wics*) as foci for the development of market exchange. Minsters were permanently occupied, attracted worshippers from the surrounding countryside and pilgrims from afar, creating an ideal setting for trade (Blair, 2005a; Britnell, 2011; Griffiths, 2011; Astill, 2012). In areas without *wics* (in Scotland and Wales, Lincolnshire and North Yorkshire) concentrations of finds of *sceattas*, imports and locally produced metalwork suggest trade took place at monastic sites from the seventh century onwards (Dyer, 2002; Sawyer, 2013).

Lacking direct connections to the agricultural economy, the *wics* neither endured nor effected lasting economic change, but the next innovations in urbanism, the *burhs*, are widely associated with fundamental economic change in England: from a socially embedded economy based upon the redistribution of surplus food by elites to a socially disembedded market economy (e.g. Britnell, 2000; Richards, 2000b; Britnell, 2011; Griffiths, 2011; Loveluck, 2013). The strategic locations of the new burhs were selected as defensible sites in the face of the late eighth and ninth century Viking incursions (Hill and Rumble, 1996; Blockmans, 2014; Blake and Sargent, 2018) but aspects of their locations facilitated their transformation into trading hubs. Their situation on main rivers, originally intended to block upstream access to warships, later facilitated the transport of goods. Their defensive walls, gates, and bridges allowed the flow of goods in and out to be controlled, and thereby taxed (Richards, 2000b). Of the burhs listed in the early tenth century Burghal Hidage (Baker, 2013), those with features such as monasteries and ports, that encouraged both permanent occupation and the movement of people and produce, were the most likely to endure and to become market towns in the eleventh and twelfth centuries (Griffiths, 2011; Loveluck, 2013; Blockmans, 2014). Urban builders and artisans (including textile-workers, bone and horn-workers, leatherworkers, potters, and brewers) were dependent on agricultural producers not just for their food but also for raw materials (Blockmans, 2014). Legal documents record a contemporary boom in purchases of rural estates by urban manufacturers (Loveluck, 2013), perhaps to display their newfound wealth, or perhaps to secure access to raw materials in an increasingly competitive market. The operation of monetised markets in the Saxon period was documented for the first time in Athelstan's Grately decrees of 920-30 which restricted high value (over 20 pence) transactions and the minting of coins to chartered towns (Hill and Rumble, 1996).

Distribution networks expanded by the late Saxon period, with industrially produced pottery present on all types and statuses of site across England (Richards, 2012). Although there was no state investment in transport infrastructure, the legal delegation of responsibility for bridge maintenance to estate owners (J. Campbell, 2000; Harrison, 2004) points to the importance of roads for communications and the movement of resources. By the late tenth and eleventh centuries an increase in the value and profitability of bulk trade is evidenced by investments in distribution infrastructure: jetties to facilitate the transhipment of goods (Miller, Schofield and Rhodes, 1986; Blair, 2007) and new designs of merchant ship that prioritised capacity over speed (Dyer, 2002; Rose, 2011). Port records suggest that the increasing volumes of agricultural produce exported were dominated by the secondary products of pastoralism (wool, cloth, and cheese) rather than by arable produce (Sawyer, 1998; Dyer, 2002).

In the later ninth century the multiple estates fragmented into smaller manors, a change variously ascribed to an increase in the number of lesser lords (Sawyer, 1998; Lewis, Mitchell-Fox and Dyer, 2001), land becoming an alienable commodity (Faith, 1997), and settlement by Scandinavian migrants (Richards, 2000b, 2000a; Dyer, 2002; Hadley, 2006). Nucleated villages developed in a north-south band from Northumberland, through the Midlands, to Dorset (Roberts and Wrathmell, 2002; Griffiths, 2011). This settlement nucleation may be associated with the renewed focus on arable agricultural productivity: the work of ploughing, harvesting, and haymaking is concentrated into short periods of time during which labourers and plough oxen must be close at hand (Faith, 2009). The onset of village nucleation was approximately contemporaneous with the emergence of the burhs and their consumer populations, but the precise timing and pace of all these rural changes remain uncertain (Hadley, 2006; Banham and Faith, 2014; McKerracher, 2018) and they were not completed until the eleventh century. The importance of urban markets to late Saxon farmers is likely to have been spatially variable. Although by the end of the eleventh century most areas of rural England were within one day's horseback journey from a town, towns were very unevenly distributed. The south and Midlands of England had towns of varying sizes, but the north of England had only a few large towns (Haslam, 1984; Britnell, 2011; Griffiths, 2012). Griffiths (2012) posits that the absence of smaller towns within the former Danelaw may result from the less rigorous enforcement of laws restricting trade, allowing more rural exchange to continue in this area.

2.3.1.3 The Medieval period

Wool constituted the majority (in volume and value) of British exports (Gutiérrez, 2018) but there are also records of the export of cereal grains and malt from England's southern and eastern sea ports (Campbell, 1995; Dodds, 2008). There is little recorded importation of cereals, but wheat, rye, and malted barley were shipped to mid-15th century Aberdeen from the principalities of the Low Countries (Gemmill, 2008).

Medieval towns were closely connected to the movement of agricultural surplus, obviously because their inhabitants needed food and raw materials for manufacturing, but also because town markets played a key role in the aggregation and distribution of agricultural produce. Although many urban dwellers had allotments of agricultural land, these were too small to have made towns self-sufficient in food (Dyer and Lilley, 2011) except in the Welsh Marches. The disproportionately large allocations granted to the residents of plantation towns here suggest that they struggled to provision themselves via trade with local farmers (Beresford, 1967; Davies, 1982).

The cheapest commodities would not have been profitable to transport far: fuel wood (Galloway and Murphy, 1991; Dyer, 2002), oats (Campbell, 1997a), and rye (Biddick and Bijleveld, 1991) have all been proposed as such products. From manorial accounts it has been estimated that London's fuel wood supplies were obtained from within a 12-mile radius of the city, farms up to 50 miles away by road sent grain, and cattle on the hoof may have originated as far away as Wales (Galloway and Murphy, 1991; Campbell *et al.*, 1993; Campbell, 1995, 1997a; Campbell, 2000; Dyer, 2002).

Whilst it is clear that the High Medieval agricultural economy produced a large quantity of agricultural surplus, the identities of the farmers who produced most of this surplus remain obscure.

Many of the new Norman landlords initially regarded their English estates as opportunities to generate cash rather than agricultural surplus, preferring cash rents to labour services from their tenants (Faith, 1997). When the inflation of the late twelfth century doubled grain prices and halved the purchasing power of rental incomes, whilst an oversupply of peasant labour suppressed agricultural wages, landlords brought their land back into direct "demesne" management as fixed term leases expired (Dyer, 2002; Routt, 2013). Demesne farming, under the supervision of appointed reeves remained the norm on large estates for the next two centuries and most of our evidence for Medieval farming practice comes from the accounts produced by the reeves of these farms (Biddick and Bijleveld, 1991; Faith, 1997).

The High Medieval period of demesne farming coincided with a rapid rise in the population, and so in the demand for food, raising questions about the extent to which this demand was met by surplus from the demesne farms. Campbell's (2000) England-wide analysis of demesne accounts found wide variations in the proportions of crops sold rather than consumed by the household which he could not explain by differences in access to urban markets: the proportions of harvests marketed varied within rather than between regions, and the amount of variation between demesnes within a region increased with the amount of variation in land ownership. On average, the proportion of demesne produce sold at market was highest during the 13th century (Biddick and Bijleveld, 1991; B. M. S. Campbell, 2000), but the high demand for cereals for household use restricted the extent to which demesne farms could exploit commercial opportunities.

Further evidence for diverse grain marketing strategies comes from demesne accounts in south Bedfordshire and Buckinghamshire where some households sold produce locally and others took advantage of villein labour services to take produce to more distant towns (Lewis, Mitchell-Fox and Dyer, 2001). Biddick and Blijveld's (1991) analysis of the Bishop of Winchester's manorial accounts found that household consumption rates for all cereal species were high, but bread wheat was the most commercialised grain (over all manors an average of 56% of the wheat crop was sold, compared to 28% of the oat, and 35% of the barley harvest). No statistically significant correlation between the price of particular cereal species and the acreage sown was found, so household consumption seems to have been the driving force behind planting strategies. The manors studied were all located far from urban markets, which may have necessitated a subsistence rather than a commercialised strategy, but their pastoral farming was highly commercialised, focussing on the production and sale of fleeces and cheeses.

In Campbell's (2000) study, however, proximity to markets was associated with an increase in the diversity and complexity of cropping regimes, so the most intensive regimes may have been associated with cash cropping. Extensification and intensification strategies are both recorded within demesne accounts. Woodland and wasteland clearance, wetland drainage, and the ploughing of pasture all increased the amount of land under cultivation (Dyer, 2002; Atherden, 2004; Creighton and Rippon, 2017). The intensive exploitation of arable land variously involved reductions in fallowing, repeated ploughings, the replacement of oxen by (faster) horses in plough teams, manuring and marling, convertible husbandry, the use of purchased seed corn (argued by Walter of Henley to be higher yielding), and the cultivation of legumes to provide a food or fodder crop and restore soil fertility (Langdon, 1986; Campbell, 1997a, 2016; Faith, 1997; B. M. S. Campbell, 2000; Dyer, 2002). Arable productivity appears to have varied regionally: in the thirteenth and fourteenth centuries, mediocre cereal yields were recorded in many Midland areas with communal fields and nucleated village settlements, while in East Anglia (which retained a high number of dispersed settlements) yields were high and intensification strategies were pursued (Lewis, Mitchell-Fox and Dyer, 2001; Dyer, 2002).

The abundance of documentary evidence for demesne agriculture belies the fact that most arable land was farmed outside this system (Dyer, 2002). Even within the demesne sector, documentary evidence is heavily biased towards the largest ecclesiastical estates. Like the peasants, the knights and gentry were hands-on farmers of their single estates, and therefore had no need of detailed record keeping. Consequently, the yields, commercial orientation, and agricultural practices on these smaller farms remain hypothesised rather than evidenced. Lacking the capital to invest in towns, or enough land to profit from sub-letting, the owners of small manors were dependent on agriculture for their income, and may therefore have been more highly incentivised to produce surplus for sale than the larger land-owners and compelled to implement more intensive farming strategies (Faith, 1997; Dyer, 2002; Dodds, 2008; Campbell, 2016). Taking this argument to its logical extreme, Dyer (2002) suggests that the proportion of produce that was marketed may have been greatest on the peasant farms with their very small households.

Artefactual evidence of increased peasant spending on manufactured goods and on the employment of specialist tradespeople such as builders, together with documentary evidence for the payment of cash rents, suggests that peasant farmers were indeed selling their produce (Hinton, 1990; Lewis, Mitchell-Fox and Dyer, 2001). Aside from livestock and their secondary products, field crops were not the only crops that could be sold; garden produce, especially fruits and the fibre crops flax and hemp, may have made a significant contribution to peasant incomes. Cash might be generated from the sale of gathered resources, such as nuts, fruits, timber, and rushes, and from the small-scale brewing of ale (Dyer, 2002, 2006). The channels of distribution utilised by peasant farmers remain undocumented but Dyer (2002; also in Lewis, Mitchell-Fox and Dyer, 2001) suggests market days may have been organised within localities so that merchants could make purchases from a series of village and small-town markets before selling their accumulated stock in larger towns at the end of the week. However, the later Medieval decline in village markets suggests a change in peasant marketing strategies (characterised by an increased willingness to transport wares directly to large towns to benefit directly from higher prices). This may have been an entrepreneurial attempt to improve profit margins at a time of falling grain prices. Following the Black Death cereals were in oversupply in England, causing a fall in prices (although consumer preference for bread wheat kept its price buoyant in comparison to that of other grains), but in Scotland the abundance of grazing and shortage of wheat growing land meant that grain prices (particularly bread wheat) rose whilst meat prices fell (Campbell, 1997b; Dyer, 2002).

Agricultural expansion came to an end across Britain in the first half of the fourteenth century when heavy rainfall caused harvest failures that resulted in famine, and there were outbreaks of bubonic plague and cattle murrain (Lamb, 1977, 1995; Flohn and Fantechi, 1984; Campbell, 1995, 2011; Epstein, 2009; Woolgar, 2016). Early fourteenth century tax assessments reveal a particularly dramatic and sustained collapse in Church revenues obtained from granges in Scotland and the English border counties during the first Wars of Independence (Dyer, 2002). The coincidence of multiple external shocks to the economy makes it difficult to disentangle the impact of specific events, but the cumulative effect on arable farmers can be seen clearly in manorial accounts that record severe shortages of seed-corn, plough-oxen, and agricultural workers (Campbell, 1995; B. M. S. Campbell, 2000). After the depopulation wrought by the Black Death there was no longer the labour force for arable cultivation, nor the demand for large quantities of cereals. Demesne accounts record that arable land was turned over to pasture (Campbell, 1997a; Dodds, 2008), and we have archaeological evidence for the contraction and/or abandonment of peasant villages, hamlets, and farms (Lewis, Mitchell-Fox and Dyer, 2001). Dyer (2002) notes that in the East Midlands the rural settlements closest to towns were the most likely to shrink: the farmers most involved in producing surplus for urban consumers were hit hardest.

2.3.2 Archaeobotanical studies and potential

The archaeobotanical remains of crop species are not a type of evidence well suited to quantified reconstructions of levels of surplus production. Crop remains are vastly under-represented in the archaeological record in comparison to the quantities in which they were originally grown and consumed. Their preservation is the result of chance, although some parts of plants are more or less likely to be preserved than others, and the quantities recovered owe more to the excavator's sampling strategy than to the abundance of remains (Hillman, 1981; G. Jones, 1991; M. Jones, 1991; van der Veen, 2007). Consequently, the quantities and proportions of crop remains within archaeobotanical assemblages are not directly representative of the actual quantities or proportions of taxa produced or consumed. The impossibility of basing quantitative reconstructions of past agricultural production and consumption on archaeobotanical remains may be the reason why archaeobotany is often excluded from projects that synthesise other kinds of archaeological evidence. For example, although the agricultural economy was a major focus of the "Oxford Roman Economy Project" (OXREP, 2017), archaeobotanical evidence was not considered: it was dismissed because it "may indicate a range of crops grown or harvested, but can hardly form the basis for an assessment of scale" (Bowman and Wilson, 2009, p. 17). Despite this, archaeobotanical remains may have the potential to give insights into relative (rather than absolute) levels of production at different times and/or sites, and into how changes in output levels were effected.

Hillman (1984) hypothesised that assemblages rich in cereal grain are most likely to occur at sites where cereals are handled in large quantities, because this is where the chance of accidents that char large quantities of grain in a single event are greatest (for example, fires in storage contexts or during bulk grain drying or parching). In contrast, the disposal into household fires of the waste products of grain cleaning before cooking, produces small assemblages of charred material rich in chaff and/or weed seeds. On this basis, van der Veen and Jones (2006) propose that the grain richness, or chaff and weed richness, of samples can be used as proxy evidence for the scale of crop handling at a site. They caution that erroneous conclusions may be reached for individual sites: grain-rich assemblages result from accidents (i.e. chance events) so they will not be created at all sites of large-scale crop handling (and even when they do their locations may not be sampled); conversely, at a small-scale site, a catastrophic fire in a grain storage context would produce grain-rich samples that give the appearance of large-scale crop handling. It may therefore be better to analyse sample data at the regional rather than the site level, to reveal broad trends whilst limiting the impact of individual sites. Lodwick (2014a) took this regional approach to her analysis of Iron Age and Romano-British samples from sites around Silchester, finding that late Iron Age samples from oppida were consistent with household-scale cereal processing (grain-poor) whilst samples from enclosed rural settlements and some hillforts were consistent with the bulk handling of cereals (grain rich).

Van der Veen and Jones' (2006) model emerged from a discussion of Late Iron Age farming, when glume wheats dominated the archaeobotanical record. Expanding analyses into more recent periods, when free-threshing cereals predominate would be problematic because, due to the archaeobotanical rarity of charred free-threshing cereal chaff, all free-threshing cereal dominated samples are relatively grain-rich. To analyse Saxon data, McKerracher (2014a) therefore used a different measure of the scale of crop handling: the density of crop plant macrofossil remains per litre of sediment sampled. High-density samples are likely to result from single rapid depositional events, and low-density samples are likely to result from the repeated deposition of small quantities of waste, therefore the density of cereal remains in a sample is likely to be positively correlated with their rate of deposition (van der Veen and Jones, 2007, p. 223). McKerracher (2014a) justified this approach by arguing that the formation processes of cereal-dense deposits are similar to those of grain-rich deposits, and those of cereal-sparse deposits are similar to those of chaff- and weed-rich ones, therefore cereal density is a useful proxy for levels of crop handling in periods and places where free-threshing cereals predominate. In his analysis of data from East Anglia and the Thames Valley he found evidence of temporal changes in the scale of crop handling (an increase in the density of samples between the early and mid-Saxon periods) and socio-economic patterning (relatively low densities of remains consistent with household-level late-stage cereal processing in the major consumer town of Ipswich, and high-density samples on surrounding rural sites with artefactual evidence of elite status).

The association of Romano-British and mid-Saxon corn dryers with surplus production is usually asserted on the basis of their potential use in preparing cereals for long-term storage (e.g. Perring and Whyman, 2002; Pelling, 2011), but stored produce is not necessarily surplus. It is therefore more reasonable to say that corn dryers may be associated with the bulk handling of cereals (this also allows for the possibility that cereals were being prepared for milling or de-husking rather than storage). But there still remain several possible uses of corn dryers that are not associated with bulk crop handling, so to draw economic inferences from trends in corn dryer distributions it is necessary to identify the particular use to which they were put. To date the only synthetic analysis of charred cereal remains from British corn dryers aiming to do this is van der Veen's (1989) study of 21 Romano-British period assemblages. Van der Veen found that the most readily identifiable use of corn dryers was as malting ovens. This use was inferred from the presence of a high proportion of germinated grains (and/or detached coleoptiles) within samples. Although her criterion for identifying malting used in the study was arbitrary (at least 75% of grains to be germinated) the general principle, that high proportions of germinated grains indicate malting, has been widely adopted by other archaeobotanists. A use other than malting may be inferred on the basis of negative evidence (i.e. the absence of a significant proportion of germinated grains), but it is impossible to infer what that alternative use was. Interpretation is confounded by two problems: firstly, the differential preservation of cereal grains and chaff when exposed to fire (Boardman and Jones, 1990) means the state in which cereals were put into the dryer (as spikelets, cleaned grain, etc.) cannot be identified; and secondly, most samples were comprised of, or mixed with, the cereal chaff used as kindling or fuel, and are unrepresentative of the crop being dried (van der Veen, 1989). The same difficulties were reported in Moffett's (1994) analysis of the kilns at Stafford and in Monk and Kelleher's (2005) synthesis of Irish data. That Monk and Kelleher encountered the same difficulties (particularly the lack of undisturbed samples from drying chambers) in Ireland, where many more corn dryers have been excavated, suggests that a new synthesis of British archaeobotanical data would probably add little to our understanding.

Rather than the remains of the cereals themselves, the remains of the crop weeds found alongside them may provide evidence for changing methods of cultivation, and therefore for the strategies employed by farmers to increase (or scale back) levels of arable production. The presence of particular crop weed species has a long history of interpretation by archaeobotanists as evidence for growing conditions in the fields. *Anthemis cotula*, a species of heavy clay soils, is probably the most frequently discussed Anglo-Saxon crop weed. A mid-Saxon increase in the frequency of samples containing *Anthemis cotula* suggests an increase in the cultivation of heavy clay soils (Greig, 1991): a change in cultivation practice associated with the expansion of arable farming onto (harder to work) marginal land (McKerracher, 2014a, 2016), the cultivation of bread wheat (Jones, 1981; Banham, 2010), and the widespread adoption of the mouldboard plough (Williamson, 2003; Oosthuizen, 2010; Banham and Faith, 2014). Other British crop weeds exist with sufficiently specific ecological requirements to act as indicator species for various soil textures, pH values, fertility, and moisture levels, but they are rare. Many (probably most) archaeobotanical samples will therefore lack any indicator species, and very few will contain the combination of species required to describe comprehensively the environment of cultivation. Interpretations based on one, or a few, weed species are potentially unreliable: they rest upon uniformitarian assumptions about weeds' habitat requirements and preferences and, as G. Jones (1992) cautions, because crop weeds grow in heavily manipulated conditions, changes in their ecological attributes over time are particularly likely.

The interpretation of more of the weed species within a sample increases the reliability of the conclusions and the range of environmental conditions that may be inferred. Several recent syntheses of British archaeobotanical data have classified and interpreted weed taxa according to their Ellenberg values. These values indicate the ecological tolerances of plants in relation to aspects of their environment. Seven aspects were assessed by Ellenberg (Ellenberg and Leuschner, 2010) for the flora of Central Europe: light, moisture, temperature, continentality of climate, soil or water pH, nitrogen levels, and salinity; Hill et al. (1999) subsequently produced a set of values based on survey of the British flora (excluding values for temperature and continentality) for 1791 native and introduced taxa.

Using the Central European indicator values, van der Veen (1992) found soil nitrogen levels were a key variable that discriminated between spatially discrete groups of northern English Iron Age samples. Using Hill et al.'s (1999) British values, both Lodwick (2014a) and McKerracher (2014a) found nitrogen and moisture levels were the variables that discriminated between regional groups of Iron Age and Romano-British (Lodwick, 2014a) and Anglo-Saxon (McKerracher, 2014a) samples. Lodwick found that regional geological differences provided sufficient explanation for the variations in her dataset, but this was not the case in van der Veen or McKerracher's studies, where differences in farming practice in response to societal and economic influences were inferred.

Using Ellenberg values to interpret crop weeds addresses some, but not all, of the problems of reliance on indicator species. Because the values are based upon field observations, they describe rather than explain the presence of a taxon in a particular environment. Consequently, it is often impossible to identify the particular environmental variable causing a species to occur at a particular site. The Functional Interpretation of Botanical Surveys (FIBS) methodology (Jones *et al.*, 2010) overcomes this difficulty by relating species' functional characteristics to specific ecological characteristics, which in turn may be equated to specific crop husbandry practices. For example, specific leaf area (area divided by dry leaf weight) is a proxy for plant growth rate, which is positively related to the fertility of the habitat in which the plant grows (Jones *et al.*, 2000, 2010). Ellenberg indicator values (see, for example, Hill *et al.*, 1999) relate mostly to edaphic conditions, whilst a much wider range of growing conditions can be inferred from functional attributes (for example: perennation and means of regeneration can be used to infer levels of soil disturbance and thereby of tillage; germination time and the onset and duration of flowering can be used to infer the season of crop sowing). The application of the FIBS methodology requires a large amount of plant functional characteristic data derived from field surveys and laboratory observations; this has restricted its adoption outside the University of Sheffield research group who originally developed the methodology and who have focussed on questions relating to prehistoric agriculture (e.g. Bogaard, 2004; Bogaard *et al.*, 2013). Its application is, however, presently being extended to the Saxon and Medieval periods (eighth to thirteenth centuries) by the FeedSax research project at the Universities of Oxford and Leicester (Hamerow *et al.*, 2019; Feeding Anglo-Saxon England, 2021), in combination with stable isotope analysis and radiocarbon dating of cereal crop and weed seeds, with the aim of identifying and precisely dating the changes in farming practice that increased arable output and fed England's rapidly growing population.

An alternative indication of an increasing separation of consumer from producer may come from evidence of an increase in the movement of food plants. The most obvious archaeobotanical evidence for the movement of food plants comes in the form of exotic taxa. Exotics may be intentionally imported food plants or weeds of cultivation harvested alongside a crop that was subsequently imported to Britain. The crop contaminant *Vicia ervilia* was used to identify grain imported from southern Europe to London's Roman forum (Straker, 1984), and *Consolida regalis* and *Lathyrus aphaca* point to the importation of southern European grain to the Roman military warehouses in York (Williams, 1979). Lentil, a crop in its own right in southern Europe, is usually interpreted as a contaminant of imported grain (Helbaek, 1964; Boyd, 1980; Straker, 1984), but Green (1981; also Banham and Faith, 2014) suggests that its cultivation in southern England would have been possible, especially during warm periods.

The earliest finds of new crop weed species help us to date the onset of the importation of grain, but once a weed becomes established in Britain's fields it no longer indicates the origins of the grain alongside which it is found. Novel weeds may be introduced with crops for consumption, or with imported seed corn. Imported seed corn may have been sown many seasons before the particular crop that was preserved archaeobotanically (Derreumaux *et al.*, 2008). The spread of a new weed around Britain may therefore reflect the movement of seed corn rather than of grain for consumption.

The ecological interpretation of crop weeds to infer past husbandry practices has already been described (Section 2.2.2). Weed analyses can also identify possible (or unlikely) places of cultivation. The movement of grain within north-west Europe will be largely undetectable from the climatic requirements of weeds (Straker, 1984), but weeds' soil preferences have been used to identify (occasional) cases of cereals not cultivated in the immediate environs of the site where they were found (e.g. Pals and Hakbijl, 1992; Robinson and Aaby, 1994). As is so often the case in archaeological interpretation, uniformitarian assumptions are risky, particularly when we consider anthropogenic environments like arable fields. A very restricted range of environmental characteristics is useful here: whilst the underlying geology will remain unchanged, soil nutrient levels may be altered by manuring, fallowing, or crop rotations, and moisture levels by drainage or irrigation. If geological conditions are the most reliable grounds upon which the movement of cereals can be inferred from crop weeds, long-distance movement may be more visible than local movement. However, throughout the study period most crop movements will have been over relatively short distances, from countryside to market centre or site of consumption.

Imported exotics are the most obviously redistributed crops in the British archaeobotanical dataset. Most archaeobotanical finds date to the Romano-British period, when the species most frequently present were the Mediterranean cash crops, fig, grape, pine nut, and olive. Olives, figs, and pine nuts were certainly imported (Dickson and Dickson, 1996), and the limited evidence for viticulture in Roman England suggests that most grapes would have been imported as well (Williams, 1977; Brown *et al.*, 2001). Archaeobotanical remains of exotic food plants in north-west Europe have been subject to two large-scale studies, first by Bakels and Jacomet (2003), then by Livarda (2008). In their analysis of Romano-British archaeobotanical finds, van der Veen, Livarda, and Hill (2008) found that fig, grape, and olive presence was particularly associated with forts and with London (the distribution of pine nut is wider, seemingly because it had a role in ritual practices). There was little available evidence from large towns other than London, but in her larger-scale study of north-west European data Livarda (2008) found these imports in the large towns of the militarised Rhineland. The socially and spatially restricted distribution of these imports suggests that their transport to military sites (then over further short distances within the Rhineland), and within the entrepôt for military supplies that was London, was profitable, but their distribution around the rest of England was not. This is consistent with the hypothesis that consignments of luxury goods piggybacked onto bulk movements of supplies for the army (Orengo and Livarda, 2016). Trends in the presence of food plants imported to Roman Britain (van der Veen, Livarda and Hill, 2008) conform to one of two patterns: decreasing over time (most imported taxa including fig, mulberry, fennel, lentil, and the probable import, grape), or peaking in the middle of the Romano-British period before declining (olive and pine nut). This is consistent with trends observed for other (food and non-food) contemporary imports to Britain. Import replacement has been proposed for manufactured goods, so might this also have been the case for the food plants? The decline in exotics does coincide with an increase in the presence of new species that could be successfully cultivated in Britain (carrot, leaf beet, black mustard, cherry, plum, damson, and walnut) but these new food plants are not obvious direct culinary substitutes for the earlier imported species. In any case, that local cultivation was possible does not mean that it was practised, and these new taxa may well have been imported (Orengo and Livarda, 2016).

By using archaeobotanical data to reconstruct networks of trading hubs, Orengo and Livarda (2016) sought to make visible the movement of goods within Britain and to identify places that functioned as distribution hubs for traded goods. Calculating a weighted index that encapsulates the number of exotic and potentially introduced taxa found at a location, and the relative rarity of each taxon within the British dataset (Livarda and Orengo, 2015, p. 248), they found the highest index values were obtained at sites that might reasonably be expected to be consumer sites: early Romano-British forts, and mid Romano-British period York (Orengo and Livarda, 2016). Fluctuating index values for London were interpreted as indicating its changing status from a centre of consumption in the early- Romano British period (high index values), to a centre of trade in the mid Romano-British period (lower values), then returning to a centre of consumption again in the late Romano-British period (increasing values). In the early Romano-British period much international trade is believed to have been centred on Silchester (which produced high index values).

Exotic taxa comprise a very small proportion of all archaeobotanical remains. A larger group of taxa are those potentially introduced into cultivation in Britain. These crops include fruits (cultivars of apple, pear, plum, and cherry), vegetables (leeks, lettuce, rape, possibly turnip), herbs (coriander, dill, parsley, summer savory, rue, lovage, and fennel), spices (white mustard), oil seeds (hemp, opium poppy, gold-of-pleasure), nuts (walnut and chestnut), and the cereal einkorn (Livarda, 2008, 2011; van der Veen, Livarda and Hill, 2008). These taxa may have been cultivated within Britain, but they may equally well have been imported. Even crops that were firmly established in British farming practice before Roman occupation (such as emmer, spelt, and barley) may have been imported when demand outstripped local supply. Importation rather than local cultivation is sometimes inferred when a concentration of remains of a species are found at one site when they are very scarce in the surrounding region. Because the numerical abundance of archaeobotanical remains does not directly translate to the number of items originally present, supporting evidence for long-distance trading connections at a site is also required: for example, the Roman army presence and the bones of the non-native golden dormouse within samples from the granary at South Shields increases the probability that the free-threshing wheat found there was imported (van der Veen, 1992); and the hops found at Graveney were within a tenth century shipwreck, also carrying Rhenish lava quernstones (Wilson, 1975). Such coincidences of evidence are rare.

For cereals, a crude indicator of increased movement may be changes in the type of cereal cultivated. If cereals are moved over long distances then those varieties that are most efficient to transport may be favoured. Transporting only grain (not chaff) to the consumer reduces the bulk and the weight of the cargo. Green (1981) and Jones (1981) suggested that the increase in (free-threshing) bread wheat cultivation during the Saxon period may have been due to this advantage in transport, but many other factors may also have been influential including environmental and resource constraints (McKerracher, 2014a, 2018), desired yields (Moffett, 2006), consumer preferences (Hagen, 1992; Banham, 2010; Banham and Faith, 2014), and the demand for cereal chaff for fuel, fodder, or construction material (van der Veen, Hill and Livarda, 2013).

The presence of cash crops (i.e. grown for sale not subsistence) show that a site was connected to the market economy as a site of production or consumption. The spatial and social distribution of cash crops may therefore provide evidence for different communities' access to, and engagement with, markets. Imported taxa show the (limited and indirect) connection of a few Roman period consumers to cash cropping farmers in the Mediterranean; they do not constitute evidence for the operation of domestic markets within Britain. To explore this issue, the cash crops of British agriculturalists must be identified. Fruits and vegetables are likely cash crops for several reasons. They are highly perishable, and gluts of produce (above household needs) are common. Their cultivation is labour intensive, as is any bulk processing into more stable, transportable products. Orchards are a particularly long-term capital investment, with several years between planting and first cropping. On peasant farms with limited labour and capital such investments will only be made in anticipation of substantial and sustained future profits (Wolf, 1966). The scale of fruit and vegetable production cannot be reconstructed from occasional waterlogged and mineralised finds, so rather than interpreting their abundance van der Veen, Livarda, and Hill. (2008) interpreted the spatial distribution of finds to support their contention that commercial horticulture and orcharding was practiced in Roman Britain. Finds of fruit and vegetable remains are concentrated in south-east England, in the same region as the large urban settlements that would have provided a ready market for these perishable products. This situation has twentieth century parallels in countries as diverse as Mexico (Wolf, 1955) and China (Fei, 1945), where peasant market gardens clustered around towns. Because the spatial distribution of fruit and vegetable finds is, at least partially, the result of a lack of excavated sites with mineralised or waterlogged preservation in northern England, we cannot assert that market gardening was not practiced in the militarised zone. However, further support for the conclusion that horticulture was concentrated in urbanised south-east and central England comes from Allen's (2014) mapping of excavated features interpreted as horticultural bedding trenches: these are concentrated in the same areas as the archaeobotanical finds.

That bread wheat became a British cash crop during the Saxon period was proposed by M. Jones (1981). Bread wheat is particularly demanding of labour and capital inputs (needing more weeding, ploughing, and more fertile soils) so he argues that there must have been an economic incentive for farmers to expand its cultivation. Various incentives have been proposed. Jones cited Green's (1979) argument that, because bread wheat is a free-threshing cereal, its profitability would been increased (relative to glume wheats) by its lower weight and bulk in transport (see also Heinrich, 2017 who advances a similar argument for *Triticum durum* in Roman Italy) . Other writers have proposed that the cultural cachet of bread wheat (Stone, 2006; Banham, 2010; Woolgar, 2016) translated into a relatively high market price (as documented in post-Black Death England). This may have been the case but demesne accounts give no evidence for price-responsive changes in sowing strategies (Biddick and Bijleveld, 1991). Given the lack of precision with which plant remains can be dated, such short-term changes would also be invisible in archaeobotanical analyses. Other incentives to increasing bread wheat cultivation include the reduction in post-harvest processing that frees up labour for other activities, while farmers growing for their own consumption are not themselves immune to changes in culinary fashions. Either, or both, of these incentives may have induced subsistence-focussed, not just market-orientated, farmers to substitute bread wheat for glume wheats. The presence of bread wheat (or indeed any other free-threshing cereal) at a rural site is, therefore, insufficient evidence of cash cropping.

By processing, the exchange value of a harvested crop may be increased; and any cereal grain may be transformed into a saleable product by brewing. Brewing adds value to cereal grains, and the sale of beer may ameliorate a common cash flow problem experienced by peasant cultivators in a market economy. To pay outstanding debts, taxes, tithes, and rents, peasant farmers are often forced to sell their produce immediately after harvesting, when aggregate supply is greatest and market prices are therefore lowest (Wolf, 1966). If they can reserve some grain to brew small batches of beer year-round, cash can be generated whenever it is needed. This strategy was observed by Beidelman (1961) in his study of the Kaguru farmers of Tanganyika, and M. Jones (1981) suggests that adoption of a similar strategy by Roman and Saxon farmers might account for the proliferation of corn dryers in these periods. Malting experiments using a reconstructed corn dryer at Butser Ancient Farm were successful (Reynolds and Langley, 1979), and suggest this is a possible function of the structures, but it remains one of several possibilities. The difficulties of identifying the particular activity represented by archaeobotanical assemblages from corn dryers has already been described, and samples where at least 75% of grains are germinated are very rarely found.

Rather than focussing on the particular species present, the identification of specialisation may be a means by which production for market might be identified at rural sites (as proposed by Forbes, 1976; Bakels, 1996, 2014; Matterne, 2001; Temin, 2012; Groot and Lentjes, 2013; Heinrich, 2017 amongst others). Specialisation in one particular commodity (agricultural or manufactured) leaves producers dependent on the surplus produce of others to provide their full range of needs and wants. Within the agricultural sector, specialisation might involve focussing on a particular type of farming (arable or pastoral), a particular type of crop (cereals, vegetables etc.) or a particular species (such as bread wheat).

Exploring the evidence for diversification or specialisation within arable farming, Matterne (2001, pp. 169–202) analysed presence records for a range of crops (cereal, pulses, oil, and fibre crops) in Iron Age and Gallo-Roman northern France. Different trends were identified in the two periods. Over the course of the Iron Age the average number of species present per rural site fell: instances of einkorn, naked barley, and spelt presence were less frequent, but the main cause was a reduction in instances of non-cereal taxa presence (pulse, fibre, and oil crops). This increased focus on a limited range of cereals (particularly on hulled barley and emmer which were present at almost all sites) was interpreted as specialisation in crops that thrive under extensive rather than intensive cultivation regimes. Matterne explains this as a rational strategy in response to a demographic shift (urbanisation in the form of oppida) that reduced the agriculturally productive proportion of the population. Urbanisation, along with monetisation of the economy, and inter-province exchange, intensified further during the Gallo-Roman period, but the average number of crop-species per rural site did not keep falling; instead there was some diversification of cereal cultivation as the frequency of bread and spelt wheat presence records increased to match those of emmer and hulled barley. Matterne (2001) suggests bread wheat may have been introduced, and spelt reintroduced, as cash crops (perhaps because of their suitability for bread-making), whilst the traditional crops were retained for farmers' household use. The introduction of commercial cereal growing may therefore produce an increase in diversity of the archaeobotanical record when measured by presence data. In contrast Bakels' (2014) comparison of data from Roman and post-Roman farms in northern France, the northern Rhineland, and the southern Netherlands did illustrate the expected patterns of lower species diversity (i.e. increased specialisation) during the Roman period, and at villas compared to native farms. The sites featured in this paper were, however, selected as exemplars of the argument being advanced: that specialisation is associated with farming in a market economy; the results of a large-scale study are not described.

The ability of presence data to reveal specialisation in particular species is limited. Analyses are likely to overstate the diversity of cereals present at a site: species no longer deliberately cultivated but persisting in fields as volunteers would be recorded as present, and taxa that made the transition from crop weed to crop (oat and rye within this study period) would be recorded as present in both states. The dual nature of peasant farms in a market economy (producing for household consumption and for sale) prohibits complete specialisation in one species (Wolf, 1966): the market may (for example) demand the cereals best suited to baking, but the farmer also requires fodder, bedding, and construction materials. Their ability to specialise may be further constrained by specific food renders. The simplest adaptation an arable farmer could make in response to changing market conditions, a change in the proportions of different species cultivated, would be invisible in a presence analysis that, by definition, gives equal weighting to abundant and rare taxa. This may explain the results obtained by Heinrich (2017): collating presence records of cereal taxa on Italian sites from the Neolithic to Roman periods, he anticipated a reduction in the variety of cereal species evidenced during the Roman period. As the economy became increasingly marketised he expected to see the end of glume wheat cultivation (because of its inefficiency in long-distance transport), but the visible trend was a decline in species diversity between the Bronze and Iron Ages, followed by an increase in the Roman period.

The potential insights to be gained from quantified analyses of sample contents are illustrated by the Rural Settlement of Roman Britain research project (Lodwick and Brindle, 2017). First, an analysis of species presence data was conducted, then a quantified analysis of sample contents was carried out (average proportions of cereal species in samples were calculated for individual sites, regions, and categories of site). The presence analysis revealed little patterning in the dataset: barley and spelt presence was ubiquitous throughout the Late Iron Age and Romano-British periods, and the proportion of sites with emmer presence declined slowly. However, the quantified analysis revealed more changes over time (a more rapid decline in the proportion of emmer within samples was apparent, and an increase in the proportion of spelt within assemblages at the expense of barley as well as emmer), space (changes occurred earlier in the south than in the north, and in the east than the west), and between site types (for example, on the West Anglian plain changes occurred first at architecturally complex farmsteads). Like Matterne (2001), Lodwick (Lodwick and Brindle, 2017), associated the increasing specialisation in spelt wheat with the extensified cultivation of surplus cereals for market.

Another form of specialisation that may be identified from sample-level analyses is the sowing of cereals in single-species stands rather than as maslins (mixed crops). Maslin sowing is often practiced by subsistence farmers (Jones and Halstead, 1995; Van der Veen, 1995); it is a risk reducing strategy that prioritises food security above yield maximisation or preferences for a particular cereal. If cereal species that thrive in different conditions are mixed, the risk of total crop failure due to adverse weather conditions is reduced. If, however, as in Iron Age northern France (Matterne, 2001, pp. 168–201), there is a decline in the frequency of mixed samples suggestive of maslin sowing (or possibly post-harvest mixing) and an increase in samples comprised of a single taxon, we cannot assume this represents a shift away from subsistence cultivation. It may be that farmers perceived the risks of crop failure to be lower: perhaps due to climate amelioration, or (as in the Iron Age) improvements in cultivation technology. Manorial accounts attest to the continued cultivation and consumption of maslins throughout the Saxon and Medieval periods (Slicher van Bath, 1963; Dyer, 2002; Stone, 2006; Moffett, 2010, 2018) and there is no reason to presume they were not traded. Maslins may, however, have commanded a lower market price, as suggested by the difference in the price of loaves made with pure wheat and with mixed grains in Medieval England (Stone, 2006). The cultivation of an increased proportion of crops as single species may therefore be consistent with an increasingly profit-oriented planting strategy, but some degree of maslin cultivation is likely to have persisted because of the need of small-scale farmers to balance potential rewards against security.

2.4 This study in context

This thesis is an exploration of the ways in which the changing representation of the charred remains of field crops (cereals, pulses, and flax) within the archaeobotanical record reflects the changing socio-economic circumstances within which decisions about agricultural production and consumption were made. Field crops were dietary staples: they constituted the bulk of arable agricultural production, and of food consumption of all social classes, throughout the study period. Additionally they had uses as fodder, fuel, and as raw materials for construction or craft-working. Focussing on this restricted range of crop taxa makes it feasible to analyse both presence-absence, and quantified sample content data from a large study area and over a long period of time. Previous large-scale data syntheses of the archaeobotanical evidence for field crops (covering all of Britain, or multiple periods from the Late Iron Age to Medieval) have focussed on presence-absence data (Green, 1981; Jones, 1981; Banham, 1990; Livarda, 2008), whilst those using quantified sample content data have been restricted to smaller regions and to shorter temporal periods (Parks, 2013; Lodwick, 2014a; McKerracher, 2014a; Lodwick and Brindle, 2017). Recent very large-scale syntheses of archaeobotanical data (Bakels and Jacomet, 2003; Livarda, 2008; van der Veen, Livarda and Hill, 2008) have focussed on novel food plants, but the socio-economically restricted consumption of these foods for long periods of time renders the consumption practices of much of the British population invisible, and the failure of many of these crops to become embedded in British agriculture renders much farming activity similarly invisible.

Through the study of field crops, insights can be gained (albeit to varying degrees) into each of the aspects of the agricultural economy described above (the emergence of a discrete consumer group, the production of surplus, the movement of surplus, and decision making in response to changing economic circumstances).

Although cereals and pulses were dietary staples, taxa were not interchangeable in culinary use, in their cultural associations, or (as evidenced by Medieval documentary sources) in their prices. Although references to the socio-economic associations and value of crops are frequently made in archaeobotanical reports, attempts to investigate the impact of such influences on the staple crop content of assemblages or samples are rare. Because cereals, pulses, and flax were staple crops, it is improbable that any particular taxon would be found in exclusive association with a particular type of consumer. Rather, if sites are categorised according to the socio-economic characteristics of their occupants, variations between categories may emerge in the frequency with which taxa are present or abundant.

Quantitative reconstructions of agricultural output cannot be produced from archaeobotanical data. However, by reference to present-day agricultural experiments and the observations of agronomists, the effect on crop yields and labour demands of substituting one species for another can be identified (i.e. the expected direction of change – increase or decrease), as can the implications of changing conditions of cultivation on the yields of any one species.

Whilst the movement of staple food crops to a site can be inferred from the socio-economic context of that site (for example, military bases and large towns can reasonably be assumed not to be agriculturally self-sufficient), the broad ecological tolerance of British field crops makes it practically impossible to pinpoint their place of cultivation. What we may see at consumer sites, however, is evidence of reliance on those taxa whose physical properties made them most suitable for transport.

Changing economic circumstances have been proposed as explanations for the adoption of various farming strategies in various times and places. Farmers may choose to exploit market opportunities by introducing new cash crops into cultivation, or to add value by the additional processing of their existing crops. Although specialisation in a particular species or type of cash crop is a feature of present-day commercial farming, in a partially marketised economy, where farmers grew for their household needs as well as for market sale, the diversification of the on-farm crop spectra seems more likely with farmers adding cash crops to those already grown for auto-consumption. Diversification is, however, also a useful risk-buffering strategy for farmers primarily focussed on their own subsistence needs. To distinguish the motivation (subsistence risk-buffering or commercial orientation) behind particular instances of diversification, the characteristics (the risks involved in, and the potential rewards from, their cultivation) of the cereals added into cultivation must be compared to the characteristics of the previously established crops.

Chapter 3. Methodology

3.1 Data Collection

3.1.1 Sources of data

Because of the broad temporal, spatial, and socio-economic scope of this study, a data collection strategy that yielded easily accessible but high quality archaeobotanical data was adopted. To reduce the amount of time spent searching for, and through, excavation reports, this study focusses on published reports (journal articles and monographs) and excludes unpublished "grey literature" reports produced by commercial archaeology units for their clients. Reviews of archaeobotanical data quality conducted by van der Veen, Livarda, and Hill (2007; 2013) concluded that archaeobotanical data within publications were generally of higher quality: better contextualised, and more precisely and securely dated. Many environmental reports presented within grey literature are based on rapid assessments of archaeobotanical material, rather than on full examinations of sample contents. Books and journal editions published after 1970 were consulted: earlier archaeobotanical studies were rare, with such *ad hoc* sampling, recovery, and reporting methods that inter-site comparisons would be invalid. When archaeobotanical data were presented separately from the published excavation report, supplementary digital material (online, on CD, or DVD) and microfiche appendices were consulted, but time did not permit visits to physical archives.

Publications containing archaeobotanical reports were identified from searches of bibliographic databases (Tomlinson and Hall, 1996; Kroll, 2005; University of York, 2008, 2016; Historic England, 2015), bibliographies within recent syntheses of archaeobotanical data (van der Veen, 1989; Greig, 1991; Huntley and Stallibrass, 1995; Livarda, 2008b; Moffett, 2010, 2018; Banham and Faith, 2014; Lodwick, 2014a; McKerracher, 2014a; Smith *et al.*, 2016), and index searches of journals focusing on environmental, regional, and Romano-British, Saxon, or Medieval archaeology. Table 3.1 contains short bibliographic references to the publications from which data were obtained.

3.1.2 Selection of data

Even within the corpus of published reports, archaeobotanical data quality is highly variable. To select data for inclusion in this study, criteria relating to the site excavated, the nature of the archaeobotanical remains themselves, and the thoroughness of the archaeobotanical analysis, were applied.

Data derived from excavations on the English, Welsh, and Scottish mainland were sought. Data from Anglesey and the Isle of Wight were occasionally encountered and were included because both islands were close enough to mainland Britain to allow regular cultural and economic exchange. The minimum dating precision required was for archaeobotanical remains to be assignable to either the Romano-British or Medieval periods, or to either the early-mid or the late Saxon sub-period (because of its longer duration, and high degree of socio-economic change). Assemblages containing the charred remains of at least one of the following cereal, pulse, or fibre crops were included in the study: einkorn, emmer, spelt, free-threshing wheat, rye, barley, oat, pea, Celtic bean, lentil, and flax. Although grains of wild and cultivated oat cannot be distinguished, oat has been grouped with the crops for this purpose, rather than the crop weeds because it is a well-documented and frequently archaeologically preserved crop of the Saxon and Medieval periods (Green, 1981; B. M. S. Campbell, 2000; Moffett, 2010, 2018), and believed to have been a minor crop, possibly a regional speciality, during the Romano-British period (Jones, 1981; van der Veen, 2016; Lodwick and Brindle, 2017). Data from rapid assessments were not used.

Charred remains are the best form of archaeobotanical evidence for British cereals and pulses. Overall, in Britain, charring is the most common way in which cereals (grains and chaff) and pulses are preserved (although pulses are less likely to be preserved, as their processing and uses mean they are less often exposed to fire than cereals) (van der Veen, 2007; Moffett, 2010, 2018). Charred preservation is the most common mode of archaeobotanical preservation of cultivated plants on British rural sites (van der Veen, Livarda and Hill, 2007; van der Veen, Hill and Livarda, 2013); although charred remains are less often encountered on urban sites, they are still common enough to expect to produce a dataset which will permit comparisons between urban and rural sites, between types of rural site, and potentially between categories of urban site. Thus, the synthetic analysis of charred data allows the comparison of archaeobotanical assemblages and samples from sites of agricultural production and consumption with those from sites of consumption alone; and from categories of site associated with various socio-economic groups. The formation processes of charred archaeobotanical samples are relatively well understood: models based upon observations of traditional peasant farming practices have been devised to reconstruct past crop-processing practices (Hillman, 1981, 1984; Jones, 1983, 1984, 1987); whilst no well-established equivalents exist for the similar interpretation of waterlogged or mineralised archaeobotanical samples. The ability to isolate the effects of crop-processing on sample composition makes it possible to identify that patterning which is most likely to result from other, socio-economic influences.

3.2 Data recording

3.2.1 Sites and excavation

Information recorded in the database pertained to the whole site (location, dates of excavation, excavating organisation, and bibliographic reference) and to the archaeobotanical investigation (archaeobotanist, archaeobotanical recovery methods, numbers of samples). Site locations were described using-present day place-names and UK National Grid References (NGR). If site locations were given as latitudes and longitudes, or eastings and northings, conversions to NGR were carried out using the UK Grid Reference Finder batch convert tool (2011). If location coordinates were not provided within the excavation report, they were obtained either by comparison of the site plans with Ordnance Survey maps (University of Edinburgh, 2018) or from the relevant Historic Environment Record

3.2.2 Chronological phases

Each phase of activity at a site was recorded by a temporal start and end point, and by the (consistent) function of the site between these dates. For example at Barton Court ((Miles and Armitage, 1986) the late Romano-British (AD 2375-375) villa phase was followed by an early Saxon (AD 400-600) phase of low status rural settlement. Information was taken directly from the excavation report (no reinterpretation was attempted) or, if necessary, from related publications referenced within it. As well as the start and end sates of each phase, the information recorded included: the nature of the settlement (e.g. farmstead, village, or town) and its occupants (e.g. military or civilian in the Romano-British period, clergy or laity in the Saxon and Medieval period), and the economic activities evidenced by archaeological finds (e.g. farming, craft, or industrial production)

Often, however, the dates of phases of occupation were described not in calendar years but as “early”, “mid” or “late” parts of centuries. In the absence of further detail, “early” was taken to mean the first half of a century (e.g. 1300-49), “mid” the middle fifty years (e.g. 1325-74), and “late” the second half of the century (e.g. 1350-99). For example, at the site of Redcliff (Lyne, 2002) the dates of the “late first/early second century” were recorded as AD50-149. Phases only described in vague terms (e.g. “Medieval” or “post-Roman”) were not included in the study data.

3.2.3 Crop presence

For each phase at each site, a record was made of the domesticated crop taxa present in the charred assemblage. Wild oat (*Avena sterilis*) and domesticated oat (*Avena fatua*) cannot be distinguished on the basis of grain morphology, so the domestication status of oat grains could be recorded only when floret bases had been used as the basis for identification to species level. Due to the rarity of finds of oat chaff, most records of oats were at the genus level (*Avena* sp.). Because of the difficulty of distinguishing domesticated pulses and flax from some of the wild species in the *Fabaceae* family, only species-level identifications (e.g. *Pisum sativum*) were used as evidence of domesticated species. Cultivated flax is easily distinguished from wild flax, so only species-level identifications (i.e. of *Linum usitatissimum*) were recorded.

3.2.4 Sample contents

Samples were included in the initial database if:

- They contained at least 30 plant parts (cereal grains, cereal culm nodes, glume wheat glume bases, free-threshing cereal rachis internodes, pulse or flax seeds) from any of the crop species listed in section 3.1.2 above
- They were processed by water flotation with a fine mesh of 500µm or less.
- Sample contents were quantified

The crop item cut-off excluded samples with too few cultivated plant remains to be considered evidence for the deliberate cultivation and utilisation of crops. The 30-item minimum was a pragmatic choice: excluding samples with no interpretative potential, but not reducing the dataset to a size that precluded inter-site comparisons.

Separate entries were made for identifications of the same taxon made with different degrees of confidence, or with differently sized seeds (legume identifications were often grouped into size categories), and for morphologically distinct barley grains (hulled and naked, straight and twisted).

Each entry in the database included taxon names (the botanical names used in the published report), the part of the plant that was identified, caveats regarding identification confidence ("*cf*", "*sl*", or "type"), the method of quantification used (counting whole items or fragments, estimated counts, weights, or volumes), and the number, volume, or weight of items identified. Data was aggregated if one discrete archaeological context had been sampled multiple times.

In a few reports, cereal "glumes" were itemised but there was no mention of "glume bases" (Miles and Armitage, 1986; Wainwright, 1995; Collins and Allason-Jones, 2010). Because glume bases are far more likely to survive charring than whole glumes (Hillman, 1981; Jones, 1985), it was assumed that "glumes" referred to glume bases, so these items were recorded and analysed as such. Counts of seeds from wild taxa, including potential crop weeds, were also recorded.

3.2.5 Sample contexts

For samples that were recorded individually, the sample number, context, and feature names used in the published excavation report were recorded, together with the context type. Notes were made about any data quality issues and the amalgamation of multiple samples from the same context.

3.3 Data Standardisation

The following section describes the standardisation measures taken relating to inter- and intra-site variations in preservation quality, contextual and dating information, and to inter-analyst variations in approaches to plant identification, naming, and quantification. All standardisation was performed in Excel 365.

3.3.1 Crop nomenclature

The nomenclature for wheat, rye, and oat follows the traditional approach described in Zohary, Hopf and Weiss (2012, pp. 29, 59, 66). The modern grouping of all barley as one species, *Hordeum vulgare* (Zohary, Hopf and Weiss, 2012, p. 57) is, however, preferred for its simplicity and because it fits well with the aggregation of barley remains (whether hulled, naked, two-row, six-row, or indeterminate) into a single count that was found in many reports.

Nomenclature standardisations (standard botanical names and the synonyms encountered in reports) are presented in tables 3.2 (wheats), 3.3 (other cereals), and 3.4 (pulses and flax).

For ease of reading, the common names of cultivated taxa are widely used in this text, with a few simplifications. The barley and oat genera contain both cultivated and wild species but, in this thesis, when the terms “barley” or “oat” (or *Hordeum* sp. or *Avena* sp.) are used without further qualification, they refer to crops. “Glume wheat” is used to refer to emmer or spelt, but not to einkorn which was not cultivated in Britain during the study period (Moffett, 2010, 2018; van der Veen, 2016). “Free-threshing wheat” encompasses any, or all, of bread, club, rivet, or macaroni wheat (*Triticum aestivum*, *Triticum compactum*, *Tricitum turgidum* or *Triticum durum*): “hexaploid free-threshing wheat” refers to the first two species, and “tetraploid free-threshing wheat” to the latter two species. “Pulse” refers to cultivated rather than wild legumes. Celtic bean “*Vicia faba*” is, for brevity, simply referred to as “bean”, and “flax” always refers to cultivated flax (*Linum usitatissimum*).

3.3.2 Plant Parts

For cereals, the standard crop plant parts were grains; culm (straw) nodes; the glume bases of glume wheats; and the rachis internodes of the free-threshing cereals, barley, rye, and free threshing wheat. Although oat chaff was recorded in the database, it was not utilised as a standard plant part for analyses because its fragility means it is very rarely preserved in charred archaeobotanical assemblages. Table 3.5 lists the synonyms encountered for the standard plant parts.

In order to avoid the double counting of fragmented grains, grains were counted only when the end of the grain bearing the embryo was present (regardless of whether the embryo itself was still attached).

Counts of glume wheat spikelet forks were converted to an equivalent number of glume bases (1 spikelet fork comprising 2 glume bases). When a composite “glume bases/glumes” count was reported (e.g. Taylor *et al.*, 2011, p. 200) all items were counted as single glume bases to give a minimum count of glume bases (though this inevitably underrepresents the number of glume bases found). The glume bases of free-threshing cereals are rarely preserved, so glume bases identified only as *Triticum* sp. were assumed to be from one of the glume wheat species (emmer or spelt). Glume bases specifically identified as from free-threshing cereals were not counted (free-threshing cereal chaff being represented instead by the more robust rachis internodes).

The description and quantification of free-threshing cereal rachis remains varies considerably between archaeobotanists (including the reporting of nodes, internodes, “rachis segments”, and “rachis fragments”), and when only one “part” of the rachis was enumerated for a sample this was used for the standard “rachis internode” count; when counts of both nodes and internodes were given, the larger value was taken to represent a minimum number of rachis internodes. When a count was given only for “rachis” or “rachis fragments”, this was also used as a minimum count of rachis internodes (though, again, this inevitably underrepresents the number of rachis internodes found). Internodes were counted whether they were described as whole or as fragments: if fragments are large enough to be identified to species level the problem of double counting internodes is unlikely to arise. If articulated rachis internodes were recorded in semi-quantitative categories (for example 1 node, 2-4 nodes, 5-10 nodes in Truman, 2001) a minimum number of internodes was obtained by multiplying the lowest number of internodes in each category (1, 2, 5 in the case of Truman, 2001) by the number of items recorded. In reports where no such information was given (e.g. Rippon, 2000; Hunter, 2012) a minimum value of two internodes was used for each instance of “articulated rachis”.

For some cereal species (emmer, spelt, rye, and oat), spikelet counts were given in some archaeobotanical reports. Emmer usually has two grains per spikelet, but spikelets at the top or bottom of the ear sometimes contain only one. Spelt wheat spikelets are more variable, containing one, two, or (less often) three grains. Rye consistently has two grains per spikelet, while oat spikelets usually contain two grains (Jacomet, 2006; Zohary, Hopf and Weiss, 2012; Kolankowska, Choszcz and Markowski, 2017). Therefore, for the glume wheats, emmer and spelt, each spikelet was counted as two grains plus two glume bases. For the free-threshing cereals, rye spikelets were counted as two grains and one rachis internode but oat (for which chaff is too rare to be usefully included in quantitative analyses) as two grains only.

For pulses, complete cotyledons were converted to an equivalent minimum number of whole seeds (each pulse seed has two cotyledons) then added to any count of whole seeds. Total numbers of pulse fragments (with no estimated equivalent number of whole seeds) were equated to one whole seed per sample irrespective of the number of fragments.

The seeds of flax are contained within capsules, and seeds and capsules were often enumerated separately in reports. If a capsule is still entire it must originally have contained at least one seed, therefore counts of whole capsules were added to counts of whole seeds, as were any counts of capsule fragments described as containing seed.

Only whole seeds of wild taxa were counted.

3.3.3 Plant identification

Variations in the identifications of crops and their weeds, presented in published reports, derive partly from the approaches of different archaeobotanists and partly from variations in the quality of preservation between sites and between contexts. These differences needed to be resolved before comparisons could be made between different archaeobotanical assemblages, as follows.

3.3.3.1 Crops

Grain size was once considered a criterion by which cultivated and wild oats could be differentiated but it has been demonstrated that the overlap in size between grains from the two groups is actually too great for them to be reliably separated (Jacomet, 2006). Species level dentifications of oat based on grain size were therefore reclassified to genus level (*Avena* sp.) Oat chaff (specifically the disarticulation scar at the base of the floret) can be a reliable way of identifying to species level (Jacomet, 2006) but it is rarely preserved archaeologically. Consequently, oat grains were combined into the broad category of *Avena* sp., except for those grains securely identified by their chaff as belonging to a wild species.

Attempts to identify free-threshing wheat grains to species on the basis of grain size are also unreliable (Jacomet, 2006), so species level identifications were amalgamated into a composite "free-threshing wheat" (*Triticum* sp. (free-threshing)) category. Free-threshing wheat rachis internodes can be identified as belonging to either a hexaploid or tetraploid type, but such precise identifications are relatively infrequent, and so, for most purposes, were integrated into the free-threshing wheat rachis internode count.

All counts of barley grains and rachis internodes were amalgamated into the species level category of "barley" (*Hordeum vulgare*). Rachis internodes were rarely identified to sub-species level (identifications of both six- and two-row barley rachis were rare), and very few grains were identified as either twisted or straight. Most barley grains are likely to be of the hulled type, naked grains were very infrequently identified.

In a few reports the possible presence of einkorn (*Triticum monococcum*) was reported. Mostly (Table 3.6) these were uncertain identifications of *Triticum monococcum/dicoccum* indicative of poorly preserved material rather than the presence of einkorn. These items were therefore amalgamated with counts of emmer (*T. dicoccum*) grains and glume bases. Only at the Roman Forum site in London was there good evidence for the presence of einkorn (Boyd, 1980; Straker, 1984; Dunwoodie, 2004).

The charred remains of legumes are often too poorly preserved to identify to species level, making it difficult to separate cultivated and wild plants. However, seed size information is often provided for legumes, so a "large legume" category (Table 3.7) was created for legume seeds (identified to family or genus level) over 4mm in diameter. This large size suggests they were deliberately cultivated (whether for food, fodder, or as a green manure).

Differential preservation (even within one sample) results in a mixture of confident and cautious identifications, species and genus level identifications, and identifications where more than one species or genus are considered possible. The less confident, and the less precise identifications are likely to represent poorly preserved specimens of taxa already identified within the sample, rather than additional taxa, and so should not be entered into analyses as separate categories, thereby creating 'noise in the data. However, excluding them from analyses would introduce another type of noise into comparisons between well and poorly preserved samples. The system described below was therefore devised for the reallocation of imprecise identifications between the more precise identifications within the same sample.

- *cf* and "type" identifications were combined with confident (i.e. unqualified) identifications
- Items that may represent either domesticated cereals or wild grasses (e.g. *Avena* or Poaceae) were removed from the data.
- Cereal plant part identifications were, whenever possible, allocated to one of the following categories: emmer, spelt, free-threshing wheat, rye, oat, and barley as follows:
- *Triticum* sp. rachis identifications were allocated to the free-threshing wheat category.
- If *Triticum* sp. was the most precise identification for wheat grains within a sample, chaff identifications were considered: if only free-threshing wheat rachis was present then the grains were allocated to free-threshing wheat; if only glume wheat glume bases (at least 30) were present the grain was allocated to the relevant glume wheat(s). If both free-threshing and glume wheat chaff was present no conclusions could be drawn, and the *Triticum* sp. identification was retained.
- Identifications relating to two possible taxa (e.g. *Triticum dicoccum/spelta*) were proportionately reallocated between those two taxa (according to the proportions of each plant part identified to the relevant taxa within the sample), then identifications relating to three possible taxa and so on.
- Finally indeterminate cereals were reallocated between all the cereal taxa evidenced in the sample by the relevant plant part.
- Broader identifications were retained for samples where no more precise identifications were made, for example the category "glume wheat" was retained for samples where no species level identifications of emmer or spelt were made.

3.3.3.2 Crop weeds

Wild taxa found in archaeobotanical samples may have arrived on site by different routes, including their arrival with harvested crops. So, in order to identify those taxa that are likely to have been weeds that grew and were harvested alongside the crops, a number of ecological and economic factors were taken into account. Some wild taxa grow in habitats that would not have been suitable for the cultivation of crops, for example aquatic species and species of highly saline environments. Similarly, species such as *Apium graveolens* (celery), which is a plant of brackish coastal marshes, is likely to have been collected from the wild or, when found inland, to have been grown as a horticultural crop. Woody perennials and heathland plants are also unlikely to have grown in arable fields, and are far more likely to have been brought onto site for use as fuel, fodder, litter, or construction material, or for their edible fruits and nuts. Edible fruits, such as *Fragaria vesca* (wild strawberry) were also considered more likely to have been gathered resources than crop weeds, as are *Juncus* species (rushes), which are plants of damp environments with a range of potential uses (such as thatching, floor covering, bedding, and basketry), and so collected from the wild for these purposes. These types of taxa were therefore not included in the list of potential crop weeds (Table 3.8) that were used in this study to identify the products and by-products of crop processing.

3.3.4 Contextual data

There is, inevitably, a great deal of variation in the types of site and features excavated, in the sites' wider environmental and geopolitical contexts, and in the level of detail reported by excavators. The standardisation of such contextual data is therefore necessary in order to make comparisons between archaeobotanical records from different dates, regions, and types of site.

3.3.4.1 Temporal divisions

To facilitate the analysis of synchronous and diachronic variations in the archaeobotanical data records were allocated to one of the following standardised temporal periods (and where possible) sub-periods:

Romano-British:	**AD 43 to AD 410**
Early Romano-British	*AD 43 to AD 125*
Mid Romano-British	*AD 125 to AD 250*
Late Romano-British	*AD 250 to AD 410*
Saxon:	**AD 410 to AD 1066**
Early-Mid Saxon	*AD 410 to AD 800*
Late Saxon	*AD 800 to AD 1066*
Medieval:	**AD 1066 to AD 1485**
High Medieval	*AD 1066 to AD 1300*
Late Medieval	*AD 1300 to AD 1485*

To distinguish between data as it appeared in the original publication, and the data as it was entered into analyses for this study, in the remainder of this thesis "phase" refers to the periods of activity described in excavation reports, whilst "periods" and "sub-periods" refer to the standard temporal divisions used within this study.

The broad temporal periods (Romano-British, Saxon, and Medieval) are defined by historic dates (the Claudian invasion of AD 43, the Rescript of Honorius in AD 410, the Norman conquest of 1066, and the accession of Henry VII in 1485). These dates and period names are used because they are so widespread in the literature that they map well onto the broad temporal phases described in excavation reports. Period names should only be interpreted as temporal descriptors, not as descriptors of ethnic or cultural characteristics. Neither should abrupt change either side of period boundaries be assumed: the Roman conquest of, and withdrawal from, Britain was gradual and time-transgressive, as was the Norman conquest; furthermore, neither were fully realised across the whole of the British mainland.

Sub-periods were devised from the data collected. Various divisions were trialled, and those that allowed the greatest number of phases to be allocated to a sub-period were chosen. Because of the scarcity of dateable artefacts many early- and mid- Saxon sites are very imprecisely dated, resulting in broad date ranges for the Saxon sub-periods.

Each phase recorded in the database was, when possible, allocated to the standard sub-period that accounted for most of its duration. When a phase was split equally between two sub-periods and the excavation report gave no suggestion that the archaeobotanical remains dated to the earlier or later part of the phase, or when a phase spanned several sub-periods, it was only assigned to a broad temporal period (Romano-British etc.).

If an excavation report identified several phases of socially and economically similar activity within one standardised sub-period, data was combined from these several phases to produce one "site-phase" and one "crop presence" record. For example, at Redcliffe (Lyne, 2002, pp. 86–88) both the "mid second century" and "late second/early third century" phases fit within the "mid Romano-British" sub-period, so the data from both were combined. Throughout this thesis, the term "site-phase" is used to refer to a standardised sub-period at a particular site.

3.3.4.2 Spatial classifications

All sites were allocated to one of Shirlaw's (1966) climatic zones. Within Britain's climate there is sufficient variation for Shirlaw to loosely describe six discrete climatic regions (Figure 3.1). Most of mainland Britain has a cool temperate climate; the far north of Scotland is cold temperate. A combination of prevailing south-westerly winds that bring rain-bearing depressions to Britain; and topography that produces precipitation as air rises over the uplands of western Scotland, Wales and the Pennines and leaves the eastern lowland in rain shadow, results in a west-east (high-low) gradient of rainfall. The difference between average winter and summer temperatures is greatest in the south-east and smallest in the north-west. Both winter and summer average minimum and maximum temperatures decrease as latitude and altitude increase. Increases in altitude produce particularly sharp decreases in average temperatures. All around the British mainland proximity to the sea mitigates the extremes of both summer and winter temperature.

The two zones best represented within the data: eastern and western central and southern England, were subdivided into smaller areas for separate analysis (Figure 3.2). The eastern climatic zone was divided into three: eastern southern England, East Anglia, and the east Midlands and South Yorkshire. The western climatic zone was divided into two: the west Midlands, and western southern England. London falls within the eastern central and southern English zone, but because of the concentration of excavations here, and because archaeobotanical records from London are likely to be atypical in their composition, they were excluded from analyses of data from this zone. Although its fortunes rose and fell, London was unusual throughout most of the study period for various reasons, including its large population, function as a focal point for international trade (including trade in agricultural produce), and function as a centre of political power (Campbell *et al.*, 1993; Barron, 2000; J. Campbell, 2000a; Keene, 2000; Perring, 2011). Consequently, London's food supplies were likely to have been drawn from a much wider geographical area (and therefore from a wider range of environments) than any other contemporary settlements.

3.3.4.3 Site types

This thesis utilises evidence from sites with evidence for human occupation (settlement sites) or land-use (landscape features directly connected to agricultural activity, trade, or industry). These sites are most likely to produce archaeobotanical assemblages derived from economic activity (whether from agricultural production or consumption). Data were also collected from sites whose primary focus was religious or ritual practice (temples, shrines, individual and cemetery burials) but these records were excluded from the analyses in the following chapters as the archaeobotanical remains obtained from them (derived from offerings, grave goods, and grave fills) are not directly comparable with those derived from day-to-day human activity. The "ritual" sites of the Romano-British period encompasses cemeteries, shrines, and temple complexes but, for the Saxon period, this category consists only of cemeteries and other burial sites. Moreover, the difficulties of ascertaining the origins of the charred archaeobotanical remains found within graves make these records problematic. Whilst in some instances the charred plant remains may be contemporaneous with, and deposited alongside the burial, in others they may derive from re-worked material (.e.g. local settlement debris). In the latter case, and in the absence of radiocarbon dates, it is impossible to establish to which temporal period or phase of local land-use they belong. Only Six site-phase records from Romano-British shrines were collated, and these varied in composition with no associations between this type of site and particular cereal or pulse crops.

The nature of urbanisation varied greatly over time, so site-phases were first categorised as appropriate to each broad temporal period. The only category of town to appear in every period was London and, even here, the location of the settlement changed over time, shifting westward between the Romano-British and early-mid Saxon sub-periods, then moving back to the site of the Roman settlement in the late Saxon sub-period (Leary, 2004; Cowie and Blackmore, 2012). The other categories of town were then classified as either "major" or "minor" towns.

In the Romano-British period, major towns other than London comprise public towns (towns granted the legal status of *civitas* capital, *municipia*, or *colonia)* (Ordnance Survey, 2016), as well as the spa town of *Aqua Sulis* (present-day Bath) which, whilst lacking a legally defined role in local government administration, is likely to have had similar socio-cultural characteristics to the public towns, and to have been primarily a centre of agricultural consumption rather than production (Davenport, Poole and Jordan, 2007). Minor towns consist of the "small towns" associated with the Roman road network (Burnham and Wacher, 1990; Burnham, 1995), *vici* settlements associated with military forts, and former *vici* (settlement at *vici* post-dating military withdrawal from the associated fort) (Ordnance Survey, 2016).

Saxon *wics*, burhs, and boroughs listed in the Domesday survey were categorised as major towns (Darby, 1977; Hall, 2012; Pestell, 2012; Baker, 2013; Blake and Sargent, 2018). Other sites, described as urban in excavation reports, but not falling within any of the major town categories, were classed as minor towns.

Major towns of the Medieval period consisted of those appearing in Hoskins' (1984) list of the 44 wealthiest provincial towns in England (based upon the 1334 Lay Subsidy tax assessment), the cinque ports (Hastings, New Romney, Hythe, Dover, and Sandwich), the palatinates of Durham and Chester (Dyer, 2000), and the Scottish burghs of Edinburgh, Leith, Aberdeen, and Perth, whose economies were heavily dependent on international trade (Barrell, 2000; Dennison and Simpson, 2000). All other towns were classified as minor.

Rural site classifications (such as farmstead, hamlet, village) obtained from excavation reports were recorded, but such classifications are often unreliable as they reflect the extent of excavation more strongly than they reflect the size of the original settlement (Allen and Smith, 2016; Creighton and Rippon, 2017). Therefore, records from rural site-phases with no archaeological evidence for elite occupation were combined into one “rural non-elite” site category.

Some urban and rural settlements were identified as sites of elite occupation. Residences of the secular elite included Romano-British villas and palaces, Saxon and Medieval halls, moated occupation sites, manors, royal estate centres, hunting lodges, castles and palaces. Religious institutions included Saxon and Medieval monasteries, hospitals, and episcopal residences. Romano-British military sites included forts (permanent military bases including legionary and auxiliary forts, and signal stations) and camps (marching and construction camps).

3.4 Data analysis

Analyses were conducted on two separate datasets (of crop species and plant parts) derived from the database: (1) a site-phase presence dataset and (2) a sample contents dataset. The analysis of these two datasets allows the inclusion of the maximum number of sites (in the site-phase presence dataset) as well as making the best use of fully quantified data, where sample size allows (in the sample contents dataset).

Potential causes of variation in crop choices at different types of site, through time, between different regions, and within different socio-economic contexts, were explored using a combination of univariate (bar charts), bivariate (line graphs) and multivariate (correspondence analysis) statistical methods, and by plotting species occurrences on maps of Britain. Discriminant analysis was used to identify the likely products and by-products of crop processing from which samples derived.

3.4.1 Correspondence analysis

Correspondence analysis is a multivariate ordination technique used in this study to analyse both the site-phase presence dataset and the sample contents dataset. It simultaneously identifies similarities and differences, in all crop taxa, between site-phases or individual samples. Like other ordination techniques, it arranges records (in this study, site-phases or samples, depending on the dataset analysed) along axes on the basis of their composition (in this study, the crop taxa present - for the site-phase dataset - or counts of crop taxa and plant parts - for the sample dataset). The first axis accounts for most of the variation in the dataset, and each subsequent axis accounts for the greatest variation remaining after the variation on previous axes has been accounted for. The package used for the analysis was CANOCO 5 (ter Braak and Smilauer, 2012b, 2012a). The mathematical principles underlying correspondence analysis can be found in Baxter (1994) and Shennan (1997).

The results of correspondence analysis are presented as two-dimensional plots of one correspondence axis against another, most often axis 1 and 2, which account for the greatest variation in the dataset, though axes 3 and 4 are also plotted in some cases. To improve visibility, datapoints for species and records are plotted separately. Species that plot towards the end of each axis tend to be present in different site-phases or to predominate in different samples, while site-phase or sample records plotting towards the ends of each axis tend to include the same species/plant parts. Hypotheses about the causes of variation within the datasets were explored by coding the data points in plots of records according to various contextual characteristics of each site-phases (e.g. period or sub-period, spatial location, type of site) leaving unclassified records represented by dots.

3.4.2 Univariate and bivariate statistical methods

To investigate changes through time in the presence of particular taxa, line graphs were plotted of individual crop species and crop categories (glume wheats, free-threshing cereals, pulses), and bar charts were produced to compare the presence of individual species at different types of site. Calculations were performed, and charts created, in Excel 365.

3.4.3 Mapping

Maps were used to explore the chronological and spatial distribution of relatively rare crop taxa, present in few site-phases. Maps were produced using QGIS 3.2 Bonn (QGIS association, 2018), using the coordinate referencing system OSGB-1936 (British National Grid). The outline map of Britain shapefile was produced by the Office for National Statistics (2020).

3.4.4 Crop processing discriminant analysis

Harvested seed crops must be subjected to a series of operations in order to extract the seed from the rest of the plant (straw, chaff and pods), and to remove weeds. Each stage in this crop processing sequence generates a product (which, in the early stages, goes on to be processed further) and a by-product that may be either be discarded or used for some purpose other than food, e.g. fodder or fuel. Threshing, to break up cereal ears, is the first stage of crop processing, during which the grains of free-threshing cereals are released from their spikelets, and pulses from their pods, while the spike (ear) of glume wheats breaks up into individual spikelets (still containing the grain). This is followed by winnowing which, for free-threshing cereals, separates the grain from the lighter straw and chaff, and pulse seeds from their pods while, for glume wheats, an additional dehusking stage, is required to release (usually by pounding with a pestle and mortar) the grains from the enclosing glumes of the spikelet. Winnowing or sieving is then used to separate the glumes (or glume bases) from the grain. Coarse sieving with a sieve that allows the grain to pass through while retaining the larger fragments of straw (and rachis in the case of free-threshing cereals) is an optional stage following winnowing. Fragments of unthreshed ears or whole spikelets may also be retained in the coarse sieve, which can be re-threshed or dehusked. Fine sieving removes the smaller contaminants while retaining the grain within the sieve (Hillman, 1981, 1984; Jones, 1983, 1984, 1987).

Weeds are removed at each stage of this processing sequence as part of the by-product at each stage: winnowing removes light seeds or those with wings, hairs etc. to improve dispersal by wind; coarse sieving removes seeds that tend to remain in heads, pods or spikes after threshing; fine sieving removes the smaller weed seeds, leaving only the larger weed seeds that must be picked out of the grain by hand. The proportions of weed seeds with these different physical characteristics can therefore be used to identify the most likely crop processing by-product from which archaeobotanical samples derive (Jones, 1983, 1984, 1987).These differences in the types of weed found at different stages were successfully used to distinguish (using discriminant analysis) between samples from different by-products, and the grain product prior to hand picking, collected during traditional crop processing on the Greek island of Amorgos (G. Jones, 1983, 1984, 1987). The cereals grown on Amorgos were free-threshing but, because the method used to distinguish the different products and by products, is based on weeds seeds, this method of identification can be applied to both free-threshing cereals and glume wheats (Jones, 1987, p. 314). The weed seed characteristics of the archaeobotanical samples in the current study were therefore compared to those of the ethnographically collected samples from Amorgos in order to determine the likely processing source of the archaeobotanical material.

The taxa identified as potential crop weeds (see section 3.3.3.2) were classified according to same three physical properties of their seeds that were used in the analysis of the ethnographic samples: size, tendency to remain in ‘heads’ after threshing, and aerodynamic properties (‘lightness’). Seeds less than 2mm in breadth were classed as “small”, those over 2mm as “big”; seeds with a tendency to remain in heads, spikes or pods were categorised as “headed”, other seeds as “free”; and light seeds or those with features that facilitate their dispersal by wind were classified as “light”, the rest as heavy. Classifications of taxa were based on those used in other studies (Jones, 1983; van der Veen, 1992; Bogaard, 2002, 2012; Lodwick, 2014a; McKerracher, 2014a), reference works on seed morphology (Hubbard, 1992; Cappers, Bekker and Jans, 2006), observations of seeds held in the reference collection at the University of Sheffield's Department of Archaeology, and discussions with Prof. G. Jones. Taxa were then allocated to one of six categories based on a combination of their physical characteristics:

- bhh big, headed, heavy
- bfh big, free, light
- shh small, headed, heavy
- shl small, headed, light
- sfh small, free, heavy
- sfl small, free, light

It was possible to classify all species-level identifications as well as taxa for which species within the taxon could be allocated to the same category. Table 3.8 presents a list of categorised taxa. Especially during the Romano-British period, it is possible that oats were, at many sites, growing as a crop weed, rather than as a deliberately sown crop, raising the question of whether oat grains might be better treated as a weed and included in the crop processing stage discriminant analysis (as a big, free, heavy seed). An experimental analysis treating oats in this way was conducted, and the outcome is described in Section 5.1.

The percentage contribution that each taxon made to the total number of categorised weed seeds in each archaeobotanical sample was calculated, and the square root of this value obtained to make the archaeobotanical data comparable with the data used in the discriminant analysis of the ethnographically collected samples from Amorgos. Total values for each category of weed seeds (bhh etc.) in each sample were calculated, and samples containing at least 10 categorised weed seeds were entered into a discriminant analysis with the ethnographically collected samples. The discriminant functions extracted to distinguish between samples from ethnographically collected samples, of known processing products and by-products, were then used to classify the archaeological samples to one or another processing group. The discriminant analysis was performed using the IBM SPSS Statistics 26 package.

Chapter 4. Results: Crop presence analysis

4.1 Description of the site-phase presence dataset

The crop presence dataset comprises 1381 site-phase records from 947 different sites: 626 dating to the Romano-British period (45%), 284 (21%) to the Saxon period, and 471 (34%) to the Medieval period. Most records derive from a small number of samples (Figure 4.1). 53% of records were based on evidence from 5 or fewer samples, and 85.7% from 30 or fewer samples. In this dataset, where 68% of records derive from excavations commenced from 1990 onwards, this is consistent with van der Veen et al.'s observation that since the 1990s the scope of archaeobotanical investigations has decreased at the same time as the proportion of developer-funded excavations has increased. 9.8% of records were derived from an unknown number of samples. At least one cereal was present in 99.3% of site-phase records. Of the 9 records without cereals, 3 contained either pea or bean, and 6 (5 of which were Romano-British) contained other cultivars (walnut, pine-nut, date or grape). For most site-phases of activity at most sites (83% of Romano-British records; 81% of Saxon records; 68% of Medieval records) charring was the only mode of archaeobotanical preservation.

Figure 4.2 shows that, during the Romano-British period, records were evenly distributed between sub-periods (25% early, 33% mid, 33% late Romano-British). This was also the case for the Saxon period (50% early-mid, 50% late Saxon) but within the Medieval dataset, the High Medieval sub-period (62%) is better represented than the late Medieval sub-period (35%). The relative abundance of Romano-British and High Medieval records compared to Saxon and late Medieval records is consistent with the temporal distribution of data identified by van der Veen et al. (2007; 2013) in their review of British archaeobotanical data, and probably results from biases in the British excavation record rather than in the data collection strategy employed for this study.

The climatic zones (see 3.3.4.2) best represented in the dataset (Figure 4.3) are those in the east and west of central and southern England, followed by the north-east of England and Scotland. Again, this is consistent with the distribution of archaeobotanical reports identified by van der Veen et al. (2007; 2013). In the two best represented areas, the temporal distribution of records is broadly in line with the temporal distribution in the whole dataset, but the north-east region of England and Scotland are dominated by Medieval records.

The proportions of records from urban and rural sites in each temporal sub-period (Figure 4.4a) again reflect known chronological trends in British urbanisation. The proportion of records from towns peaks in the mid Romano-British sub-period; largely due to a doubling of the number of records from the "small towns" (Figure 4.4b) that proliferated along the road network at this time

(Burnham and Wacher, 1990; Allen and Smith, 2016). The post-Roman collapse of urban life (K. R. Dark, 2000; Esmonde Cleary, 2001, 2007, 2012; Hinton *et al.*, 2012) means the early-mid Saxon dataset is overwhelmingly comprised of rural records and London records dominate the urban category. The late Saxon saw a resurgence of urbanism in the form of burhs and boroughs (Haslam, 1984; Hill and Rumble, 1996; Blockmans, 2014). The High Medieval sub-period is the first in which urban records outnumber rural ones; again this increase is largely attributable to the increase in records from minor towns at this time of new town construction (Beresford, 1967; Dyer, 2002; Lilley, 2002) as well as the expansion and replanning of pre-existing settlements that transformed villages into market towns (Lewis, Mitchell-Fox and Dyer, 2001; Lilley, 2017).

Some (often elite) site types only occur in certain temporal periods: forts and *vici* only feature in the Romano-British period, and monasteries only in the Saxon and Medieval periods (urban monasteries do not appear in the dataset until the late Saxon sub-period).The early-mid Saxon decline in the proportion of records from sites potentially occupied by socio-economic elites (rural and urban, secular and religious, military and civilian, Figure 4.5) is consistent with the dearth of any kind of archaeological evidence for early Saxon socio-economic stratification, and the continued lack of archaeobotanical evidence from elite sites throughout the Saxon period can also be seen in van der Veen et al.'s (2013, p. 155) survey. Urban secular elite sites do not appear until the High Medieval period, and even then, they are too rare to constitute a useful analytical category.

Figure 4.6 shows the distribution of Romano-British records, where a north-south division can be seen, not only in the frequency of records but also in the type of site, which reflects the differing nature of settlement in the military (north) and civilian (south) administered areas of Britannia (Roberts and Wrathmell, 2002; Allen, 2016b; Brindle, 2016a, 2016b; Smith, 2016b). Military-influenced sites (forts and *vici*) predominate in the north whilst civilian towns and rural settlement (elite and non-elite sites) predominate in the south. Over the Romano-British period, towns and rural non-elite settlement records expand northwards into Yorkshire, but rural elite records remain relatively rare here. In the Saxon period, there is a marked spatial contraction in the distribution of records (Figure 4.7). During the early-mid Saxon sub-period most records are concentrated in southern and southern-central England, with northern records largely restricted to the eastern seaboard. The late Saxon increase in records from western central England is associated with an increase in urbanisation in this area. The concentration of rural records in the south and east continues throughout the Medieval period (Figure 4.8), with urban records more widely distributed.

4.2 Temporal trends

To explore the general trends in crop presence through time, a correspondence analysis was performed using all site-phase records. Table 4.1 lists the taxa entered into the analysis, and the codes that represent them on the resulting species plots. In the species plot (Figure 4.9a) the glume wheats (emmer and spelt) plot towards the positive (right) end of axis 1 while, on axis 2, the pulses (pea, Celtic bean, and lentil) and flax plot towards the positive (top) end and free-threshing cereals (barley, free-threshing wheat, rye and oat) plot towards the negative (bottom) end. This indicates a tendency for the crops within each of these three categories to be present in the same site phases. When site-phase records are coded by broad temporal period (Figure 4.9b) the majority of the Romano-British records plot towards the positive (right) end of axis 1 (associated with emmer and spelt) and some plot towards the negative end of axis 2 (associated with free-threshing cereals), but they are largely absent from the top left quadrant of the plot where the pulses (and flax) are located. The Medieval records, on the other hand, mostly plot towards the negative (left) end of axis 1. Some of these records are associated with the pulses and flax (in the top left quadrant of the plot), while others are associated with free-threshing cereals (towards the negative end of axis 2), but they are largely absent in the top right quadrant where the glume wheats are located. Saxon records mostly plot with the Medieval samples towards the negative end of axis 1, but a few plot towards the positive end associated with glume wheats. This may indicate two changes over time: a decline in the presence of glume wheats (which predominate in the Romano-British period) and an increase in pulses and/or flax in the Saxon and Medieval periods, while free-threshing cereals are well represented in all periods.

To identify any changes in crop presence during each broad period, the same plots of species and site-phase records are presented in Figure 4.10, highlighting records from the Romano-British period in Figure 4.10b, Saxon records in Figure 4.10c, and Medieval records in Figure 4.10d, in each case with site-phase records coded by sub-period. No clear trends in the presence of different cereals were identified within any of the broad periods. There is, however, a tendency for early Romano-British records to be absent in the upper left quadrant (Figure 4.10b), where the pulses and flax are located (Fig. 4.10a), and a corresponding tendency for late Saxon records to extend further into this quadrant than the early-mid Saxon records (Fig 10.c). This suggests that the increase in the presence of pulses (and possibly flax) through time (noted in relation to Figure 4.9), occurs gradually between the mid Romano-British sub-period and the late Saxon sub-period.

These trends in the three broad categories of crop types can also be seen in line graphs of these categories based on the percentage of records in each sub-period containing that category (Figure

4.11). Free-threshing cereals as a group are well represented in all periods, being present in c.90-100% of site-phases. Most change is apparent in the glume wheat category: glume wheat presence is high throughout the Romano-British period, declines sharply with the advent of the Saxon period and continues to fall (more slowly) until the High Medieval sub-period. Pulses occur less frequently than the cereals, and the increase in pulse presence occurs more gradually throughout the Saxon period.

To explore trends relating to individual crop taxa that may not follow the general trends for crop types, similar line graphs were plotted for each crop taxon (Figure 4.12). Figure 4.12a shows that emmer and spelt follow the same chronological trend relating to their declining frequency, although spelt is always more often present than emmer. The ubiquity of free-threshing cereals over time is clearly due to the constant ubiquity of barley (Figure 4.12b). The presence of free-threshing wheat, rye and oat increases over time. The presence of free-threshing wheat and rye increases primarily during the transition from the Romano-British to Saxon period, and more gradually thereafter, mirroring the decline in spelt and emmer. Oat is commonly present in all periods and its presence increases gradually through time though many of these records, especially in the Romano-British period, are probably of wild rather than cultivated plants. Within the pulse category, trends in the presence of pea and bean differ from that of lentil (Figure 4.12c). The frequency of all three species is low at the start of the Romano-British period, and the presence of pea and bean changes little during the Romano-British period, increasing thereafter. The frequency of pea increases steadily throughout the post-Roman period, whilst that of bean increases rapidly during the Saxon period (largely in line with the increase in free-threshing wheat and rye though at a lower level of frequency). Lentil is always infrequent, and is almost absent in early-mid Saxon site-phase records. The small increase in flax presence in the early-mid Saxon sub-period may be an anomaly given the small number of site-phases in which flax occurs.

4.3 Spatial patterning

To explore broad spatial variations in crop presence over time, line graphs, based on the percentage of records in each sub-period containing each taxon, were plotted for each of the three climatic zones (Shirlaw, 1966) for which there were at least 100 records in the presence dataset: north-east England and east Scotland, east central and southern England, and west central and southern England (see Figure 3.1 for zones). The graphs for the north-eastern zone (Figure 4.13a) are based on a smaller number of records than the graphs for the more southerly zones (Figures 4.13b-c), which probably accounts for the more variable percentage presence values in the north-east.

Nevertheless, the broad temporal changes in the presence of wheat taxa (the long-term decline in the presence of emmer and spelt and the increase in free-threshing wheat), that were apparent in the whole dataset (Figure 4.12), can be seen in each of the three climatic zones (Figure 4.13). There are, however, north-south differences in the timing and degree of change in the presence of different wheat taxa. In the early Romano-British sub-period, emmer is present at similar levels in all three climatic zones, but in the north-eastern zone it declines earlier (in the mid Romano-British sub-period – Figure 4.13a), while spelt declines rapidly from the late Romano-British sub-period to the early-mid Saxon sub-period in all zones. The apparently more gradual decline in the presence of emmer in the country as a whole (Figure 4.12) may therefore be due partly to regional differences, its decline beginning earlier in the north than in the south. In the southerly zones, the rapid rise in the presence of free-threshing wheat coincides with the greatest decline in emmer and spelt (Figure 4.13b-c), but temporal changes in its presence in the north-east are more difficult to interpret because the large mid Romano-British peak and the early Romano-British and early-mid Saxon troughs (Figure 4.13a) may be a result of the smaller number of records in this zone.

To address this problem of sample size, aggregated data for wheat taxa presence from all three northern, and all three southern climatic zones were compared (Figure 4.14). The changes in the south and the early decline of emmer in the north are still apparent with the larger dataset, but the fluctuating presence of free-threshing wheat in the north is much reduced, and perhaps best described as a gradual increase through time. It is impossible to say whether this is a more accurate reflection of changes in the north due to increased sample size or the result of genuinely contrasting changes in the north-east and north-west.

There is also a more gradual increase in the presence of rye in the north-east (Figure 4.15a) while, in the south, the presence of rye increases primarily during the Saxon period (Figure 4.15b-c). Other than the particularly low presence of oat in the north-east in the early Romano-British period, there are no significant differences in the presence of oat or barley between climatic zones. North-south and east-west differences in the presence of pea and bean appear in the post-Roman period (Figure 4.16). The presence of pea and bean increases in all zones, except the north-east, where the presence of bean does not increase further. In the more southerly zones, the presence of both species increases for longer, and reaches higher levels, in the east than in the west.

The two southerly climatic zones (east and west), which have the largest number of site-phase records, were further sub-divided to investigate intra-zone variations in the presence of crop taxa. Within the eastern zone (Figure 4.17), the data from East Anglia (Figure 4.17a) exhibits differences compared to other areas of the zone: the presence of free-threshing wheat in East Anglia is consistently lower than in other areas, and increases more gradually through the whole Saxon period, whilst the presence of rye increases more rapidly at the end of the Romano-British period, than it does in the other areas. In the western zone (Figure 4.18) the presence of rye is always lower, and the post-Roman increase in the presence of pea more gradual in southern England than in the Midlands.

For the rarest species, chronological trends in their spatial distribution were explored by mapping site-phase presence records, coded by broad temporal period. The distribution of lentil (Figure 4.19a) contracts between the Romano-British and the Saxon periods becoming largely restricted to sites in eastern and southern England. The presence of flax (Figure 4.19b) is concentrated in the east of Britain during all periods.

As free-threshing wheat and oat can only be identified to species from their chaff remains (rachis nodes and floret bases respectively), spatial and chronological changes in these relatively uncommon finds were also explored by mapping site-phase presence records. Records of hexaploid free-threshing wheat rachis become more frequent over time (from presence in 5% of Romano-British, to 12% of Saxon, and 24% of Medieval, records) and are widely distributed (Figure 4.20a). Tetraploid rachis finds also become more frequent (increasing from only two Romano-British records to presence in 6% of Saxon and 12% of Medieval records) but remain spatially restricted to the Midlands and southern England (Figure 4.20b).

Finds of *Avena sativa* (common oat) floret bases increase between the Romano-British (present in 3% of records) and Saxon periods (present in 11% of records) and remain stable in the Medieval period (present in 12% of records). Their distribution extends further into northern England and Scotland in the Medieval period (Figure 4.21a), especially compared to the Saxon period, but this may partly reflect the increase in the number of northern site-phase records between the Saxon and Medieval periods (Figures 4.7-4.8). *Avena strigosa* floret bases remain rare (recorded in only 0.3% of Romano-British records and 3% of Saxon and Medieval records) and concentrated in two areas: most (including both Romano-British records) are in the north-east; and five of the remaining seven are in Wales and south-west England (Figure 4.21b).

The correspondence analysis presented in sections 4.1.4 and 4.1.5, is that using all site-phase presence records (first presented in Figure 4.9). The results of this analysis are reproduced in the figures, with site-phase records coded in different ways depending on the purpose of the figure. In all figures, the species plot resulting from this analysis (showing the clear clustering of glume wheats (emmer and spelt), free-threshing cereals (barley, free-threshing wheat, rye, and oat), and pulses (pea, Celtic bean and lentil) with flax) is reproduced for ease of interpretation.

4.4 Urbanisation

To explore the effects of urbanisation on crop taxa presence, comparisons were made between records from urban and rural sites and between records from different types of town.

4.4.1 Urban and rural sites

The site-phase plots in Figure 4.22 highlight records from the Romano-British (Figure 4.22b), Saxon (Figure 4.22c) and Medieval (Figure 4.22d) periods. In the Romano-British period, both glume wheats and free threshing cereals are well–represented at both urban and rural sites (Figure 4.22a). A difference between urban and rural records first appears in the Saxon period (Figure 4.22c) when urban records become predominant towards the negative end of axis 1 leaving predominantly rural records towards the positive end, indicating that the shift away from glume wheats may have occurred earlier at urban than at rural sites. It is primarily in the Medieval period (Figure 4.22d), that records from rural sites also shift towards the negative end of axis 1, away from the glume wheats. In the Saxon and Medieval periods, first urban and then rural sites extend further into the top left quadrant of the plot associated with non-cereal taxa (Figures 4.22c and d). The presence of free-threshing cereals remains constant at both urban and rural settlements.

Line graphs comparing temporal trends in wheat presence at urban and rural sites (Figure 4.23) show that the decline in emmer and spelt presence is broadly contemporaneous at both urban and rural sites, though the decline of spelt and the increase of free-threshing wheat are again seen to be more rapid at urban sites (complete by end of the early-mid Saxon sub-period) than at rural sites (not complete until the Medieval period). For the Romano-British period as a whole, free-threshing wheat (Figure 4.23) and rye (Figure 4.24) are present more often at urban than at rural sites. As for free-threshing wheat, the increase in the presence of rye at urban sites is complete by the end of the early-mid Saxon sub-period and more gradual at rural sites (not peaking until the Medieval period - Figure 4.24). The same temporal trend (rapid post-Roman increase at urban sites, more gradual increase at rural sites) occurs for oat (Figure 4.24), pea, and bean (Figure 4.25). At rural sites, levels of pea and bean presence are always very similar (Figure 4.25b), but the relatively small numbers of finds at urban sites (especially in the Saxon period) make interpretation difficult. Lentil is a predominantly urban find in the Romano-British period (Figure 4.25a), but from the late Saxon sub-period onwards it is more frequently, and increasingly, present at rural sites (Figure 4.25b). Flax is less frequent at urban than rural sites and the early-mid Saxon increase in presence identified in the whole dataset analysis (Figure 4.12c) is solely attributable to an increase in its presence at rural sites (Figure 4.25b).

In the Romano-British and Saxon periods, rachis fragments of free-threshing hexaploid wheats were mostly found at rural sites but, in the Medieval period, they are common at both urban and rural sites (Table 4.2). The only Romano-British records of tetraploid free-threshing wheat rachis fragments were from Springhead: one from the urban settlement and one from the temple complex, but when records become more frequent, from the Saxon period onwards, they are similarly distributed to those of the hexaploid type (predominantly at rural sites in the Saxon period but equally common at urban and rural sites in the Medieval period)

4.4.2 Types of town

Throughout the study period London was consistently the largest nucleated settlement in Britain and is exceptional not only in its size but also, for example, in its international trading connections, affluence, and associations with aristocratic and political elites. Comparisons were therefore made between London and other sites, in particular contemporary towns, to determine whether its atypical nature is reflected in archaeobotanical assemblages.

The site-phase plot in Figure 4.26 highlights records from London only, with records coded by broad temporal period. Some records from all periods plot in association with free-threshing cereals towards the negative (bottom) end of axis 2 and others towards the positive (top) end in association with pulses and flax. Romano-British records tend to plot towards the positive (right) end of axis 1, associated with glume wheats, and post-Roman records towards the negative (left) end, away from glume wheats. On axis 2, Romano-British records tend to plot more positively than post-Roman records, which could indicate a greater representation of pulses in general at Romano-British sites or a closer association with lentil, which plots at the extreme end of this axis.

To explore temporal trends for individual taxa, line graphs were plotted comparing the presence of crop taxa in London with their presence in the rest of the country (Figures 4.27-4.29). The same broad trends in the presence of cereal taxa occur in both London and elsewhere, but several major changes occur earlier in London: the presence of emmer falls sharply between the early and mid Romano-British sub-periods (Figure 4.27a), and the largest increases in the presence of free-threshing wheat (Figure 4.27a) and rye (Figure 4.28a) occur between the mid and late Romano-British periods. The rarity of non-cereal taxa finds, and the low number of London records, limits comparisons with the rest of the country. The most striking difference is the disproportionately high presence of lentil in London in the Romano-British period, this is therefore the most likely explanation of the high frequency of non-cereal taxa in Figure 4.26, while pea and bean are absent until the late Romano-British sub-period (Figure 4.29a). Flax is also somewhat less frequently found in London than elsewhere.

Bar charts were used to compare the presence of taxa in London and other major and minor towns, in all periods or sub-periods for which there were sufficient records. In the Romano-British period, it is apparent that, the larger the town, the lower the presence of emmer or spelt, while the presence of free threshing wheat is lower in the minor towns than in the major towns and London (Figure 4.30a). The early decline in the presence of emmer seen in London also occurred (more gradually) in major towns (though this is based on a small number of records), but not in minor towns (Table 4.3). The relative scarcity of barley in London, is not replicated in other towns (major or minor) (Figure 4.30b). Variation in the presence of non-cereal taxa in different types of town may not be significant, given the small numbers of records, but the frequent occurrence of lentil in London, and its near absence in other towns, is again striking (Figure 4.30c). Pea, bean and flax are more frequent in the major towns than in either London or the minor towns.

The scarcity of records from urban settlements outside London precludes independent analysis for the early-mid Saxon period and, because of changes in the economic basis of urban settlement between the mid and late Saxon sub-periods (from *wics* to burhs – see section 2.1.1.2), it would have been inappropriate to combine records from the two sub-periods. For the late Saxon sub-period, towns have not been categorised on the basis of size, as available measures are unlikely to reflect their relative wealth *per capita*. In this period, oat and barley were less frequently present in towns outside London (Figure 4.31a) but finds of pea were more frequent (Figure 4.31b).

In the Medieval period (Figure 4.32) there is little difference in the presence of cereal taxa between the different types of town, apart from the lower occurrence of barley in High Medieval London, where there is also a greater frequency of free-threshing wheat (Figure 4.32a). In the late Medieval sub-period, the highest frequency of barley is in major towns (outside London) and the lowest frequency of rye is in the minor towns (Figure 4.33b). In the High Medieval sub-period, the smaller the town the greater the frequency of pea and bean but, in the late Medieval sub-period, these species are most frequent in the major towns (again, outside London). Flax is always rare but (in the Romano-British and Medieval periods at least) occurs more often in towns other than London (Figures 4.30c and 4.33).

4.5 Social status

To explore the effects of social differentiation on crop taxa presence, comparisons were made focussing on records from elite, military, and religious sites and comparing these with non-elite, civilian and secular sites.

4.5.1 Rural secular sites: elite and non-elite

The site-phase correspondence plot in Figure 4.34b highlights records from rural sites with evidence for occupation by secular elites (villas in the Romano-British period, and aristocratic manors in the Saxon and Medieval periods), while the plot in Figure 4.34c highlights records from non-elite rural sites. Records in both plots are coded by broad temporal period. As in the dataset as a whole, elite and non-elite Romano-British records tend to plot towards the positive (right) end of axis 1, associated with glume wheats, and post-Roman records towards the negative end, away from glume wheats, while some records of all periods are associated with free threshing cereals at the negative (bottom) end of axis 2.

There is, however, a difference between elite and non-elite sites in the pace of these changes. At elite sites (Figure 4.34b) there is a fairly abrupt transition between the Romano-British period, when most of the records are associated with glume wheat (plotting towards the positive (right) end of axis 1), and the post-Roman period, when very few records plot in association with glume wheats, clustering instead in association with free-threshing cereals or non-cereal taxa (towards the negative (left) end of axis 1).

At non-elite sites, this transition is more piecemeal (Figure 4.34c), as indicated by several Saxon records associated with glume wheats, and a few Romano-British records associated with non-cereal taxa. A more gradual change at non-elite sites is also indicated by the predominance of Saxon records near the midpoint of axis 1 (reflecting the presence of both crop types), while Medieval records extend further into the area of the plot associated with non-cereal taxa (Figure 4.34c). There is also no apparent change through time in the occurrence of free threshing cereals at non-elite sites.

4.5.2 Roman military influence

The site-phase correspondence plots in Figure 4.35 highlight records from sites with different degrees of military influence: military forts (Figure 4.35b), *vici* (Figure 4.35c), and former *vici* (i.e. *vici* following military withdrawal from their associated fort – Figure 4.35d), and comparable civilian sites (contemporary small towns with no military influence - Figure 4.35e). Records in each plot are coded by Romano-British sub-periods.

The three fort records plotting furthest towards the positive end of axis 1 (associated with glume wheats) are all from the early Romano-British sub-period (Figure 4.35b), while fort records from subsequent sub-periods are largely located (with the rest of the early Romano-British records) in or near the lower right quadrant of the plot reflecting the presence of both free threshing cereals and glume wheats. Only one record (from an early Romano-British fort) plots in the upper left quadrant associated with non-cereal crops. In contrast, at small civilian towns (Figure 4.35e), several early and mid Romano-British records are located towards the positive (upper) end of axis2 (associated with non-cereal taxa) as well as the negative (bottom) end (in association with free threshing cereals). The association of site-phase records with glume wheats towards the right end of axis 1 is also not confined to the early Romano-British sub-period, with two late Romano-British records plotting at the positive (right) end of axis 1).

Records from functioning *vici*, like the majority of records from forts, cluster in and around the lower right quadrant of the plot (Figure 4.35c, indicating the presence of glume wheats and free-threshing cereals), but *vici* records are absent at the positive end of axis 1, where glume wheats are located. However, a few early Romano-British *vici* records plot towards the positive (upper) end of axis 2, indicating the presence of both glume wheats and non-cereal taxa. Only one *vicus* record plots in the upper left quadrant, associated primarily with non-cereal taxa. Several records from former *vici* plot towards the positive (right) end of axis 1 (associated with glume wheats - Figure 4.35d), having more in common with civilian small towns (Figure 4.35e) and early Romano-British forts (Figure 4.35b), even though they are of mid to late Romano-British date, perhaps indicating a recurrence of glume wheat as military influence declines. The majority of former *vici* records, however, are grouped around the origin of the plot indication the presence of several different crop types.

Bar charts comparing the presence of individual cereal taxa at military-influenced sites (forts, *vici* and former *vici*) and at small civilian towns in the Romano-British period (Figure 4.36) indicate that spelt presence was lower at forts than at the other types of site.

4.5.3 Saxon and Medieval religious influence

The site-phase correspondence plots in Figure 4.37 highlight records from Saxon and Medieval religious (Christian) institutions: monasteries, hospitals, and the residences (palaces and manors) of high-ranking clergy (Figure 4.37b), and comparable secular elite sites (manor houses, castles, and palaces – Figure 4.37c). Some of the records from religious sites plot towards the negative (bottom) end of axis 2 associated with free-threshing cereals, and others in the upper left quadrant of the plot in association with non-cereal taxa. None of these records plot towards the positive (right) end of axis 1 associated with glume wheats. These religious site-phase record share their associations with free-threshing cereals and non-cereal taxa, and their lack of glume wheats, with records from secular elite sites (Figure 4.37c). No differences between the three categories of religious institution were evident. Coding records by temporal period or sub-period, and by rural or urban location did not reveal any further associations (plots not shown).

4.6 Summary

The major change in crop presence over the study period is the decline in glume wheat presence and the concomitant rise in the presence of free-threshing cereals (primarily free-threshing wheat and rye). This transition occurs primarily between the late Romano-British and mid Saxon sub-periods. Of the two glume wheats, spelt is present more often than emmer (at least twice as frequently), and free-threshing wheat occurs more frequently than rye. Barley presence is frequent in all periods, and the presence of oat (some of which may be wild) increases gradually over time which, together with finds of the cultivated variety, *Avena sativa,* in the Saxon period, suggests that at least some of this increase is due to the cultivation of oat from this period onwards. The decline in the presence of emmer occurs earlier in the north (during the Romano-British period) than in the south of the country (where emmer and spelt both decline primarily between the Romano-British and Saxon periods), and the rise in the presence of free-threshing wheat and rye is more gradual in the north than in the south, where both cereals increase more rapidly between the late Romano-British and mid-late Saxon sub-periods. There is also some evidence that, in the Saxon period, rye was more frequently present in East Anglia and the West Midlands.

This transition from glume wheats to free-threshing wheat and rye occurs more rapidly at urban than rural sites (complete by the mid Saxon period) and begins earlier in London (in the Romano-British period) and at sites connected to the Roman army (forts and *vici*), while glume wheats persist at some civilian sites (including former vici), and at some sites without evidence for elite occupation, into the Medieval period. In the Romano-British period, the greater the size of the town, the lower the presence of glume wheat and (less consistently) the higher the presence of free-threshing wheat and rye. In the Romano-British countryside, the transition from glume wheats to free-threshing cereals was apparently completed earlier and more abruptly at elite sites, (between the Romano-British and Saxon periods, in common with religious sites) than at non-elite sites, where the transition was more piecemeal throughout the Romano-British and Saxon periods.

The presence of pea and bean begins to rise in the post-Roman period, at the same time as the increase in the presence of free-threshing wheat and rye, and continues to rise until the Medieval period, rising more rapidly in the east of the country, at urban sites, and rural elite sites, than in the west and at rural non-elite sites. The distribution of lentil is very different to that of the other pulses. Finds of lentil are rare except in London in the Romano-British period, and on rural sites in central and southern England from the late Saxon sub-period onwards. Finds of non-cereal taxa are relatively rare at Roman military-influenced sites (forts, *vici* and even former *vici*) compared to comparable small civilian towns. Records of pulses are less frequent than those of cereals, and records of flax are less common than those of pea or bean. Flax tends to be more frequent at rural than urban sites from the Saxon period onwards, and it is particularly rare in London.

Chapter 5. Results: Sample contents analysis

The analysis of the sample contents dataset aimed to explore in more detail the spatial and socio-economic patterning identified in the site-phase analysis (Chapter 4), to identify trends that may not have been apparent, or which were unclear, in the presence data. In particular, the analysis of individual samples is useful for distinguishing crops that were deliberately cultivated from those that may have been present on site merely as contaminants of another crop or a minor component of a mixed crop.

Before the cultural, economic, and environmental influences on sample composition can be explored, the effects of preservation method and crop-processing on sample composition should be considered. Charring favours the preservation of cereals over pulse and fibre crops, and preservation by charring is most likely to occur in settings where fire is used (in domestic, industrial, or crop drying contexts).

5.1 Crop processing analysis

For the purposes of this study, the crop processing stage from which samples derive was considered primarily because of the confounding effect this has on sample composition: by reducing the variation due to subsequent crop processing, the effects of decision-making relating to crop cultivation prior to processing can be isolated, so that comparisons between samples can be more reliably interpreted as reflecting these earlier decisions.

Discriminant analysis was used to classify samples according to their crop processing status on the basis of their weed seed characteristics, by comparison with samples of known processing status, following the method proposed by Jones (1984, 1987) as described in Chapter 3. Of the 2994 archaeobotanical samples containing at least 30 field crop items, 1933 contained at least 10 seeds of wild species (identified to genus) that were considered potential weeds of cultivation (see Section 3.4.3.3), which is the threshold used by Jones (1987) for inclusion of archaeobotanical samples in this type of crop processing analysis.

The discriminant analysis successfully discriminates between the different ethnographically collected crop processing products and by-products: 84% of the Amorgos samples were classified to their known crop processing status on re-analysis (Jones 1984). The discriminant functions extracted by the analysis of the ethnographically collected samples were used to classify the archaeobotanical samples. Of these samples, 1689 were classified as fine sieve by-products, 222 as fine sieve products, and 22 as winnowing by-products, with a probability of 50% or over. No samples were classified as coarse sieve by-products. These results are visually presented in Figure 5.1, which displays the relationship of the archaeobotanical samples to the ethnographically collected samples on discriminant functions 1 and 2 (function 3, which primarily separates samples of winnowing by-products from other samples, is not shown).

The scarcity of winnowing by-products, and the absence of coarse sieving by-products amongst the archaeobotanical samples is consistent with observations of traditional farming communities, where early processing stages are usually conducted well away from household fires (Jones, 1983) (e.g. in threshing barns - (Peters, 1998; Claridge and Landgon, 2011; Wadsworth, 2016) - or on covered threshing floors - (University of Leicester Archaeological Services, 2000). So their by-products are relatively unlikely to come into contact with fire accidentally and, if they were deliberately burnt as kindling or fuel, their light chaff content is more likely to be destroyed than preserved (Boardman and Jones, 1990).The rural origins of nearly all (19 of 22) samples classified as winnowing by-products (Table 5.1) is consistent with their derivation from an early stage of crop processing. Such a small number of samples, with little socio-economic diversity, makes the winnowing by-product sample dataset unsuitable for further analysis as a group on their own.

222 samples were classified as likely to represent fine sieve products, i.e. cereal grains or pulse seeds cleaned and ready for use. Every type of site is represented in this processing group, which is unsurprising since the consumption of staple field crops is to be expected at all occupation sites However, although there are reasonably large numbers of samples from the main temporal periods and of samples classified as either urban or rural, the number of samples is small for many site types, particularly those relating to socio-economic status (e.g. types of towns, secular elite sites, and religious institutions) which are the main focus of this analysis (Table 5.2). The fine sieve products dataset was not, therefore, too small for reliable analysis as a separate group.

The classification of most samples (87% of those entered into the discriminant analysis, n=1933) as likely to be fine sieve by-products is also consistent with the predominance of discard contexts in the dataset. Late-stage cereal processing is most often carried out in domestic settings, where waste is likely to be used as fuel or simply disposed of by burning in hearths (Hillman, 1984). Fine sieve by-products are therefore particularly likely to enter the charred archaeobotanical record. Unlike the other processing groups, the fine sieve by-product samples constitute a large enough dataset for detailed analysis.

The crop processing analysis was repeated, treating oat grains from the Romano-British period as crop weeds rather than a cultivated crop. As expected, this resulted in some of the Romano-British samples previously classified above as fine sieve by-products (c.50 out of 687) being re-classified as fine sieve products (due to the large size of oat grains). There was little change in the distribution of fine sieve by-product samples between the various socio-economic categories; in particular, the re-classified samples were no more likely to derive from storage contexts or consumer sites, suggesting that these too were primarily from discard contexts. The slightly increased number of fine sieve product samples would also remain of an insufficient size for reliable independent analysis. A consistent approach for all temporal periods was therefore favoured, with oat treated as a crop rather than a weed throughout.

An initial correspondence analysis of the dataset as a whole (including winnowing and fine sieve by-products, as well as the products of fine-sieving), was dominated by a clear crop processing signature on axis 1, with chaff categories (emmer and spelt glume bases) plotting towards the negative (left) end of the axis, and grain of both glume wheats and free-threshing cereals towards the positive (right) end (Figure 5.2a). The purpose of crop processing is to separate grain from chaff (and weed seeds), thus altering the proportions of grain and chaff items found in a harvested crop, but this crop processing effect may mask differences in crop species composition due to other, socio-economic, factors prior to processing. The analysis of fine-sieve by-product samples as a group on its own, however, reduced (but did not eliminate) the effect of processing on the analysis**.** This revealed differences in crop species composition along axis 2 (Figure 5.2b), with greater separation between the chaff of emmer (plotting towards the positive (upper) end) and spelt (plotting more neutrally), as well as a smaller improvement in the separation of emmer from spelt grains along the same axis. This may indicate differences in the crop choices made by farmers or consumers. The processing signature is still apparent on axis 1, probably reflecting the mixed composition of these ‘discard’ samples that, although primarily derived from processing by-products, may also contain the remnants of discarded processing products.

Further sample analyses were therefore conducted on this fine-sieve by-product group of samples (which also includes the samples that would have been reclassified out of this group if oat had been treated as a (large-seeded) weed). The distribution of these samples between temporal, spatial, and socio-economic categories is described below.

5.2 Description of the sample contents dataset used in analyses

The distribution of fine sieve by-product samples between and within the three broad temporal periods (Figure 5.3) is very similar to that of records within the site-phase dataset (Figure 4.2). The Romano-British and Medieval periods are, again, better represented than the Saxon period: 687

samples date to the Romano-British period, 399 samples (24%) to the Saxon period, and 602 samples (36%) to the Medieval period. Sample records are evenly distributed between the sub-periods of the Romano-British and Saxon periods, but (as in the site-phase dataset) the High Medieval period is better represented than the late Medieval.

The spatial distribution of the sample records, as represented by their frequency in the six climatic zones (Figure 5.4), conforms to the same broad pattern as that of the site-phase records. The two central and southern zones of England are best represented, and the north-east England and eastern Scotland zone is (again) the only other zone with over 100 records. However, there are some differences between the two datasets: the predominance of eastern central and southern records is greater in the sample dataset (comprising 60% of samples compared to 45% of site-phases), and there are even fewer (only 2) sample records from the Saxon period in the northern England and eastern Scotland zone.

In the Romano-British and Saxon periods, the relative proportions of urban and rural records are again similar for the sample (Figure 5.5a) and site-phase datasets (Figure 4.3b). For the Medieval period, urban records are proportionately less well represented in the sample dataset than in the site-phase dataset. Figure 5.5b illustrates that London sites are poorly represented in the sample dataset in the Romano-British and Medieval periods, but are more predominant in the early-mid Saxon sub-period than in the site-phase dataset, while minor towns are even more rare in the Saxon period as a whole.

Figure 5.6 shows the origins of samples from the various socio-economic site categories analysed below (Section 5.3.4). In the Romano-British period, samples from military influenced sites (forts and *vici*) are rare in comparison to the number of site-phase records, but the proportion of rural secular elite (villa) sites is very similar in the two datasets. The proportion of Saxon period samples and site-phase records associated with secular elite and religious occupation are similar. High Medieval rural secular elite sites are better represented in the sample dataset than the site-phase dataset, as are late Medieval rural religious institutions.

To summarise, the under-represented site types in the fine sieve by-product dataset are primarily either Late Medieval sites, sites outside central and southern England, Romano-British military sites, or London sites of the Roman and Medieval periods. The relative lack of high quality archaeobotanical data from the Late Medieval period, and from sites outside central and southern England, is consistent with wider biases in the British excavation and publication record (Evans, 2015). The shortage of records from military sites and sites in London may relate to their status as consumer settlements (with an expected bias towards fine sieve product samples). However, for none of these categories would combining the product and by-product groups solve the problem of low numbers of samples. Analysing both groups together would only increase the number of Late Medieval samples by 6 (a 3% rise), and all other site types would still be represented by fewer than 25 records (see Tables 5.2 and 5.3 for numbers), so the analysis of products and by-products together would not materially increase the reliability of conclusions drawn (while introducing a potentially confounding bias due to the influence of crop processing on sample composition). The analysis of fine-sieve by-products alone (by far the largest group in the overall dataset) is therefore preferred, and interpretations based on the data from the smaller site categories are used as supplementary evidence and treated cautiously.

The correspondence analyses described in the remainder of this chapter derive from the analysis of the cereal content of samples only. The sample data show that, when present, pulses rarely constitute a large proportion of total crop contents. In 99% of samples, pulses account for less than 30% of the total crop content; in 97% of samples, pulses account for less than 10% of total crops. Only 7% of samples contained cultivated flax (*Linum usitatissimum*), and very few of these contained s large proportion of flax: in only 1% of samples did flax seeds account for more than 10% of the total crop content. When pulse and fibre crop seeds were included in correspondence analyses, they exerted such a strong influence over the first and second axes that more significant patterning relating to the cereal crops was obscured). Variation in the pulse and flax content of samples is described at the end of each major section below. Grain and chaff items were coded separately in all analyses.

A correspondence analysis of fine sieve by-product samples from all temporal periods was conducted, along with separate analyses of data from each broad temporal period. Glume wheats were included in the analysis of Romano-British samples but, in the post-Roman periods, the small number and size of the glume wheat records create noise in the analyses, that could mask more robust patterning relating to free-threshing cereals. Glume wheats were therefore excluded from the analyses of Saxon and Medieval samples. The rachis internodes of free-threshing cereals tend to be poorly represented compared to grain in charred assemblages from late-stage processing because these parts are usually removed off-site, while the glume bases of glume wheats tend to be well represented compared to grain in the by-products of late-stage crop processing. Grain records therefore provide the best indication of variation in the cultivation and use of free-threshing cereals while chaff best represents this for the glume wheats. For these reasons, analyses including Romano-British samples include all fine sieve by-product samples containing a minimum of 30 grains and/or chaff items of glume wheat or free-threshing cereal, while analyses of Saxon and Medieval samples include only samples containing a minimum of 30 grains of free-threshing cereal. Table 5.4 lists the taxa and plant part codes that appear on the resulting species plots.

5.3 Temporal trends

In the species plot of axes 1 and 2 from an analysis of all periods (Figure 5.7a), grain from all free-threshing cereals plots near the positive (right) end of axis 1, while free-threshing chaff (rachis internodes) plots positively but mostly less strongly. Barley, oat and rye grain (and to a lesser extent barley chaff) plot towards the positive (top) end of axis 2, while free-threshing wheat grain and chaff plot towards the negative end. Glume wheat grain and chaff (glume bases) all plot in, or close to, the upper left quadrant of the plot (towards the negative end of axis 1 and the positive end of axis 2). There is also a consistent tendency for chaff to plot more negatively on axis 1 than the grain of the corresponding species, which perhaps indicates a residual effect of crop processing. Oat, and especially rye, also plot separately from the glume wheats on axis 3 – the former towards the positive (right) end, the latter (except spelt chaff) towards the negative (left) end (Figure 5.7c). On this axis, free-threshing wheat and barley (as well as spelt chaff) plot neutrally, while emmer chaff plots positively (near the top) on axis 4. The correspondence analysis plots of samples were first coded by broad temporal period (Figure 5.7b and d). In the plot of axis 1 and 2, (Figure 5.7b) most of the Romano-British samples are associated with glume wheats and/or barley towards the negative (left) end of axis 1 and the positive (top) end of axis 2, while the Saxon and Medieval samples plot towards the positive (right) end of axis 1, associated with grains of free-threshing cereals. The Medieval samples are concentrated towards the negative (bottom) end of axis 2, associated with free-threshing wheat, while Saxon samples are distributed along the length of axis 2, associated with both free-threshing wheat and/or other free-threshing cereals. So, although the *presence* of free-threshing wheat increased rapidly between the Romano-British and Saxon periods, it was not until the Medieval period that it became the *major component* of most samples, barley being the major component of a larger number of Saxon samples. Almost all of the samples rich in emmer (grain or chaff) and spelt grain (plotting towards the negative end of axis 3 in Figure 5.7d) date to the Romano-British period, while most rye-rich samples (plotting towards the positive end) are of Medieval date. The few samples with significant quantities of emmer chaff (plotting towards the positive end of axis 4) all date to the Romano-British period.

Separate correspondence analyses were then conducted for each temporal period, with samples coded by sub-period. The plots resulting from the analysis of the Romano-British samples are presented in Figure 5.8. As in the species plot for all fine sieve by-products, there is a residual crop processing effect on correspondence axis 1: grain-rich samples tend to plot towards the positive (right) end of the axis and chaff-dominated samples towards the negative (left) end. Free-threshing wheat and barley grains (and to a lesser extent rye grain) plot nearest to the positive end of axis 1, and are separated from each other on axis 2, free-threshing wheat near the positive end, barley near the negative end (with rye in a neutral position (Figure 5.8a). Emmer chaff plots near the positive end of axis 3 away from other cereals (Figure 5.8c).

Samples rich in free-threshing wheat grain (plotting in the upper right quadrant of the plot) become more frequent in the mid and late Romano-British sub-periods (Figure 5.8b), but there is no change in the frequency of barley-rich samples (plotting in the lower right quadrant). On the other hand, a decline in emmer chaff-rich samples is indicated by the relative paucity of samples from the mid and late Romano-British sub-periods (compared to those from the early sub-period) towards the positive end of axis 3 (Figure 5.8d).

In the species plots resulting from analysis of Saxon samples, axis 1 separates free threshing wheat, towards the positive end, from the other cereals (Figure 5.9a). These other cereals are separated along axis 2: barley towards the negative end, oat and rye towards the positive end (Figure 5.9a and c). Oat and rye are separated on axis 3 towards the negative and positive ends respectively (Figure 5.9c). The reduced number of cereal species (free-threshing cereals only) entered into this analysis means that the variation within the dataset is adequately described by these three axes.

Unlike the plots of Romano-British samples, Saxon samples are fairly evenly distributed along axes 1 and 2, with some samples rich in one species and others containing a mixture of different species (Figure 5.9b). Samples dominated by barley and free-threshing wheat are equally common in the early-mid Saxon sub-period: samples are evenly distributed between the lower left quadrant (towards the negative ends of both axes 1 and 2 in in Figure 5.9b) and towards the positive (right) end of axis 1 respectively. The proportion of samples rich in free-threshing wheat increases in the late Saxon period, when most samples cluster towards the positive (right) end of axis 1. Late Saxon samples predominate close to the positive end of axis 2 (Figure 5.9b and d) and negative end of axis 3 (Figure 5.9d). This is best seen in relation to species composition in the lower right quadrant of Figure 5.9d, indicating an increase in oat-dominated samples in this sub-period which may represent the rise of cultivated oat (as opposed to wild oats growing as a weed of other cereals in earlier sub-periods). A few rye-rich samples occur in both the early-mid and late Saxon sub-periods, plotting positively on axis 3 (Figure 5.9d).

In the species plots from the analysis of Medieval samples, free-threshing wheat plots towards the negative end of axis 1, while oat and rye plot towards the positive end (Figure 5.10a). On axis 2, oat plots negatively, while rye plots positively. Axis 3 separates barley (towards the positive end) from the other species (Figure 5.10c). As for the Saxon period, these three axes sufficiently describe the variation of the free-threshing cereals in the Medieval samples. Samples rich in free-threshing wheat predominate throughout the Medieval period, clustering towards the negative (left) end of axis 1 (Figure 5.10b and d) and the negative (bottom) end of axis 3 (Figure 5.10d). There is also little change in the proportion of rye-, oat- or barley-dominated samples between the high and late Medieval sub-periods, all of which are relatively infrequent compared to samples in which free-threshing wheat predominates (Figure 5.10b and d).

The two pulse species that are most abundant in Romano-British samples are lentil and pea, and the Romano-British period is the only period in which there is a sample dominated by lentil. Pea dominated another sample and, based on size, is likely to be the pulse accounting for the poorly preserved “large legumes” predominating in two others). No samples were predominantly comprised of bean, or bean-sized legume seeds.

Although the presence of lentil recurs in the late Saxon sub-period, this is not associated with lentil-dominated samples: the number of seeds is always fewer than 10 per sample, and these always account for less than 3% of identifiable crop items). Pea is also only a very minor component of Saxon samples, never accounting for more than 10% of the identifiable crop items in a sample, and, although there are six bean-rich samples (three of which are comprised predominantly of bean) these all derive from one site.

Rather than being dominated by one pulse species (as in the Romano-British and Saxon periods), the eight pulse-rich samples of the Medieval period tend to be comprised of several species (pea, bean and, in two cases, also including lentil).

In four samples (one late Romano-British and three early-mid Saxon), flax accounts for the majority of seeds. There are no Medieval samples in which flax accounts for 10% or more of the identifiable crop seeds.

5.4 Spatial patterning

Sample plots for the separate correspondence analyses of Romano-British, Saxon, and Medieval periods were then re-coded by climatic zone (Shirlaw, 1966) to explore the spatial and climatic influences on sample composition. Samples from the three climatic zones represented by over 100 samples (north-east England and eastern Scotland, eastern central and southern England, western central and southern England), plus those from Wales and south-west England, are highlighted in the sample plots. Although there are few samples from Wales and south-west England, these were highlighted separately because they occupy distinctive positions in the correspondence plots. To improve visibility, samples from different climatic zones are displayed in separate plots in some of the figures in this section.

In the Romano-British period, there are proportionately more barley grain-rich samples in the north (Figure 5.11b), (plotting in the lower right quadrant, towards the positive end of axis 1 and negative end of axis 2) than in the south (Figure 5.11c-e). Barley-rich samples are particularly infrequent in Wales and south-west England (Figure 5.11e). There are relatively few samples rich in free-threshing wheat grain in any zone (in the upper right quadrant towards the positive ends of axes 1 and 2), and none in Wales and south-west England (though the overall number of samples in this zone is small). Samples rich in emmer chaff, plotting near the positive (right) end of axis 3, are present in all zones (Figure 5.12c-e) except the northern zone (Figure 5.12b) though, even here, there are a few samples with a significant proportion of emmer chaff. The lack of samples rich in free-threshing wheat and barley grain in Wales and south-west England (Figure 5.12e) is also apparent towards the negative (lower) end of axis 4.

The east-west difference in central and southern England identified in the Romano-British period (more barley-rich samples in the east than the west) continues into the Saxon period (Figure 5.13b): A large group of free-threshing wheat-dominated samples from the eastern zone cluster towards the positive (right) end of axis 1, and a smaller group of barley-dominated samples plot in the lower left quadrant (towards the negative ends of axes 1 and 2) whereas, in the western zone, there is a smaller cluster of free-threshing wheat-dominated samples and no cluster of barley dominated samples. The western zone is characterised by a large number of samples containing oat or rye, mixed with varying proportions of free-threshing wheat, in the upper right quadrant of the plot and extending into the upper left. The samples from Wales and south-west England are again very distinctive, characterised primarily by samples in which cereals other than free-threshing wheat predominate (plotting towards the negative end of axis 1). It is clear from the plot of axis 2 and 3 (Figure 5.13d) that the samples from Wales and south-west England (distributed from left to right along axis 2 and towards the negative end of axis 3) are rich in oat or barley, with an admixture of some free-threshing wheat), rather than rye which is confined to samples from central and southern England (plotting towards the positive (upper) end of axis 3.

In the Medieval period, samples rich in free-threshing wheat and/or barley are most common in central and southern England (plotting negatively on axis 1 and/or axis 2 in Figure 5.14c and d), while oat-rich samples are more common in the north and in Wales/south-west England (plotting in the lower right quadrant of Figure 5.14 b and e). It is apparent from Axis 3 that the majority of samples from central and southern England are rich in free-threshing wheat rather than barley (tending to cluster in the lower left quadrant in Figure 5.15c and d). This contrasts with the north-east and Wales/south-west England, where there are no barley-dominated samples (plotting near the positive (top) end of axis 3 in Figures 5.15b and e), though in these zones there are a few samples with a significant proportion of barley (which plot slightly positively on axis 3).

88% (n=17) of pulse-rich samples (pulses comprising 30% or more of the sample) are from sites in the east (north-eastern and eastern central and southern climatic zones), which is consistent with the predominantly easterly distribution of pea and bean presence records in the site-phase analysis. 5 of the 7 (74%) flax-rich samples were also from the east (eastern central and southern climatic zone only).

5.5 Urbanisation

To explore the effects of urbanisation on the crop composition of samples, comparisons were made between samples from urban and rural sites and between samples from different types of town.

5.5.1 Urban and rural sites

Sample plots from the correspondence analysis of Romano-British samples were re-coded according to whether they were from urban or rural sites (Figure 5.16), indicating that there is little difference in the proportion of samples from urban and rural sites that were dominated by either free-threshing wheat or barley grain (samples from both types of site are distributed across the plot of axes 1 and 2 in similar proportions (Figure 5.16b). Rural samples are, however, more often rich in emmer chaff (plotting positively (right) on axis 3 in Figure 5.16d), although a single urban sample contained a higher proportion of emmer chaff than any other sample.

Sample plots from the correspondence analysis of Saxon samples were first coded by whether they were from urban or rural sites and, secondly, separate plots highlighting urban or rural samples were coded according to sub-period (early-mid or late Saxon). Although there appears to be little difference in the proportions of samples dominated by different cereal taxa in the Saxon period overall (Figure 5.17b), this masks a change over time during this period. It is apparent from the two plots highlighting urban and rural sites separately (Figure 5.17c and d respectively), that there is a decline in barley-rich samples (plotting in the lower left quadrant towards the negative ends of axes 1 and 2) between the early-mid and late Saxon sub-periods, at both urban and rural sites. This decline in barley occurs earlier at urban sites than at rural sites: few samples from urban sites plot in association with barley even in the early-mid Saxon sub-period (Figure 5.17c) and, although many samples from rural sites do plot with barley (Figure 5.17d), most of these date to the early-mid Saxon sub-period.

Alongside the decline in barley–dominated samples, there is a corresponding increase in oat- and/or rye-dominated samples in the late Saxon sub-period (plotting in the upper left quadrant of Figure 5.17c and d). Rye-dominated samples appear first primarily at early-mid Saxon rural sites (plotting towards the positive (upper) end of axis 3 in Figure 5.18d), though there are relatively few urban sites in total in this early sub-period. By the late Saxon sub-period, there are many more rye-dominated samples, and these are virtually all from urban sites.

In the Medieval period, there is no longer a difference in the incidence of barley-rich samples at urban and rural sites, but rye-rich samples retain their urban associations (outnumbering rural samples in the upper right quadrant of Figure 5.19b). Coding samples according to temporal sub-period (not shown) revealed no changes in sample composition during the Medieval period.

The Saxon period is also unusual in relation to finds of pulse-rich samples. In the Romano-British and Medieval periods, pea and bean-rich samples are restricted to rural sites, but in the Saxon period the bean-rich samples are restricted to London.

5.5.2 Types of town

In Figure 5.20, sample plots from the correspondence analysis of Romano-British samples highlight urban samples, coded according to whether they derive from London, other major towns or minor towns. There are very few samples from London in the dataset, and all but one of these date to the early Romano-British sub-period. Barley predominates in some of these (plotting into the lower right quadrant of Figure 5.20b, towards the positive end of axis 1 and negative end of axis 2) while, in other samples, barley is mixed with other species. The single late Romano-British sample is the only Romano-British sample from London dominated by free-threshing wheat (plotting in the upper right quadrant, towards the positive ends of both axes). Samples from other major towns tend to be rich in free-threshing cereal grains (all plotting towards the positive end of axis 1, Figure 5.20b) but the number of samples is relatively small. Some of these are rich in barley (plotting in the lower right quadrant of Figure 5.20b, towards the negative end of axis 2) and others have significant quantities of free-threshing wheat plotting in the upper right quadrant, towards the positive end of axis 2), though all four samples are from the same site. Most of the Romano-British urban samples come from minor towns, and relatively few of these plot towards the positive end of axis 1 with either free-threshing wheat or barley grain. Of the few urban samples with significant quantities of emmer chaff (plotting positively on axis 3 in Figure 5.20d), all but one are from minor towns, as are almost all urban samples rich in emmer or spelt grain (plotting towards the positive end of axis 4 in Figure 5.20d). The only sample from London plotting (slightly) positively on axis 3 dates to the early Romano-British sub-period.

In the Saxon period, clear differences between samples from London and other major towns emerge. Samples from London are more often rich in free-threshing wheat grain (plotting towards the positive (right) end of axis 1 in Figure 5.21b), while samples from other major towns are more often rich in rye and/or oat grain (plotting in the upper left quadrant towards the negative and of axes 1 and positive end of axis 2). It is clear from axis 3, however, that, while rye-dominated samples (plotting positively) are present in both London and other major towns, oat-dominated samples are a feature of other major towns only (plotting towards the negative (lower) end of axis 3 in Figure 5.21d).

In the Medieval period (Figure 5.22), the (few) samples from London are mostly of mixed composition being widely distributed along all three axes, often in a central position. Samples from other major towns tend not to be rich in rye (with few samples plotting positively on axis 2 in Figure 5.22b) but tend to have a higher proportion of samples dominated by or with a significant component of barley (plotting positively on axis 3 in Figure 5.22d). Free-threshing wheat samples from minor towns are proportionately well represented towards the negative end of axis 1 and axis 3, and samples rich in oat and rye are also well represented in these towns (plotting towards the positive end of axis 1 and the negative end of axis 3).

To summarise, the relationship between urbanisation and pulses/flax, the Saxon period is again distinctive. In the Romano-British and Medieval periods, pea- and bean-rich samples are restricted to rural sites, but in the Saxon period bean-rich samples are restricted to London. The only pulse-rich samples from urban sites (of any period) are the Saxon bean-rich samples from the Long Acre site in London. In contrast, there were no flax-rich samples in London in any period.

5.6 Social status

To explore the effects of social differentiation on the crop composition of samples, comparisons were made between samples from elite, military, and religious institutions and samples from non-elite, civilian and secular sites.

5.6.1 Rural secular sites: elite and non-elite

In the Romano-British period (Figure 5.23), there is less variation in the composition of samples from rural elite sites than in those from non-elite sites. Allowing for the relative number of samples from elite (59) and non-elite (239) sites, fewer samples from elite sites are dominated by barley grain (plotting in the lower right quadrant of Figure 5.23b), and none contain significant quantities of emmer chaff (plotting towards the positive end of axis 3, Figure 5.23d). Samples rich in free-threshing wheat (plotting in the upper right quadrant near the positive ends of axes 1 and 2 in Figure 5.23b) are relatively rare at both elite and non-elite sites. This relative lack of samples dominated by free-threshing wheat and barley grain, and emmer chaff, suggests a focus on spelt at Romano-British rural elite sites.

In the Saxon period (Figure 5.24), samples from non-elite rural sites are widely distributed along all three axes, with some samples mostly composed of one cereal taxon, while others are more mixed. The samples from elite sites, on the other hand are either dominated by free-threshing wheat (clustering near the positive (right) end of axis 1) or by barley (plotting in the l lower left quadrant near the negative ends of axes 1 and 2) (Figure 5.24b). It is likely, however, that their restricted distribution, and the absence of samples rich in rye or oat (none plot towards the positive end of axis 2 in Figure 5.24b) is the result of the small number of samples from Saxon elite sites (11 samples from four sites, of which only two are from the late Saxon sub-period). Samples rich in oat are common at non-elite sites (plotting towards the positive end of axis 2 and negative end of axis 3 – Figure 5.24d), and a few samples from these sites are rich in rye (plotting towards the positive end of axes 2 and 3 – Figure 5.24d).

Rural elite sites are much better represented in the Medieval dataset but almost all of these samples (113 out of 120) date to the High Medieval period. Although samples rich in free-threshing wheat predominate at both elite and non-elite sites, plotting towards the negative (left) end of axis 1 (Figures 5.25b and d) and negative (bottom) end of axis 3 (Figure 5.25d), non-elite sites are rich in barley, plotting towards the positive end of axis 3 (Figure 5.25d), or oat, plotting towards the positive end of axis 1 and negative end of axis 2 (Figure 5.25b). or rye (plotting towards the positive end of axis 2 in Figure 5.25b). Rye is not particularly well represented at either type of site.

5.6.2 Roman military influence

Most of the samples from forts contain a significant quantity of free-threshing cereal grain (plotting towards the positive (right) end of axis 1), usually barley (plotting towards the negative end of axis 2) or free-threshing wheat grain (plotting towards the positive end of axis 2), along with the only sample from a *vicus* (Figure 5.26b). No samples from former *vici* are rich in free-threshing wheat grain (none plot positively on axis 2), and only one is rich in barley grain (plotting towards the negative end of axis 2). This low proportion of barley grain is common to both former *vici* and civilian small towns, but samples rich in free-threshing wheat grain are found at the latter. Although dating to the mid and late Romano-British sub-periods, samples from the former vici are therefore dominated by the established crops of the late Iron Age: mostly spelt, with some barley, while a single late Romano-British sample from a former *vicus* was almost entirely composed of emmer chaff (plotting towards the positive end of axis 3 on Figure 5.26d).

5.6.3 Saxon and Medieval religious influence

Samples from religious institutions are compared to samples from secular elite sites (i.e. castles and manors) in Figures 5.27 and 5.28. There are few Saxon samples from either secular elite sites or religious institutions (Figure 5.27), but the composition of samples from religious institutions is more varied, with some (all from one site) rich in rye (plotting towards the positive end of axis 3 on Figure 5.27d). As in the Saxon period, the composition of samples from Medieval religious institutions is more varied than at secular sites, again including samples dominated by rye (plotting in the upper right quadrant of Figure 5.28b). Although rye is generally scarcer in the north, the rye-rich samples come from the two northernmost religious sites (the hospitals at Brough St Giles in North Yorkshire, and St. Nicholas' Yard in Cumbria).

The only point of note regarding the relationship between social status and pulses is that the one lentil-dominated sample of the Romano-British period comes from an early Romano-British *vicus*.

5.7 Integration of sample analyses with site-phase analyses

The sample contents analyses presented in this chapter is broadly in line with the findings from the site-phase analyses, but also provides additional evidence (albeit from a smaller dataset) on the contribution of different crops to the agricultural repertoire. The sample analysis confirms, for example, the finding of the site-phase analysis that a major change occurred between the late Romano-British and early-mid Saxon sub-periods, involving the replacement of glume wheats by free-threshing cereals. Both the presence of spelt, and its dominance in individual samples (grain and chaff) declined rapidly during this relatively short period. but the decline of emmer was well advanced by the beginning of the Romano-British period, occurring only half as *frequently* as spelt. Then, between the early and mid Romano-British sub-periods, the sample analysis reveals a fall in the *proportion* of emmer-rich samples that precedes the final decline in the presence of emmer between the late Romano-British and early-mid Saxon sub-periods, suggesting that some of the emmer in mid-late Romano-British samples is residual crop contamination representing only the remnants of its earlier, more widespread, cultivation.

Barley is ubiquitous throughout the Romano-British to Medieval periods, and is the only free-threshing cereal that is regularly abundant in Romano-British samples. Then, while the proportion of barley-dominated samples increases (along with other free-threshing cereals) in the Saxon period, the increase in barley-dominated samples is not as great as that of free-threshing wheat or oat. The increased presence of free-threshing wheat and rye occurs simultaneously in the late Romano-British to early-mid Saxon sub-period. The increase in the proportion of samples rich in free-threshing wheat is greatest, however, between the early-mid and late Saxon sub-periods, and free-threshing wheat remains the dominant cereal into the Medieval period. Rye, on the other hand, is always present at lower frequency than wheat and, although a few samples rich in rye appear in the early-mid Saxon sub-period, rye-rich samples never become frequent. The gradual increase in the presence of oat grain is probably best interpreted as due to the addition of cultivated oats against a background of the wild, weedy species, on the combined evidence of an increase in oat-dominated samples and the number of (rarely preserved) floret bases of cultivated oat, both of which occur in the late Saxon period, suggesting that this was when oat cultivation became widespread.

Some of the regional variations seen in the presence data are also reflected in, or enhanced by, the analysis of sample contents. The earlier decline of glume wheat presence in the north compared to central and southern England, and the greater presence of barley here in the Romano-British period, are congruent with the lower proportions of-glume wheat-rich samples and the higher proportion of barley-rich samples in the north. In the Medieval period, the higher proportion of oat-rich samples, and lower proportion of samples rich in free-threshing wheat in the north-east, compared to central and southern England, gives a much clearer indication of a north-south difference in the proportions of these two species than was apparent in the analysis of the presence data. An east-west differentiation also emerges from the analysis of ample contents: in both the Romano-British and Medieval periods, there is a comparative lack of samples rich in barley or free-threshing wheat, and a greater proportion of oat, in the far west (Wales and south-west England).

The transition from glume wheats (especially emmer) to free-threshing wheat, seen to be most rapid at urban sites in the presence data, is particularly apparent in composition of samples from London, where free-threshing wheat-dominated samples are common in the early-mid Saxon sub-period). Among Romano-British towns, there appears to be an inverse relationship between town size the presence of emmer and spelt, and a lower proportion of free-threshing wheat at minor towns. The relationship of emmer with town size is strengthened by the absence of samples with significant quantities of emmer chaff at the larger towns, but samples rich in free-threshing wheat are well represented at minor towns. In later periods, in towns other than London, glume wheat-rich samples tend to be replaced by those rich in a variety of free-threshing cereals, as the number of major towns increases (in the late Saxon sub-period) and minor towns emerge (in the High Medieval sub-period. The composition of samples from rural elite sites follows the general trend from glume wheat-rich samples in the Romano-British period, to those dominated by free-threshing wheat or barley in the Saxon period, and finally to samples primarily dominated by free-threshing wheat in the Medieval period, whereas samples from non-elite sites are more often of a mixed composition. An association between military presence (at forts and *vici*) and free-threshing cereals, and between military departure (at former *vici*) and glume wheats was seen in both datasets.

The proportion of barley-rich samples declines earlier (by the early Saxon sub-period) at urban than at rural sites (in the late Saxon sub-period), while the proportion of oat-rich samples is greater (by the late Saxon period when its cultivation probably first became widespread) at urban sites. In the Roman-British period, the proportion of barley-rich samples is greater in London and other major towns than in the minor towns, and, declines rapidly by the Saxon period. Oat-dominated samples, on the other hand, are particularly well represented in major Saxon towns other than London. While barley-rich samples are rare at elite sites in the Romano-British period, they appear in the Saxon period but are absent again in the Medieval period, and oat-rich samples are absent at elite sites of all periods. Samples rich in rye first appear in the early-mid Saxon sub-period at rural sites but, by the late Saxon sub-period, rye-dominated samples are restricted to urban sites.

The only lentil-rich sample (from the Romano-British period) comes from the *vicus* at Carlisle (with military and international trading connections), while samples rich in pea and/or bean are found primarily in London in the Saxon period and later at rural sites in the Medieval period. Flax-rich samples are mostly found at rural sites (except in the Romano-British period) and never in London.

Chapter 6. Discussion

The following discussion interprets the patterning identified in the analyses of the site-phase and sample datasets (see Chapters 4 and 5). At different times, and in different environmental and socio-economic contexts, each taxon may be considered most likely to have been deliberately cultivated and consumed or to have been a contaminant (i.e. a weed) of another crop. Some crops were widely cultivated and consumed, while others were restricted to certain places, economic circumstances, or social groups. Taxa present as crop weeds also evidence temporal, spatial, and socio-economic variations in farming practice.

For the identified variations within the datasets, their implications and potential causal factors are considered: first those that would have affected all farmers and/or consumers across Britain during a given period of time, then those which varied spatially, finally those which varied according to socio-economic context.

6.1 Temporal trends

Within the whole site-phase and sample datasets, three broad temporal phenomena were visible: glume wheats virtually disappear from the archaeobotanical record, samples rich in various free-threshing cereals (free-threshing wheat, rye, and oat) become more frequent and there is a change in the species of non-cereal taxa that are most often present at British sites.

6.1.1 The glume wheat decline

The decline of emmer was far more protracted than the decline of spelt. Data syntheses covering earlier temporal periods show that across large swathes of England, the decline in emmer began in the Iron Age: Van der Veen (1992) identified a fall in emmer-rich samples in north-eastern England; and Green (1981) a fall in instances of emmer presence in Wessex. In the present analysis, two later periods of decline are visible: first a reduction in emmer-rich samples between the early and mid Romano-British periods, secondly a final decline in emmer-rich samples and in emmer presence between the late Romano-British and early-mid Saxon periods. Most instances of emmer in the mid- to late Romano-British period represent its persistence as a crop weed (probably growing alongside the alternative glume wheat, spelt) There were no post-Roman samples in which emmer comprised over 30% of the identified cereal items, and only three in which emmer comprised over 20%. Of these three, only one (from late Saxon Yarnton) is securely dated. The absence of emmer-rich samples, and the near-complete absence of emmer presence, indicates that emmer was no longer cultivated or present as crop weed by the early-mid Saxon period. Interpretations of the Yarnton sample vary: in his archaeobotanical report on the Yarnton material, Stevens (in Hey, 2004) suggests it represents a rare example of the continuation of emmer cultivation, while Pelling and Robinson (2000; see also Pelling, 2003) posit that, as there were no definite identifications of emmer in earlier Saxon samples at Yarnton, the ninth-century sample is evidence for the reintroduction of emmer as a crop. The two alternative interpretations have very different implications: the continued cultivation of emmer suggests a conservative, risk-averse farming strategy, but its reintroduction would have been an innovation contrary to contemporary British farming practice. The latter interpretation leads Pelling and Robinson (2000) to suggest it was the action of migrant Germanic farmers. A conservative interpretation is however preferred here because there is no archaeobotanical evidence to associate Migration Period farmers with the cultivation of emmer in their (German or Scandinavian) homelands (see below, this section). The presence at Yarnton of occasional indeterminate glume wheat items (*Triticum spelta/dicoccum*) in samples from early Saxon phases may simply indicate that emmer had continued in cultivation, or that it had persisted in arable fields as a tolerated volunteer species (perhaps within a spelt crop), which then flourished during one of the episodes of climatic amelioration that occurred towards the end of the first millennium (Lamb, 1977, 1995; Flohn and Fantechi, 1984; Stuiver, Grootes and Braziunas, 1995; Bryant, 1997; McDermott, Mattey and Hawkesworth, 2001).

Unlike emmer, finds of spelt are abundant throughout the Romano-British period: spelt accounts for the majority of identified cereal plant parts in the majority of samples in all sub-periods. The declines in spelt presence and spelt abundance were both very abrupt, occurring almost entirely between the late Romano-British and early-mid Saxon periods. The decline in spelt presence was, however, less complete than that in emmer presence. There is some evidence for the continuation of very limited spelt cultivation into the early-mid Saxon period: samples where spelt accounted for the majority of identified cereal items occurred at six early-mid Saxon period sites, and one High Medieval site (but in this case, at Bierton, the also incongruous presence in Iron Age contexts of samples dominated by free-threshing wheat raises suspicions of high levels of post-depositional mixing). With around 20% of Saxon site-phases recording the presence of spelt, it appears to have persisted at least as a crop contaminant at a substantial minority of sites.

The trajectories of decline for emmer and spelt suggest that before and during the Romano-British period there was some reason to reduce emmer but not spelt cultivation, but at the end of the Romano-British period the simultaneous decline of both glume wheats implies a disadvantage that was shared by the two species.

Studies of extant peasant farming communities (Giuliani, Karagoz and Zencirci, 2009; Yaman *et al.*, 2019) and of British archaeobotanical material (van der Veen, 1992; Lodwick *et al.*, 2021) associate emmer cultivation with small-scale growing by farmers producing grain primarily for auto-consumption and producing a livestock surplus. In a warm, dry climate, emmer is a safe, undemanding crop for subsistence orientated farmers. It requires little soil nitrogen and thrives on light, easily worked soils, suiting it to farmers who cannot, or do not wish to, invest large quantities of time and fertiliser in soil preparation and fertility maintenance. Its yield stability and (like spelt) its resistance to insect, bird and fungal pests reduces the risk of poor harvests (Percival, 1921; Zaharieva *et al.*, 2010; Bencze *et al.*, 2020), advantages that may be particularly highly valued by subsistence farmers. Emmer may be suited to the production of a large grain surplus: modern experimental work has demonstrated that increasing nitrogen inputs produce increased emmer yields (Marino *et al.*, 2016). This intensification of husbandry would not be possible, however, if extra labour was not available, or if a switch in emphasis from pastoral to arable production reduced the availability of manure. In such circumstances a switch from emmer to spelt would be a rational strategy for farmers seeking to increase total arable output: comparisons of modern emmer and spelt cultivars suggest that spelt produces higher yields per acre in almost all environments (van der Veen and Palmer, 1997; Rachon, Bobryk-Mamczarz and Kieltyka-Dadasiewicz, 2020), while spelt's tolerance for a broad range of soils (Percival, 1921) would have facilitated the expansion of arable cultivation onto new ground, as part of an extensification strategy.

Such a change, from intensive garden-scale cultivation to low-input extensive farming, was identified in late Iron Age and early Romano-British period north-eastern England by analysis of the crop weeds associated with emmer and spelt (van der Veen, 1992), and at early Romano-British period Stanwick (in Northamptonshire) by isotopic analysis of cereal grains (Lodwick *et al.*, 2021). Although there would have been a one-off labour cost of expanding the area of arable land in cultivation, requiring the communal effort of multiple households (Wigley, 2007; Haselgrove *et al.*, 2016; Garland, 2020), over the long-run a move towards extensive spelt farming should have produced higher yields with little change in the day-to-day labour demands on the individual farming household. The change is contemporaneous with an increase in another possible indicator of large-scale grain handling: the number of crop-dryers in eastern, central and southern Britain (van der Veen, 1989; Lodwick and Brindle, 2017). For consumers, a switch from emmer to spelt would likely have involved dietary change. Emmer lacks the gluten forming proteins that make bread dough rise and is therefore usually consumed as porridge, pastry, or in soups (Percival, 1921; Zaharieva *et al.*, 2010). Spelt is better suited to bread-making and will produce a reasonably well-risen loaf (Percival, 1921; Cool, 2006).

Multiple sources of climate proxy (P. Dark, 2000; McDermott, Mattey and Hawkesworth, 2001; McCormick *et al.*, 2012; Manning, 2013) and textual (Lamb, 1995) evidence associate the Romano-British period with warmth and moisture levels ideal for arable agriculture, conditions that emerged during the late Iron Age. Although the first two centuries AD appear to have been characterised by climatic stability, a deterioration occurred in the third century, with a shift towards colder, more arid, conditions. Although the climate improved again in the fourth century, this marked the beginning of a period of much increased instability (McCormick *et al.*, 2012; Manning, 2013). Climate change is an unlikley explanation for the major decline in emmer cultivation, which was almost completed by the early Romano-British period (the period with the warmest summers, best suited to emmer cultivation), although the continuing drop of emmer presence later in the Romano-British period (and into the early-mid Saxon) could have been engendered by the recurring periods of low summer temperatures.

However, if we view the emmer decline as an indication of a desire to increase total grain output, it is consistent with changes in the wider politico-economic context. The urbanisation of Britain began with the development of oppida in the later Iron Age, followed by the early-mid Romano-British period establishment and growth of the *civitas* capitals and small towns. Once systems of state administration were established, the relative political and economic stability may have encouraged investment in the productive capacity of agricultural land to meet sustained demand from the towns. We lack documentary evidence for the nature of land tenure in Roman Britain, but the evidence from other provinces suggests that land became an alienable and taxable commodity during occupation (e.g. Breeze, 2002; Mattingly, 2007; Bowman, 2009; Palet and Orengo, 2011). Gregson (1982) has argued that the expansion of villa building in third and early fourth century Britain evidences the development of a property market: the construction of permanent, stone-footed buildings constitutes an investment that may be later realised through market sale. Furthermore, the increasingly smooth size distribution of villas over the course of the Romano-British period (from a small corpus of early Romano-British sites, consisting of a few very large villas and a majority of very small buildings, to a much larger corpus of late Romano-British sites, with a greater number of medium size constructions), results from less tradition-bound construction styles. Gregson (1982) associates this change with the social disembedding of the Romano-British economy and a move towards marketisation (and thereby with a shift in villa ownership from a restricted social elite to the wealthy). Twentieth century ethnographic observations (Ellen, 1977) suggest that the acquisition of agricultural land by purchase rather than through kinship or clientage relationships would have been likely to shift farmers' focus of attention towards financial returns. Farmers may have been under pressure to increase the productivity of each unit area of land, and the value of that product. Tax demands would have further increased the pressure on farmers to produce surplus.

The cultivation of spelt would have helped farmers achieve both aims: land used to grow spelt would have been more productive per unit area, and spelt is likely to have commanded a higher exchange value (or price) than emmer. Food render evidence from Saxon and Medieval England shows that the grains most highly prized in rents and tithes were those most associated with high-status food preferences, i.e. for wheaten bread (Dyer, 2002; Hare, 2008; Woolgar, 2016). Wheat suitable for breadmaking (spelt, rather than emmer) is also likely to have been most highly valued within a Romanised food culture. The increased culinary importance of baking is evidenced by the introduction of new culinary technologies to Britain: some kitchens were provisioned with ovens in addition to hearths (the principal heat source in Iron Age cooking), whilst hearthstone baking was possible in all households with the use of earthenware *clibanus* or *testum* baking covers (Cool, 2006). Although the demand for wheat-flour suitable for bread-making may have accelerated the decline of emmer, the expansion of baking post-dates emmer's initial (late Iron Age) decline. The expansion of baking may therefore have been a consequence of an increase in spelt cultivation rather than its precipitant.

The virtual end of glume wheat cultivation between the late Romano-British and early-mid Saxon periods coincided with an exceptionally severe climatic deterioration. Climate proxy studies provide evidence for colder conditions which persisted from the mid sixth to mid seventh centuries (Lamb, 1977, 1995; K. R. Dark, 2000; P. Dark, 2000; Fowler, 2002; Barber, Chambers and Maddy, 2003; Büntgen *et al.*, 2016; Toohey *et al.*, 2016). This "Late Antique Little Ice Age" is believed to have been triggered by two high magnitude volcanic eruptions occurring in rapid succession (AD 536 and 540) in the northern hemisphere (Büntgen *et al.*, 2016; Toohey *et al.*, 2016). The sustained period of cold summers would have been particularly detrimental to arable farming and, following the identification and precise dating of the volcanic events, but despite the impossibility of dating archaeobotanical and other archaeological evidence with similar precision (Moreland, 2018), there has been a recent revival of environmentally deterministic interpretations of broadly contemporaneous economic, social, and political changes (e.g. Haldon, 2016; Toohey *et al.*, 2016). Climate change does not, however, explain the replacement of glume wheats with free-threshing alternatives in Britain. The early Saxon climate would not have favoured the continued survival of emmer as a crop weed, but climatic deterioration does not explain the widespread abandonment of spelt as a major crop. In these conditions spelt would probably have yielded as well as, any of the free-threshing cereals cultivated in the early-mid Saxon period, even free-threshing wheat: in addition to its cold hardiness, and high germination rates even in cold, waterlogged soils, its grains fill better than free-threshing wheat when summer temperatures are low (Percival, 1921; Rüegger, Winzeler and Nösberger, 1990a, 1990b). (Percival, 1921; Rüegger, Winzeler and Nösberger, 1990a, 1990b). Improving crop yields in a challenging environment does not, therefore, appear to have been the motivation for change in crops cultivated during the early-mid Saxon period.

A longstanding view of early Anglo-Saxon rural land use is of the widespread abandonment of farmland (particularly on heavier soils) following the collapse of the Romano-British economy (Arnold and Wardle, 1981; c.f. Hamerow, 1991). However, the persistence of spelt as a minor crop or weed in early-mid Saxon fields suggests continuity of land use at many sites, and is consistent with a growing body of evidence for survival of many Romano-British field systems into the Saxon period (Upex, 2002; Rippon, 2008; Banham and Faith, 2014).

The substitution of free-threshing wheat, rye, and oat for glume wheats would have increased some of the risks faced by farmers, particularly in a damp climate. In the field, glume wheat grains are better protected from bird attack and more resistant to a wide range of fungal diseases, furthermore spelt is practically immune to frost. In storage, glume wheat grains stored within their spikelets are, again, better protected from pests, and less likely to sprout in damp conditions, than free-threshing cereal grains (Percival, 1921). Increased labour inputs may have been required: the harvesting of free-threshing cereals is more time-critical than the harvesting of glume wheats (free-threshing cereal grains in the field being less protected from rain and predation), necessitating the mobilisation of a larger workforce for this short period of time (possibly including hired day-labourers). Depending on which free-threshing cereal(s) replaced the glume wheats, there may have been increased labour demands at other times of year (6.1.2 below). Potential yields also depend on which alternative cereal was cultivated, but whichever it was, there is no reason to assume that they would have increased. Even after centuries of attention paid to the improvement of free-threshing wheat yields, with very little attention paid to spelt, experiments comparing present-day cultivars show that, spelt wheat and free-threshing wheat yields (usually the highest yielding free-threshing cereal) are fairly similar (spelt produces smaller grains, but more of them), except in extreme conditions (when, in low temperatures, spelt actually outperforms free-threshing wheat), (Rüegger, Winzeler and Nösberger, 1990a, 1990b).

Of course, free-threshing cereals also possess advantages in comparison to glume wheats. With the exception of hulled barley, free-threshing cereals require less processing to separate the high-value grain from the low-value chaff for human consumption. Moreover, since the glumes of emmer and spelt afford protection to the grain in storage, while their removal tends to damage the grain, de-husking is usually undertaken immediately before cooking (Nesbitt and Samuel, 1995). Accordingly, free grain of free-threshing wheat, rye or oat is far less bulky to transport from producer to consumer than glume wheat and easier for the latter to prepare for consumption. In addition, bread wheat (the variety represented by most British free-threshing wheat remains) and rye both produce better risen loaves than spelt (Percival, 1921; Zohary, Hopf and Weiss, 2012).

The potential disadvantages of abandoning glume wheat cultivation thus all fall upon the farmer, whilst the benefits of free-threshing cereals are mostly enjoyed by the end consumer. The change in the Saxon period crop spectrum is therefore likely to have been demand-led. After the collapse of urban consumer economies, the demand for surplus grain would have fallen, so demand for cereals with specific qualities (actual or symbolic), rather than for the largest possible total quantity, is a likely motive for change.

The change to cultivating just free-threshing cereals is coincident with a period of migration to Britain (Brugmann, 2012). However, consideration of the cultivation histories of cereals on mainland Europe suggests that (at best) the influence of migrant farmers offers only a (very) partial explanation for the changes in Britain. There is insufficient evidence to conclude that Germanic and Scandinavian migrants would have completely discontinued glume wheat cultivation. Glume wheat-rich samples disappear from the archaeobotanical record of Britain and southern Scandinavia (Grabowski, 2011) around the same time; but the evidence from Germany is more ambiguous. Evidence from northern Germany (believed to have been the origin of most migrants to Britain) is sparse but while emmer presence was rare, spelt continues to be appear on Migration period (fifth to seventh century) sites in the lower Rhine Valley (Knörzer, 1991). In southern Germany (for which more data has been synthesised), it appears that emmer fell out of cultivation (rare examples of presence in the Migration period) but spelt cultivation continued (it was the main component of assemblages at many sites into the High and Late Medieval periods) (Rösch, Jacomet and Karg, 1992; Rösch, 1998). Rather than explaining a (poorly evidenced) reintroduction of emmer cultivation (as proposed by Pelling and Robinson, 2000; Pelling, 2003), Germanic migration may actually offer a better explanation for the localised continuation of spelt cultivation. The role of migration in the introduction of the various free-threshing cereal genera is considered below (Section 6.1.2).

6.1.2 The increase in free threshing cereals

Most research attention has focussed on free-threshing wheat. A very small number of Romano-British samples contain a high proportion of free-threshing wheat, which suggests very limited cultivation. There seems to have been a slight increase in the proportion of samples that are rich in free-threshing wheat between the early and mid Romano-British periods but the dataset is too small to be sure this is meaningful. Whilst there are (more than) enough free-threshing wheat-rich samples to infer the crop was widely cultivated in the early-mid Saxon period (approximately one quarter of samples have free-threshing wheat as the majority component of their cereal content), free-threshing wheat's transition from Romano-British rarity to the predominant cultivar of the Medieval period was more protracted than analyses focussing on the Saxon period alone (e.g. Monk, 1977; Green, 1981; Banham, 1990, 2010; McKerracher, 2014a, 2018) and analyses of presence-absence data (Green, 1981; Banham, 1990; Chapter 4 of this study) imply. The proportion of samples where free-threshing wheat accounts for the majority of identifiable cereal items increases by approximately 50% between the early-mid and the late Saxon periods, and by the same proportion again into the High Medieval period. It is not until the High Medieval period that free-threshing wheat is the majority component of the majority of samples.

Barley is the only free-threshing cereal for which rich samples provide evidence that it was commonly cultivated in all periods, and was the only free-threshing cereal widely cultivated in the Romano-British period.

Although oat grains are present at the majority of sites in all periods, it is not until the late Saxon period that oat-dominated samples, and finds of rarely preserved oat chaff, become frequent enough to infer the widespread adoption of oat into cultivation. Before this, the frequent presence but low proportion of oat within most samples is consistent with its presence as a crop weed, rather than as a crop. Earlier, very localised oat cultivation is, however, suggested by a few samples in each period (five Romano-British period and five early-mid Saxon period samples) in which oat grains comprise the majority of identified cereal remains, in regions which later focus on the cultivation of oat rather than free-threshing wheat (below, 6.2.2).

Although rye presence is much rarer than oat presence during the Romano-British period, it increases earlier, and more rapidly in the early-mid Saxon period. However, the rapid increase in rye presence is not matched by a dramatic increase in rye-rich samples: there are only five rye-dominated early-mid Saxon samples from four sites, with a restricted, easterly, spatial distribution. Although rye was introduced into cultivation, it remained the least abundant of all charred free-threshing cereals. Samples characterised within correspondence analyses by their rye content are rarely dominated by rye: in all post-Roman periods, samples in which rye comprises over 30% of identified cereal contents might be considered relatively rye-rich.

Some writers (Fowler, 1980, 2002; Green, 1981; Banham, 2010; contra McKerracher, 2016 for rye) have largely dismissed the significance of rye and oat in the Saxon period. Although there is no evidence that they were major crops everywhere in Britain, both changed status from Romano-

British crop weed to Saxon (and Medieval) crop, and surely the introduction of two new crops during the same (Saxon) temporal period must be considered a significant development in farming practice worthy of explanation.

The particular qualities for which each free-threshing cereal may have been valued are discussed further below, but an advantage (compared to glume wheats) which applies to them all is their relative efficiency in processing and transport. Early Saxon economies were very localised, and even the mid-Saxon petty kings were more likely to move themselves to their food supplies, than to move their food to their households (Lewis, Mitchell-Fox and Dyer, 2001; Condron, Perring and Whyman, 2002). The development of *wics* necessitated some increase in the movement of produce from countryside to a limited number of nucleated settlements (unfortunately the data is too sparse to examine this issue further) but it was not until the late Saxon period that there was a widespread resurgence of urbanism, and the concomitant movement of large quantities of grain. The relative efficiency of free-threshing cereals in transport is therefore likely to have become a more significant advantage over time, rather than the initial precipitant of change. It is known that great quantities of glume wheats were moved around the Roman empire at the behest of the state (Pals and Hakbijl, 1992; Bowman, 2013; Kooistra *et al.*, 2014), but security of food supplies (particularly the security of supplies to the army in the northern provinces) to maintain political stability may well have been prioritised above cost efficiency. In later periods there was no state subsidised grain transport (B. M. S. Campbell, 2000; Harrison, 2004), making the cost of transport relative to expected market price a more critical factor when farmers were selecting a cash crop.

The four free-threshing cereals grown during the Saxon and Medieval periods are not completely interchangeable in either cultivation or use. Although their tolerances are fairly broad, each genus is best suited to different environmental conditions; requires different combinations of land, labour, and capital inputs; and exposes farmers to different risks. Their culinary qualities also differ: free-threshing wheat and rye flours both produce well-risen loaves but their taste, texture, and appearance differ, resulting in associations with consumers of different socio-economic status (high and low, respectively). Barley produces a poorer loaf, and like oat is associated with a different cuisine – one of unleavened bannock breads, porridges, and pottages (Hagen, 1992; Cool, 2006; Zohary, Hopf and Weiss, 2012). Rye, barley, and oat were also used as animal feed supplements (B. M. S. Campbell, 2000; Zohary, Hopf and Weiss, 2012), and rye straw (long, pliable and tough) is particularly well suited to construction and craft-working uses (Moffett, 1994; Letts, 1999).

Of the Saxon and Medieval free-threshing cereals, free-threshing wheat is the riskiest to cultivate. It is a relatively poor competitor against weeds; vulnerable to bird, insect, and fungal attack; less tolerant of drought than rye, and of waterlogging than barley or oat; and its grains are less protected from heavy rainfall than those of hulled barley (Percival, 1921; McCorriston, 2000b, 2000a; Peterson and Murphy, 2000; Zohary, Hopf and Weiss, 2012). The addition of rye and oat into cultivation, and the continued cultivation of barley (a known and tolerant crop), would have buffered some of the risks of free-threshing wheat cultivation. Rye will germinate when it is too cold, and thrive when it is too dry, for wheat; oat is the most tolerant of all the cereals and will grow where all others fail (B. M. S. Campbell, 2000; Peterson and Murphy, 2000; Zohary, Hopf and Weiss, 2012). Free-threshing wheat cultivation also makes the heaviest labour demands on farmers, for weeding, bird-scaring, and manuring, marling, or the planting of cover crops to maintain soil fertility. In the small-scale household-based economy of the early Saxon period, the expansion of free-threshing wheat cultivation would have been limited by the availability of labour. Barley, oat, and rye are all better suited to extensive cultivation, are all less dependent on manuring than free-threshing wheat, and yield better on the lightest (and most easily worked) soils (Percival, 1921; McCorriston, 2000b, 2000a; Peterson and Murphy, 2000; Zohary, Hopf and Weiss, 2012). Another benefit of the cultivation of a variety of cereals would have been the utilisation of a wide range of soils. This would have become a more important advantage from the late Saxon period onwards, when arable land was in greater demand. Bread wheat has the most specific soil preferences of any of the major Saxon and Medieval cereals, needing moisture retentive (but not waterlogged) and nitrogen-rich soils to achieve high yields. The other free-threshing cereals can be grown on soils unsuited to bread wheat: barley on lighter, less fertile soils; rye on droughtier, sandier and more acidic soils; oat on wetter and more saline soils.

Given the higher costs and risks associated with growing free-threshing wheat, it would only be cultivated in anticipation of high future rewards. Such rewards may be financial or derived from high utility in auto-consumption (these two incentives are obviously interlinked, as high utility should result in a high market price). Discussions of the utility of free-threshing wheat (e.g. Hagen, 1992; Stone, 2006; Banham, 2010; Woolgar, 2016) centre on its culinary use: not only does it produce the lightest textured loaf, it produces the whitest bread; the latter quality was proposed by Banham (2010) as the reason for its high cultural cachet. In England, this high cachet is attested by its primacy in food renders and elite household accounts and was translated into a high price as shown in accounts of sales from High Medieval demesne farms (B. M. S. Campbell, 2000; Dyer, 2002). A focus on cultural cachet as an explanation for agricultural change gives primacy to utility in food consumption, but the other free-threshing cereals had a wider range of uses: for brewing, barley was prized above all other grains; barley, oat, and rye are all feed supplements for livestock; and the long straw of rye suits it particularly well to thatching, other construction and craft uses, and to fuel use (in post-Medieval times, rye straw has occasionally commanded a higher price than rye grain) (B. M. S. Campbell, 2000). The introduction of a variety of new cereals may therefore have been associated with a demand for more specialised products, each best suited to a particular use.

Comparison of the British data with syntheses from southern Scandinavia and north-western continental Europe offers little support to the hypothesis (e.g. Moffett, 2010) that migrants from these regions (whether via processes of culture replacement or transmission) expedited the replacement of glume wheats with free-threshing cereals. Widespread free-threshing wheat cultivation is associated with neither contemporary Germany nor Scandinavia. Although rye is widely associated with Germanic and Scandinavian cultures, this is due to its greater culinary importance, and more abundant archaeobotanical preservation in these regions, not because its cultivation on the continent preceded its cultivation in Britain. The best evidence for the transition of rye from crop weed to crop (in the form of rye-rich and rye-dominated samples, not just rye presence) occurs concurrently in Britain, Germany, and southern Scandinavia (Behre, 1992; Rösch, Jacomet and Karg, 1992; Rösch, 1998; Grabowski, 2011, 2013). The present data analysis suggests that the rise of free-threshing wheat, rye, or oat cultivation was not so abrupt as to rule out endogenous change.

The early Saxon climatic downturn created a challenging environment for arable farming.

The early Saxon climatic downturn created a challenging environment for arable farming. Büntgen et al. (2016) date the Late Antique Little Ice Ace from 536 to c. 660 AD, and the subsequent trajectory of climatic amelioration was not smooth. Charman (2010) interprets speleothem and chironomid evidence to suggest warming as early as the 8th century, but most sources describe an unsettled climate with greater variation between summer and winter temperatures, and frequent perturbations throughout the mid Saxon period (Briffa *et al.*, 1990; Lamb, 1995; Bryant, 1997; Fowler, 2002). In such conditions, the introduction of free-threshing wheat is the least explicable change: unlikely to improve either total wheat yields or their reliability. The concurrent cultivation of the more tolerant crops, on the other hand, may well have been necessary to reduce the risk of total harvest failure.

Warmer and drier conditions were established from the tenth century onwards: temperatures peaked in the eleventh and twelfth centuries and were maintained at up to 1°C above late 20th-century seasonal equivalents until the late 13th/early 14th century (Lamb, 1977, 1995; Flohn and Fantechi, 1984; Stuiver, Grootes and Braziunas, 1995; Bryant, 1997; McDermott, Mattey and Hawkesworth, 2001; Büntgen and Hellmann, 2014). Free-threshing wheat yields would have improved, encouraging the further expansion of its cultivation; rye cultivation (yielding well in the drier conditions) might also have been expected – other things being equal – to expand, but levels of presence, and of rye-rich samples, remain stable. Conversely, oats become more abundant within archaeobotanical samples during a period of climate change that would have reduced farmers' dependence on them.

The turn of the 14th century marked the beginning of another climatic deterioration that outlasted the Medieval period. Summers were generally wetter, winters harsher, and storms more frequent (Lamb, 1977, 1995; Flohn and Fantechi, 1984; Campbell, 2011; Büntgen and Hellmann, 2014; White, 2014), but there is no evidence for contemporaneous change in the cereal crop spectrum (although it must be borne in mind that the Late Medieval sample dataset is relatively small). Two major changes in post-Roman agricultural practice therefore appear to have been implemented despite, rather than in response to, climate change: free-threshing wheat was introduced into widespread cultivation at a time when spelt would have been a more reliable crop, and the widespread introduction of oat into cultivation occurred not when it would have been most useful as a risk-buffering crop, but once the climate improved. Socio-economic factors appear, therefore, to have exerted a greater influence on farmers' crop-choices.

6.1.3 Non-cereal crops

Within both the site-phase and sample datasets the frequencies of finds of lentil, pea and bean, and flax follow different temporal patterns, and are therefore discussed separately below.

6.1.3.1 Lentil

Lentil's appearance in the archaeobotanical record can be divided into two distinct temporal periods: the Romano-British and the late Saxon to late Medieval. Lentil practically disappears during the early-mid Saxon period (with only one tentative identification from Maiden Lane, London).

The early Romano-British finds of lentil are its first appearances in Britain's archaeobotanical record (Hubbard, 1976; Greig, 1991). Roman occupation was the catalyst for the introduction of numerous new food plants to Britain, some adopted into local cultivation and others remaining imports (Preston, Pearman and Hall, 2004; van der Veen, Livarda and Hill, 2008; Witcher, 2013). Today lentil is very difficult to cultivate successfully in Britain: warmer summers are required to produce well-filled seed pods (Greig, 1991). Within climatically very favourable areas, and in the relative warmth of the early to mid Romano-British period, some localised cultivation may have been possible and lentil's disappearance in the early-mid Saxon period is coincident with a climatic deterioration that would have doomed British cultivation to failure. However, trends in the frequency of lentil finds during the Romano-British period are contrary to those we would expect had it been adopted into British cultivation, and its decline begins before the climatic deterioration of the third century. Lentil presence is most frequent at the start of the Romano-British period, declining in each subsequent sub-period, but if it had been introduced as a crop we would instead expect to see an increase over time, as knowledge of the crop, its uses, and its husbandry requirements expanded. Van der Veen, Livarda, and Hill (2008) also identified a declining temporal trend in their analysis of charred lentil presence in Roman Britain, and found that it was shared by fig (a definite import) and grape (most likely to be imported) (D. Williams, 1977; Dickson and Dickson, 1996; Brown *et al.*, 2001). Lentil's decline is also contemporaneous with a decline in the frequency of finds of many kinds of imported manufactured good in Britain (Silver, 2012). Further support for the interpretation of lentil as a Romano-British import, comes from lentil's association with sites where other exotic food plants (fruits and nuts) were present. Of the twenty-three sites where charred lentil was present, fourteen also had contemporaneous waterlogged or mineralised archaeobotanical assemblages and the remains of exotics were found in all of them. In another two site-phases, where only charred preservation occurred, other exotics were found alongside lentil.

Lentils may have been imported deliberately as a foodstuff or accidentally as a contaminant of imported grain. Some evidence of a demand for lentils as a foodstuff is provided by (very) occasional lentil-rich charred samples: a fine-sieve by-product sample from Carlisle (Huntley, 1992) and several unclassified samples from the 1 Poultry site in London (Hill and Rowsome, 2011); and a purchase order for lentils amongst the Vindolanda tablets (Bowman, 1983, 2003). However, the early Romano-British dates of all the lentil-rich samples, and the decline of lentil presence over time, suggests this pulse never became embedded within Romano-British foodways. Although lentils are found at the same sites as other exotic foods, their pre-deposition histories are different (leading to their preservation by different means). Most lentils occur as very minor components of cereal-rich samples and are, therefore, most likely to represent grain contaminants. Lentil is a characteristic companion of wheat and barley in Mediterranean arable agriculture (Zohary, Hopf and Weiss, 2012), and may therefore suggest the origins of grain imports to Britain, and a decline in these imports over the period of occupation. In their cereal taxa content, site-phase presence records containing lentil are similar to the dataset as a whole, except for a higher incidence of free-threshing wheat presence (73% (n=23) of records containing lentil also contain free-threshing wheat, compared to 43% (n=626) of all Romano-British records). Sites with access to lentil may have also had preferential access to free-threshing wheat, but it cannot be established that the lentil arrived on these sites along with the wheat (i.e. that the free-threshing wheat was imported): in the sample content dataset, free-threshing wheat is no more or less likely to be present in samples with, or without, lentil. If a household was affluent enough to buy imported foodstuffs (including lentil) they may also have used their wealth to purchase novel (at this time) locally grown cereals.

There is less evidence to associate lentil with other imported foods in the late Saxon and Medieval periods, but, at least in part, this may be due to the scarcity of waterlogged preservation at sites with charred lentil (of twenty-eight site phases with lentil presence only six had contemporaneous waterlogged or mineralised assemblages, and in only two of these were exotic taxa present; another four sites had exotics preserved by charring). Contemporary documentary sources make no mention of lentil, but discussions of late Saxon and Medieval archaeobotanical material are more likely to consider that local cultivation occurred (e.g. Green, 1981; Booth *et al.*, 2007; Moffett, 2010; contra Caple, 2007). The climatic amelioration at this time is often cited in support of this contention, but it was a very erratic process and lentil yields are likely to have been very unreliable. In other countries lentil was (and still is) associated with peasant foodways, and the low status associations of most pea and bean based dishes in the British culinary tradition (Hagen, 1992; Jotischky, 2011; Woolgar, 2016) suggest that, if cultivated for food, lentil would have had similar associations in Britain. However, as a low-yielding, unreliable crop (when grown in the British environment) lentil seems unsuited to the role of peasant staple. Alternative uses were possible: Moffett (2018) suggests lentil might have been grown as a fodder crop or green manure. There are no contemporary documentary records of its use in such a manner, although in his "Natural History of Oxford-shire" the early-modern academic Plot (1677) describes the cultivation and ploughing-in of lentils on exhausted soils. Again, however, with other legumes (pea, bean, or common vetch) more likely to thrive and produce large quantities of plant matter, lentil seems a relatively unlikely choice. The garden-scale cultivation of lentil (i.e. as a supplementary food) seems most likely to have been successful: in sheltered plots and subject to more intensive husbandry. The archaeobotanical finds of charred lentils may derive from escapes from garden cultivation that grew as crop-weeds, or from the mixing of household refuse (with cooking waste deposited alongside cereal-cleaning waste).

6.1.3.2 Pea and Bean

Bean has a long history of presence but not abundance in British archaeobotanical assemblages from the late Bronze Age onwards and this continues into and throughout the Romano-British period. Pea was less common and appears later, in pre-history, with occasional Late Iron Age finds. Although pea was introduced to Britain at a later date than bean, (Green, 1981, 1981; Greig, 1991), in the present dataset pea-dominated samples occur earlier (first in the Romano-British period) than bean-dominated samples (first in the Saxon period). Green (1981) posits that the rarity of Late Iron Age pea finds suggests their importation from established Roman provinces, but, over the Romano-British period, finds do not conform to the same declining temporal trend as lentil: levels of pea (and bean) presence are always low.

The post-Roman increase in pea and bean presence is contemporaneous with the increase in free-threshing cereals. High levels of presence but low levels of abundance, in a dataset comprised of crop-processing by-product samples, suggests that these pulses represent contaminants of cereal harvests. If these remains represent grain contaminants their increase in presence reflects an increase in their field (rather than garden) cultivation. Alternatively, they may have entered discard contexts (the predominant type of context represented in the dataset) separately to the cereal sieving by-products, and thus represent accidentally burnt foodstuffs. Relatively low levels of pulse presence within charred assemblages are believed to be consistent with the deliberate cultivation and culinary use of pulses, usually on the grounds that pulses are far less likely to be preserved archaeologically because they are less likely than cereals to be exposed to fire during processing (especially if they are consumed green rather than dried) (Moffett, 2010; Treasure and Church, 2017).

The field cultivation of legumes as part of crop rotation schemes is well attested in Medieval manorial accounts. By fixing nitrogen in the soil, improving soil structure, and suppressing weed growth, rotations of legume cultivation address some of the difficulties resulting from free-threshing wheat cultivation in a relatively non-labour-intensive way. Pea seems to have been favoured over bean for this purpose: it is more frequently mentioned in manorial accounts of crop rotations (B. M. S. Campbell, 2000) and its consistent increase in each post-Roman sub-period mirrors the increase in free-threshing wheat-rich samples. The increase in bean is completed more rapidly, with a sudden increase in presence between the late Romano-British and early-mid Saxon periods. The earlier increase in bean is unlikely to have been a response to climate change: bean is no more hardy than pea, indeed modern bean cultivars are less likely to germinate at low temperatures than peas (Raveneau *et al.*, 2011). This raises the possibility that bean was put to a different use than pea; consideration of similarities and differences between the socio-economic contexts associated with the two crops (Section 6.3) may elucidate this issue.

6.1.3.3 Flax

No clear temporal patterning in flax was seen, probably because remains preserved by waterlogging give a better representation of its distribution: the bulk of flax grown in Britain was used in textile production and flax retting (the soaking of stems in water to allow the separation of bast fibres) was usually carried out away from settlements (and therefore away from places of likely exposure to fire) due to the foul smell that emanated from the decomposing material (M. C. Higham, 1989; Robinson, 2003). Even those flax seeds that did come into contact with fire (if used in cooking, or discarded as grain contaminants) were relatively unlikely to enter the archaeobotanical record, because their high oil content makes them more likely to be consumed by fire than to be preserved by charring (van der Veen, 2007).

6.2 Spatial variations

Farmers and consumers were never operating within a homogenous natural or socio-economic environment across the whole of Britain. There are north-south and east-west variations in Britain's climate (Shirlaw, 1966; Met Office, 2019) and regional variations in soils and topography (Woodcock, 1994; Toberman *et al.*, 2016) which make different crop taxa more, or less, likely to thrive. In some areas it may have been impossible, or very resource-intensive to introduce or maintain a crop in cultivation: some new crops may have failed, and some existing crops may have been discontinued early in marginal environments. Regional socio-economic differences would also have affected choices relating to crop consumption and farming methods. In the following section information regarding soil attributes comes from Cranfield Soil and AgriFood Institute (2021) and Toberman *et al*. (2016), and information regarding regional climates from Shirlaw (1966) and The Meteorological Office (2019).

6.2.1 Glume wheats

Emmer disappeared from cultivation earlier in the north of Britain compared to the south. The end of northern emmer cultivation may have been almost complete before the study period began: only three Romano-British samples from north-eastern Britain were characterised by emmer-richness, two of which dated to the early Romano-British period (the third was not closely dateable), and in all three emmer only comprised between 25% and 30% of identified cereal items (and could therefore simply represent high levels of "weed" contamination, probably of a spelt crop). The abrupt decline of emmer presence in the north, between the early and mid Romano-British periods, suggests that emmer ceased to be a common crop weed at this time (which is also consistent with the decline of cultivation occurring sometime earlier). In central and southern England, emmer-rich, including emmer-dominated, samples persist throughout the Romano-British period, only disappearing between the late Romano-British and early-mid Saxon periods. No north-south differences in spelt presence or abundance were visible within the Romano-British period.

The colder northern climate is less suited to emmer but its cultivation was not marginal here: van der Veen's (1992) study showed that emmer cultivation had been successful in north-eastern England during the colder and wetter conditions of the Iron Age, and that it persisted longer in the far north (between the rivers Tyne and Tweed), than in the south (between the Tyne and the Tees) of that region. In the present dataset, the three Romano-British emmer-rich samples from north-eastern Britain all come from sites north of the Tyne. The late Iron Age and early-mid Romano-British climatic improvement would have made emmer cultivation less, not more, challenging, allowing its continuation if socio-economic circumstances were favourable. Likewise, differences in soils do not seem a likely explanation: northern Britain does have a greater proportion of seasonally wet soils, but emmer cultivation had been successful here during wetter periods, and van der Veen (1992) found no relationship between edaphic conditions and spatial trends in the Late Iron Age- early Romano-British emmer decline. Having discounted environmental factors as stimuli to change she sought socio-economic explanations for the spatially variable abandonment of emmer cultivation, proposing (on the basis of crop-weed ecology) that the end of emmer cultivation meant the end of small-scale intensive crop husbandry and the total adoption of extensified spelt and barley cultivation. The centralisation of elite power within the Tyne-Tees region (as for example at the *oppidum* at Stanwick) would have encouraged the production of a grain surplus to support the consumer lifestyles of the ruling elite and increased local political stability, enabling farmers to make more long-term investments and commit fully to extensified cultivation. In the Tweed-Tyne region to the north greater political instability would have encouraged farmers to focus instead on pastoral rather than arable farming as, in times of upheaval, animals are easier to relocate than crops. Emmer cultivation was associated in this area with small-scale subsistence-focussed arable farming.

A similar set of circumstances may have brought about the end of subsistence-scale emmer cultivation in the far north during the Romano-British period. The establishment of permanent garrisons in the frontier region created both a demand for surplus grain and the political stability within which arable cultivation could expand. The end of emmer presence as a crop weed, may have been associated with a reorganisation of arable farming in which new land was brought into cultivation (an expansion also suggested by the development of more intensive stock handling systems, new field systems, and farmsteads) (Allen, 2016a; Brindle, 2016b). The traditional view of the military impact on native farmers is that innovation was stifled (N. J. Higham, 1989; Mattingly, 2007), but the northern decline of emmer shows there was no reversion to garden-scale arable cultivation; the shift begun in the Late Iron Age towards an extensive, low-input, farming system was completed.

The south of England came under a civilian state administration, based round the *civitates*. The *civitas* capitals of the south are widely accepted as consumer settlements with close ties to the agricultural producers in their hinterlands (Hingley and Miles, 2002; Pitts and Perring, 2006; Jones, 2007). Innovations such as *villa* farming, complex farmsteads, and market gardening, expanded across central and southern England, yet small-scale emmer cultivation continued at some sites (Jones and Mattingly, 1990; Jones, 2007; King, 2007; Allen, 2016b; Ordnance Survey, 2016; Smith, 2016b; van der Veen, 2016). With greater demand for surplus produce and more evidence for agricultural innovation, the continued cultivation of emmer at some sites in this region requires explanation if we interpret it as a proxy for subsistence farming. Perhaps within the civilian zone, native farmers may have had greater freedom to choose whether or not to produce surplus (above any demanded tax or tribute) for the urban market, and over what and how much to grow; the level of compulsion to produce surplus for the garrisons may have been much higher in the militarised north.

Although all post-Roman spelt-rich samples were from central and southern England, no north-south variations in farming or culinary practice can be inferred: the lack of spelt finds in the north may simply result from the relative under-excavation of this region, particularly of Saxon settlements. Of the seven Saxon sites with spelt-rich samples, six are located in eastern central and southern England and only one in the west. Admittedly this is a very small dataset, but other lines of archaeological evidence (changes to settlements, field systems, and funerary practices) suggest stronger migrant influence on Saxon rural life in eastern England (Hamerow, 1991, 2012), and the continuation of spelt cultivation is consistent with contemporary Germanic farming practice. There is no obvious environmental reason for this east-west difference in spelt: the greater proportion of lighter soils in the west may have been expected to favour the retention of spelt rather than the introduction of free-threshing wheat, making a cultural explanation more plausible.

6.2.2 Free-threshing cereals

During the Romano-British period, the only free-threshing cereal in widespread cultivation, barley, exhibits spatial patterning in its archaeobotanical abundance. The north of Britain has a greater proportion of barley-rich samples than the south, and barley-rich samples are particularly scarce in Wales and south-western England. These results are consistent with the results of presence analysis in Lodwick's (Lodwick and Brindle, 2017) discussion of charred cereal remains from rural Romano-British sites. She found a north-south difference in the relative frequencies of barley and spelt presence (with barley more frequent in the north, spelt in the south), and the greatest disparity between barley (least frequent) and spelt (most frequent) in Wales and the Marches. The variations in barley representation within archaeobotanical samples are consistent with variations in environmental conditions between the regions, and therefore suggest the local provisioning of northern, Welsh, and south-western English sites. In the north-east, barley's tolerance of cold temperatures and moderately acidic soils may have been valued. The soils of Wales and south-western England also tend to be acidic, and lower in nutrients than those of the north-east, but here the wetter climate would have hindered barley cultivation. Oat can cope with such conditions, and in the post-Roman period, is very strongly associated with Wales and south-west England. The Romano-British evidence is limited, but the presence of samples in which oat comprises the majority of identified cereals at three westerly sites (Plas Coch, Shepton Mallet, and Redcliff, Poole Harbour) hints at the possibility of early oat cultivation in the far west. The spatial restriction, and first appearance of, oat-rich samples during the late second to early third centuries (i.e. in the mid Romano-British period), when the climate may have shifted from relative stability to increasing aridity, suggests that the (possible) cultivation of oats was a response to local conditions, rather than to broader climatic changes.

With its low-status connotations of peasant food, military punishment rations, and animal fodder, barley was an inferior cereal compared to emmer and spelt. A greater focus on this lower-value crop does not necessarily mean northern farmers were less market-oriented than farmers in central and southern England. The fattening of surplus cattle may have increased on-farm demand for barley, and barley itself may have been demanded by the local military garrisons for horse fodder. However, commercialised pastoralism was not unique to this area: increased demand for meat was not restricted to the north of England (the major towns of the south would have demanded large quantities (probably greater than those demanded at the forts) and neither is there evidence (complex farmsteads, new field systems, and animal bone evidence for livestock improvement) that urban demand was met by native farmers (van der Veen, Livarda and Hill, 2008; Allen, 2014, 2016b; Maltby, 2016; Smith, 2016c, 2016b). The intensification of cattle husbandry may not therefore account for the difference in the barley-richness of samples between regions, but the greater demand for barley in the north, from the military, might. If farmers themselves bore the costs of transporting their grain to the military granaries (or to other collection points), low-value barley would not have been worth transporting far; northern farmers may therefore have had a comparative advantage in cultivating it. In Wales and the south-western English peninsula, far from the military market, settlement density was low, grazing land abundant, and there would have been little need for livestock feed supplementation even within this largely pastoral farming economy.

Within the distribution of Romano-British free-threshing wheat samples, some spatial patterning was visible, but although samples predominantly comprised of free-threshing wheat occur more frequently in the east of Britain, this may simply correspond to the distribution of all samples within the dataset.

In the post-Roman period, every free-threshing cereal is present in some site-phases in each climatic region (Shirlaw, 1966) but the most important crops vary regionally, often in ways clearly related to the environmental differences between regions.

Free-threshing wheat and rye are most frequently present, and abundant, within samples in central and southern England. This area of England has the greatest proportion of soils (fertile loams and clays) naturally suited to free-threshing wheat, but the advantages of *natural* fertility would only have been gained on virgin or long-abandoned land and only enjoyed for a short-period of time (and probably outweighed by the high start-up labour costs of bringing such land into cultivation). The association between southern England and free-threshing wheat cultivation, in contrast, endured over the long-term: throughout the Saxon and Medieval periods. There is little evidence for free-threshing wheat cultivation in northern Britain with an absence of free-threshing wheat dominated samples in all but one area of the north-east (North Yorkshire and Teeside). Free-threshing wheat dominated samples are also completely absent from Wales and the south-western English peninsula. It seems that, although free-threshing wheat can be cultivated on acidic soils if regular manuring or marling is practiced (Percival, 1921), this strategy was not widely adopted in either the far north or west. In these upland, predominantly pastoral farming economies (Rees, 1924; Davies, 1982; Carr, 2000; Barrow, 2004; Dalgleish, 2011), manure would not have been in short supply, but these were areas of widely dispersed rural settlement, so the labour to apply it may have been scarce.

Of the two varieties of tetraploid free-threshing wheat cultivated in north-west Europe, only rivet wheat (*Triticum turgidum*) will grow in Britain's climate, and then only in favourable areas: dry enough year-round to prevent lodging and hot enough in summer to produce good yields (Percival, 1921; B. M. S. Campbell, 2000). All identifications of rivet wheat rachis are restricted to central and southern England, so there is no evidence this crop was moved out of the area in which it was cultivated (although the relative rarity of rachis finds, and the tendency for rachis to remain at the site of early-stage crop-processing must be borne in mind). Rivet wheat grain has a specialised culinary use (although unsuitable for bread flour it is better for biscuits than bread wheat) but evidence for the presence of rivet wheat on consumer sites comes in the form of rachis not grains. After threshing, the rachis of free-threshing wheat remains attached to the straw, and rivet wheat straw is a rare combination of long and tough, which makes it very useful for thatching (Percival, 1921; Letts, 1999). Straw is very bulky in relation to its weight, commands a lower market price than grain, and is consequently relatively unprofitable to transport far (B. M. S. Campbell, 2000) which could account for its restricted spatial distribution.

Rye is also strongly associated with central and southern England. The two sub-regions in which it is most frequently present and in which rye-rich samples were most abundant, East Anglia and the West Midlands, both have large areas of sandy soils. In East Anglia, acidic sandy soils are found across Norfolk (with large expanses north of Norwich, and on the Breckland plateau east of Thetford) and Suffolk (along the coast between Lowestoft and Ipswich). Rippon, Smart, and Pears (2015) identify a fifth to seventh century increase in the proportion of rye within site-phase assemblages from the Breckland which did not occur elsewhere in contemporary England, while within his East Anglian study region, McKerracher (McKerracher, 2014a, 2016) also notes an unusually high proportion of rye-dominated samples of seventh to ninth century date on Breckland sites, which he interprets as a local response to environmental conditions (McKerracher, 2016, p. 98). In the West Midlands, sandy soils also account for a large proportion of agricultural land, with large parcels near Lichfield, Kidderminster, Stourbridge, and Bridgnorth. In all these locales, the proximity of the aforementioned thriving late Saxon and Medieval towns would have meant high demand for grain, perhaps encouraging local farmers to utilise even their droughtier soils unsuited to free-threshing wheat cultivation. Urban demand for construction materials (for which rye straw is well suited) would also have been high, and the distances over which this bulky, low value commodity needed to be transported were short.

Occasional Romano-British and early-mid Saxon oat-dominated samples are concentrated in the south and west of Britain, and also occur in Scotland, suggesting the cultivation of this crop began as a regional speciality. Late Saxon and Medieval oat-rich samples then occur most frequently in two climatic regions: north-eastern Britain and Wales and south-western England. That oat was grown not just for animal fodder but for human consumption, is evidenced by contemporary documentary sources: the food renders of Welsh aristocrats demand oats and oatmeal (Rees, 1924) rather than the wheaten bread demanded by their English counterparts; in his account of his Welsh travels, Giraldus Cambrensis (1978) describes oats as the subsistence grain of the population, and John Mair similarly describes the oat-based diet of the northern English and Scottish peasantry in his *Historia Majoris Britanniæ, tam Angliæ quam Scotiæ* (Cowan, 2011). The challenges facing arable farmers differ between the north and the west, but oat has the broadest climatic and edaphic tolerances of any cereal cultivated in Saxon and Medieval Britain. In Wales and south-west England, the relatively warm and wet climate is optimal for high oat yields, whilst the cultivation of free-threshing wheat would have been hindered by the predominance of infertile acidic soils, and the cultivation of rye (free-threshing wheat's nearest culinary substitute) by the poor drainage of most lowland soils (these would also have been sub-optimal for barley cultivation). In northern Britain, particularly on the eastern coastal plain from which most archaeobotanical evidence derives, moderately fertile soils are not in such short supply but soil acidity and seasonal wetness remain problematic. Of the free-threshing cereals (oat, barley, rye) which cope with moderately acidic soils, oat is better suited to wetter soils but the cooler temperatures in the north are not optimal for common oat (*Avena sativa*). This may explain the relatively high frequencies at north-eastern coastal sites of floret base identifications of bristle oat (*Avena strigosa*), the most tolerant species of this most tolerant genus (Moffett, 2010), and the occasional samples rich in barley (more cold and frost tolerant).

6.2.3 Non-cereal crops

6.2.3.1 Lentil

In the two discrete periods when it is present within archaeobotanical assemblages (the Romano-British, and late Saxon to Medieval) the spatial distribution of lentil is very different.

Most Romano-British finds of lentil are from London but the remainder are spatially widespread, including sites in the north (too cold) and west (too wet) where local cultivation could not have taken place. All finds come from sites obviously connected to trade routes. Most come from sites along the Thames estuary (several in London, but also at Springhead), the main point of entry to Britain for grain and other goods imported from continental Europe. The onward overland distribution of imported produce is evidenced by lentil finds in Leicester (sited on a major junction of the Roman road network). Waterborne transport along Britain's coastline is also suggested by lentil finds along the south coasts of Wales (at RAF St. Athan) and England (at Fishbourne Roman Palace), on the Humber Estuary (at Melton), and close to the Solway Firth at several sites in Carlisle.

Late Saxon and Medieval lentil finds are almost completely confined to southern England (below a line running from the Wash to the Bristol Channel). Within this area, which has the warmest and driest summers in Britain, and in this period of climatic amelioration, lentil may have been locally cultivated. Charred lentils are never found in large enough quantities to suggest they represent anything more than a grain contaminant. The restriction of lentil finds to southern England suggests there was little long-distance movement of crops around Britain, especially in the late Saxon period; the two finds further afield date to the Medieval period, which is consistent with a (limited) expansion of crop movement to more distant consumer sites. At both sites, the local climate rules out the possibility of local lentil cultivation: too cold at Eldbotle (in Scotland) and too wet at Dryslwyn (in Wales), so it must have been moved long-distance, either deliberately or as a contaminant of the free-threshing wheat, which is also found at both sites (and which was equally unlikely to have been locally grown). Both sites are socially atypical, with artefactual and architectural evidence for wealthy occupants at Eldbotle (Hindmarch and Oram, 2012), and documentary records of the garrisoning of Dryslwyn by the English (Caple, 2007).

6.2.3.2 Pea and Bean

During the Romano-British period, pea and bean finds are equally widespread across Britain. Differences in pea and bean distribution emerge afterwards. In the north, pea presence becomes more frequent, but bean presence does not; in central and southern England, both taxa become more frequently present, especially in the east. These spatial variations are consistent with differences in climate and soils. Bean is less suited than pea to cultivation in northern Britain: it is not frost hardy and is less likely to germinate at low temperatures (Raveneau *et al.*, 2011). Climate differences do not account for the east-west variations in the frequency of pulses in central-southern England (summers are dry and warm over the whole area) but variations in soil types might. Bean grows best on heavy soils, and pea on medium to heavy soils which comprise a greater proportion of the farmland in eastern, compared to western, southern England. The strong association of pulses with central and southern eastern England is unlikely to be wholly attributable to environmental factors; this was also the region with the greatest density of large arable demesne farms, and, unsurprisingly, where Campbell's (2000 Fig.3.05) analysis of manorial accounts found that some of the most intensive regimes of crop rotation were applied.

6.2.3.3 Flax

Charred flax seeds always have a strong easterly bias in their distribution. Flax can be grown on a wide range of soils, but historical accounts show that it was believed to grow best, and to require less intensive husbandry on moist (but not waterlogged) nutrient-rich soils which are more common in the east (Anon., 1781; Macadam, 1847; Short, 1903).

6.3 Socio-economic variations

6.3.1 The impact of urbanisation

6.3.1.1 Romano-British period

Comparison of archaeobotanical assemblages and samples from the three broad categories of town (London, major towns, and minor towns) and from rural sites showed that archaeobotanical records from minor towns have more in common with those from rural sites than with those from larger towns, while major town records were more similar to those from London (albeit with some significant differences between London and other major towns).

The finding that charred crop assemblages from minor towns are more like those from rural sites than those from larger towns, is consistent with studies of many other types of data, including the archaeobotanical remains of the exotic and novel food plants introduced to Roman Britain (van der Veen, Livarda and Hill, 2008). Although they did not make comparisons with large towns, Lodwick and Brindle's (2017) analysis of archaeobotanical data found little difference between assemblages from roadside settlements (broadly equivalent to the minor towns category in the present dataset) and various types of non-villa farmstead. Two economic functions that researchers have proposed for Romano-British minor towns are consistent with such similarities: that they were self-sufficient communities of agricultural producers (Reece, 1992; Allen and Smith, 2016), and that they served as centres for the aggregation of rural produce before its onward movement to consumer cities (Hingley and Miles, 2002). However, the present data do not support the latter hypothesis, with little evidence for connections between minor and major town economies: emmer is frequently present in low quantities (i.e. as a contaminant of other crops) at minor towns but not at major ones, suggesting that grain from different sources was being handled at the different types of site. The continued presence of emmer as a contaminant of minor town assemblages suggests that these settlements did not stimulate change in arable agricultural practice in their hinterlands.

London and major town samples tend to be barley-rich, while minor town and rural samples tend to be spelt-rich. This is contrary to the proposed association of spelt, not barley, with the expansion of Iron Age and Romano-British arable production to produce a grain surplus for the emerging urban market (e.g van der Veen, 1992; Lodwick and Brindle, 2017). It is possible that the relatively small number of London and major town sample records may have produced an anomalous result, but in the larger site-phase dataset there is also a clear inverse relationship between settlement size and spelt presence (97% of small town, 72% of major town, and 66% of London site-phase assemblages contain spelt). The potential urban demand for barley within towns may have been under-estimated because of its associations with fodder rather than food, and by the conflation of such low-status consumption with "peasant" (i.e. rural) foodways. Fodder would, however, have been needed in towns: stalled animals kept within large towns would have been in greater need of feed supplements than pastured animals on rural sites or in minor towns with easy access to grazing land. Different methods of byre waste disposal in town and country may have biased the relative level of barley contained within charred archaeobotanical samples. If byre waste was burnt as fuel in towns, but spread on fields as manure in the countryside, the result may have been an over-representation of barley (and correspondingly lower proportion of spelt wheat) in urban samples. However, total fodder demands (due simply to a much larger total number of animals) would have been greater in the countryside, and urban samples from household contexts are most likely to represent culinary waste, so an explanation for the differences which relates to food provisioning may be more apposite. Research by Britton and Huntley (2011) suggests that the Roman military demand for barley as a foodstuff has been underestimated due to its inferior image, and the same may have been true for urban demand. Although cities, especially London, are often regarded as places of high-status consumption, they would also have been home to large numbers of poor individuals, who necessarily prioritised affordable nutrition over culinary sophistication. Cultural cachet is not the only quality that makes a good cash-crop: lower-priced crops can be profitable if they are cheap to produce and bring to market. Barley is equally as suited to low-input cultivation as spelt, and would have been more cost-effective to transport: as a free-threshing cereal it is less bulky than spelt in the spikelet, and the palea and lemma of hulled barley grains still afford a high level of protection from damage in transport.

Urban demand did not encourage the cultivation of new cereals as cash crops. Remarking on individual Romano-British urban sites associated with free-threshing wheat presence, some researchers (e.g. Green, 1981 on Winchester; Davis in Watson and Heard, 2006 on Paternoster Square, London) have suggested that urbanisation might have encouraged the cultivation of free-threshing wheat as a cash crop for the urban market. However, the present large data synthesis contains no evidence to support such a contention, with very few samples rich in free-threshing wheat from urban sites. Considering the association of both towns with imported produce (lentil), the four free-threshing wheat-rich samples from Leicester and the one from London (Figure 5.20b) are as likely to have been imported as domestically cultivated. The evidence for free-threshing wheat cultivation on contemporary mainland Europe (and therefore for the potential sources of imported grain) varies widely between provinces. Most evidence derives from the Iberian peninsula, where free-threshing wheat was a very common crop with a long history of cultivation (Buxó i Capdevila *et al.*, 1997; Alonso Martinez, 2005; Tereso, 2009; Tereso, Ramil-Rego and Almeida-da-Silva, 2013), and trade links between Britannia and Hispania Baetica based upon the import of Baetican olive oil are evidenced by finds of Dressel 20 amphora across Britain (Coto-Sarmiento and Rubio-Campillo, 2021). In other provinces the evidence for free-threshing wheat cultivation is sparse: excepting some assemblages dominated by free-threshing wheat in the Ile-de-France region (Matterne, 2001) and around Basel (Rösch, Jacomet and Karg, 1992; Brombacher, Jacomet and Kühn, 1997), most evidence for free-threshing wheat comes in the form of occasional presence, rather than abundance (e.g. Kooistra, 1996; Cavallo, Kooistra and Dütting, 2008; Zech-Matterne and

Brun, 2016), and so gives no indication that it was a crop rather than a weed. Although rye is more often present on urban sites of all sizes (from minor towns to London) than on rural sites, nowhere is it found in quantities that suggest it was deliberately cultivated. That emmer had lost its value as a crop is evidenced by the restriction of emmer-rich samples to minor towns (occasionally) and rural sites (frequently). Although a mainstay of Mediterranean cuisine, lentil failed to become embedded in British foodways, its likely high price (deriving from the high cost of long-distance transport) may have been incompatible with its image as an inferior peasant food.

Pea and bean are so rare within Romano-British assemblages that variations in their presence between settlement types are difficult to interpret. The most striking feature of their distribution is their absence from London until the late Romano-British period. If these late Romano-British peas and beans represent foodstuffs, they may evidence the adoption of aspects of a lower-status diet by some consumers (Zohary, Hopf and Weiss, 2012), that may be associated with the declining fortunes of the city (Reece, 1992; Wacher, 1995; Esmonde Cleary, 2007; Jones, 2007). However, if they simply represent contaminants of cereal crops (as suggested for Medieval finds) their increase at the same time as a decline in lentil suggests a change in the origins of the cereals supplied to London: possibly a shift away from imported cereals towards the consumption more domestically cultivated produce.

Interpretation of the frequently present, but never abundant, taxa as contaminants of spelt and barley crops suggests that a change in the provisioning of London occurred between the early and mid Romano-British periods: the decline in emmer presence was broadly coincident with the widespread reorganisation of rural settlements (the expansion of villa farming and the architectural reorganisation of many native British farmsteads) and field systems across central and southern England (Roberts and Wrathmell, 2002; Allen, 2016b; Brindle, 2016a; Smith, 2016b). This was followed by further change (increases in free-threshing wheat, rye, pea, and bean presence) between the mid and late Romano-British periods suggestive of provisioning from an increasingly wide range of sources. If free-threshing wheat indicates the cultivation of heavy soils, and rye the cultivation of lighter soils, the simultaneous increase in both taxa suggests that demand from London was incentivising farmers to cultivate all available soils, not just the easiest or most productive. A change in London's grain provisioning strategy is also suggested by the increasing numbers of crop dryers and granaries within the city as its inhabitants engaged more directly in bulk crop processing and storage.

6.3.1.2 Saxon and Medieval periods

Almost all early-mid Saxon urban data comes from London where the major trends of the Saxon and Medieval periods (the decline in spelt and barley, and the increase in free-threshing wheat) either begin or are completed earlier than in the rest of Britain. In the early-mid Saxon period, spelt-rich samples are only found on rural sites, and barley-rich samples are comparatively infrequent in London. What replaced the Romano-British staples also differed: in London samples predominantly comprised of free-threshing wheat became common, but on rural sites samples are more likely to comprise a mix of free-threshing wheat, oat, and rye. When new towns emerge, first the "major towns" (burhs and boroughs) of the late Saxon period, then the "minor towns" (market centres) of the High Medieval period, samples from these sites tend not to be dominated by free-threshing wheat or barley, but to contain a mix of the new free-threshing cereals.

The first major cash-crop to emerge in the post-Roman period was free-threshing wheat. The lack of diversity and predominance of free-threshing wheat, within early-mid Saxon London samples is consistent with an economy focussed on human consumption, rather than an agriculturally productive economy (which would have had additional needs for fodder and litter). The scarcity of those cereal taxa most tolerant of infertile, droughty, or waterlogged soils suggests that total grain demands from London no longer incentivised rural arable producers to cultivate marginal soils. Rye-rich and oat-rich samples were restricted to rural sites, and largely to the east and west of the country respectively (as described in Section 6.2.2 above); reflecting choices made by local farmers in response to the environmental conditions facing them, rather than to market incentives.

The transition on urban sites from glume wheat- to barley-rich samples (in the Romano-British period) and then to free-threshing wheat-rich samples (in the Saxon period) may be associated with the desire to provision consumer towns in the most efficient way. Such a transition would be most necessary, and is most complete, at the largest town, London. Each of these transitions in urban grain consumption would have reduced the bulk of goods transported from farm to town, increased the proportion of valuable product (grains rather than chaff) moved per cartload, and the nutritional value of each load (measured by volume) delivered to consumers. Throughout the study period the standard unit of grain quantification was based on volume not weight (from the Roman *modius* to the Norman bushel). Estimates of grain weight, in the state in which each crop was most likely to have been transported, range from 0.4 to 0.5 kg per litre for glume wheats (stored in the spikelet), 0.56 to 0.61 kg per litre for hulled barley (with hulls), and tend to agree on c. 0.78 kg per litre for free-threshing wheat (threshed) (Foxhall and Forbes, 1982; Halstead, 1985). Although the calorific values of each cereal are quite similar (US Department of Agriculture: Agricultural Research Service, 2019), their different densities, and the lower flour extraction rate of barley (B. M. S. Campbell, 2000), result in increased nutritive values per unit of volume moved from countryside to town, with each successive change.

From the late Saxon period onwards, free-threshing wheat-rich samples are equally frequent at rural and urban sites. Now rye and oat make the transition from crops grown for auto-consumption on rural sites to cash-crops for urban consumers, while Late Saxon rye-rich samples are now almost exclusively found in London and other major towns, and oat-rich samples are most strongly associated with major towns. These oat and rye-rich samples are less spatially restricted than in the early-mid Saxon period: the distribution of rye-rich samples expands westwards across England, and the distribution of oat-rich samples expands eastwards. Another crop which makes the transition from rural sites (in the late Saxon period) to urban sites (in the High Medieval period) is tetraploid free-threshing wheat. The commercialisation of these various new cereals may have been associated with food consumption by the urban poor, and/or a demand for more specialised products for non-culinary use.

Rye-rich samples (or at least samples characterised by sufficient rye to suggest it was deliberately grown and moved, rather than present as a crop weed) occur most often in major towns during the Late Saxon period, and in minor towns during the High Medieval. In culinary use, rye was regarded as inferior (Dyer, 2002; Stone, 2006; Jotischky, 2011; Woolgar, 2016) and we might expect it to be associated with poorer consumers. However, if patterns of food consumption by poorer households were solely responsible for the distribution of rye-rich samples we would also expect to see rye well represented at non-elite rural (i.e. peasant) sites, which we do not (6.3.2.2 below). Rye is often found alongside, rather than instead of, free-threshing wheat, suggesting that people had access to a “better” bread-making grain. Wheaten-bread eating households may therefore have used rye flour to eke out the more expensive free-threshing wheat flour, or may have been using rye for another (probably non-culinary) purpose. If rye was valued for its tough straw (as a construction material and a fuel for industrial processes) rather than for its grain, its association with the most rapidly expanding type of settlement in each temporal sub-period (from the expanding and frequently re-built rural settlements of early-mid Saxon England, to the burhs and boroughs of the late Saxon, and then the new planned market centres of the High Medieval period) makes sense. Rye may have been a more profitable crop than its status as an inferior foodstuff suggests: its grain commanded a higher price and was less bulky to transport than barley or oat, and its straw was more valuable than that of other cereals.

Oat-rich samples occur on both rural and urban sites but, when found beyond the north and west (where the climate makes them a necessary subsistence staple), oat-rich samples are particularly frequent in major towns during the late Saxon period. Oats are lightweight (with a lower grain density per bushel than barley) with a poor flour extraction rate (Foxhall and Forbes, 1982; Halstead, 1985; B. M. S. Campbell, 2000), which makes them a relatively inefficient foodstuff to transport from farm to town. However, they are high in fats and micronutrients. Oats also have a specific purpose as a high-energy horse feed supplement (B. M. S. Campbell, 2000; Peterson and Murphy, 2000; Woolgar, 2016) that would have been increasingly demanded from the late Saxon period onwards when horses were popularised for both riding and haulage (Langdon, 1986).

A decline in the urban demand for barley would be consistent with its status as an inferior food (producing a poor loaf, and a less nutritious animal feed) in an economy where more specialised substitute products were increasingly available. Barley, however, had one specialised purpose which may have encouraged its continued cultivation and sale: it was the preferred brewing grain of the Saxon and Medieval periods (Dyer, 2002).

It was suggested above that bean and pea were used for different purposes, and during the Saxon period socio-economic variations in the distribution of bean and pea finds support this contention. Pea presence does not differ between rural and urban sites (it is relatively infrequent at both, with no rich samples anywhere), but the frequency of bean presence is much higher in London than anywhere else (there are also some bean-rich samples here but they all come from one site, 67-68 Long Acre). In the Medieval period bean then returns to similar levels of presence and similar socio-economic patterns of distribution, to pea. Both legumes were inferior goods, a substitute for meat in peasant diets, eaten more widely in times of shortage, dried and milled to bulk out cereal flours in cheap loaves, and often given as food alms to the poor (Stone, 2006; Woolgar, 2016). The extremely high levels of bean presence in Saxon London, may therefore derive from consumption in a time and place where the demand for food was high, but systems of food provisioning were under-developed. As for whether beans were used differently to peas, there is little written evidence; some manorial and monastic accounts from later periods (primarily the High Medieval) record the giving of both pulses in alms, while others record one or the other (Stone, 2006; Woolgar, 2016).

6.3.2. The impact of culture and status

Group diets result from the interplay of several factors, including the cultural affiliations that individuals, households, or communities wish to align themselves with or to reject, the means of food provisioning available to them, and the degree of autonomy enjoyed by consumers and producers. The following analyses explore commonalities within the archaeobotanical assemblages and samples derived from the places of occupation of various social groups, and the differences between archaeobotanical records associated with each group and the rest of contemporary British society.

6.3.2.1 Romano-British period

The three potential elite consumer groups considered for this period are: the inhabitants of London, the Roman military, and the occupants of villas (the secular rural elite sites of the period).

The only feature common to all three potential elite site categories (London, forts, and villas) is a lack of emmer-rich samples in comparison to other site types. There are more similarities between the assemblage and sample records from London and from forts, than there are between these two settlement categories and villas. The London and fort datasets are most similar to each other during the early and mid Romano-British periods, when they are both characterised by relatively low levels of emmer, rye, pea, and bean presence, and a relatively high proportion of barley-rich samples. In the late Romano-British sub-period, increases in rye, pea, and bean presence occur in London records but not in those from forts. Lentil presence is always associated with London but not with forts, whilst free-threshing wheat-rich samples occur more often (but never frequently) at forts than in London. Although emmer-rich samples are relatively uncommon at villas, emmer was not replaced by free-threshing wheat or barley: samples rich in the former are equally rare on all statuses of rural site and those rich in the latter are even less common at villas than at non-villa rural sites.

The lack of emmer-rich samples at elite sites does not appear to be linked to culturally Roman patterns of consumption: emmer is frequently found within Roman (i.e. Italian) archaeobotanical assemblages and samples (Sadori and Susanna, 2005; Murphy, Thompson and Fuller, 2013; Mariotti Lippi *et al.*, 2015; Bosi *et al.*, 2017) and was shipped northwards to provision garrisons on the Rhine frontier (Pals and Hakbijl, 1992). Its absence on British elite sites may, however, be linked to their economic basis: if emmer was a subsistence crop, its consumption would have been restricted to the sites on which it was grown (i.e. on small native farms, and around small towns whose inhabitants were directly engaged in farming); it would not have been moved to consumer sites (London, forts, and also the major towns).

The greater frequency of barley-rich samples at forts and in London does not suggest stereotypically "Romanised" consumption either. The negative connotations of barley consumption appear repeatedly in classical literary sources: Polybius (Shuckburgh, 1889, p. 38) and Plutarch (Clough, 1865, p. 1555) describe it as military punishment rations for deserters who escaped execution, and

Vegetius (Milner, 1993, p. 14) as a food for unproven soldiers. The archaeobotanical evidence in the present study for high levels of barley use at forts is, however, consistent with Britton and Huntley's (2011) conclusion that barley was indeed eaten by people not just horses at Birdoswald (one of the sites with barley-rich samples in this dataset) and Carlisle forts, and with evidence from the Vindolanda tablets where barley is listed as food not fodder (Bowman, 1983). That barley appears most abundantly (and spelt less abundantly) in samples from the two types of elite consumer-only settlement to which grain must have been moved (forts and London) is consistent with the prioritisation of the costs and practicalities of transport over culinary tastes. In contrast the relative rarity of barley-rich samples at villas may reflect the easy availability of (culinarily preferable) spelt wheat on site, i.e., with no need to consider transport costs. Although one aim of villa farming would have been the production of saleable surplus, the villa household would also have been provisioned from the crops grown on site; the aim of self-sufficiency runs through agricultural treatises aimed at wealthy Roman landowners (Cato and Varro, 1912; Garnsey, 1999) and a lack of association between villa sites and imported food plants (van der Veen, Livarda and Hill, 2008) suggests that the situation was no different in Britain.

The free-threshing wheat-rich samples found on military sites date to the mid (New Cemetery Rocester) and late (South Shields, Birdoswald) Romano-British periods. The consumption of free-threshing wheat at Roman forts, in areas with no evidence for its local cultivation, also occurred at the forts at Valkenberg and Alphen-aan-den-Rijn in the Netherlands (Bakels, 1991; Cavallo, Kooistra and Dütting, 2008), where importation from areas of loess soil (found in the German Rhineland, southern Netherlands, Belgium, and northern France) is concluded to have occurred. However, there is no reason to assume the free-threshing wheat at the British forts was imported. Whilst at South Shields the presence of golden dormouse bones suggests a continental origin for at least some of the granary's contents, the importation of any particular batch of free-threshing wheat cannot be ascertained. Again (see also Section 6.1.2 above) the evidence is slight, but the dates of the free-threshing wheat-rich fort samples are contemporaneous with the proposed mid Romano-British increase in free-threshing-wheat rich samples across Britain, including (albeit infrequently) on rural sites across England where cultivation seems more probable than importation. The most northerly rural samples in the dataset come from the villa at Ingleby Barwick, approximately 40 miles south of South Shields Fort but there is no reason to consider free-threshing wheat cultivation purely an innovation of villa farms (in the present dataset, villas are no more likely to yield free-threshing wheat-rich samples than non-villa rural sites). The necessity to import cereals (of any species) to Britannia was also reduced during this period, and documentary evidence suggests that cereals were actually being exported from Britain to the Rhine frontier (Mattingly, 2007, p. 505).

The relative rarity of other probable grain contaminants (rye, pea, and bean) is common to both fort and London assemblages during the early and mid Romano-British periods, but in the late Romano-British period they increase in London but not at forts. Londoners may have turned to alternative suppliers to meet their grain needs, but it seems that the military did not. The other difference between military sites and London relates to lentil. High levels of lentil presence occur in London (see 6.3.1.1 above), but not at forts or vici. The three records of lentil presence from Carlisle (one from the fort, two from the vicus) all date to the early Romano-British period when, in the immediate aftermath of conquest and before local provisioning was established, the importation of supplies would have been most necessary.

The close economic interrelationship between forts and *vici*, evidenced in numerous artefactual studies, is suggested again in this comparison of archaeobotanical data between the two site categories (Allason-Jones, 2001, 2016; Taylor, 2001; Livarda, 2008a, 2011; Livarda and van der Veen, 2008). Archaeobotanical records from *vici* adjacent to occupied forts have several of the characteristics (glume wheats are less significant, free-threshing cereals are more significant) that distinguish fort records from civilian settlement records, and these characteristics also distinguish *vici* from similarly sized small towns without military connections. Records from former *vici* sites (i.e. from phases of activity at *vici* after military departure from their associated fort) are, however, more similar to those from civilian small towns, than those from contemporary forts. Despite being mid or late Romano-British in date (when emmer is becoming increasingly uncommon at other types of site) emmer is more frequently present at the former vici. If emmer (often present but not abundant) is interpreted as a crop weed this suggests different sources of grain supply to the *vici* and former *vici*. Rather than being provisioned by larger farms focussing on the extensified cultivation of spelt and barley, the former *vici* may have depended on smaller-scale agriculturalists. As the military presence in Britain declined so did the *vici* (Davies 2007, Brindle 2016a). The development of economic connections with their rural agricultural hinterlands would have been essential to the survival of the former *vici*. The site-phase dataset contains no records from former *vici* north of Catterick (North Yorkshire). In part this may reflect the excavation bias towards central and southern England, but it is also consistent with Brindle's (2016b) hypothesis that the most northerly vici were the least likely to survive after military withdrawal because they were particularly poorly integrated within their local rural economies. Mattingly (2007) suggested that in the militarised zone the army would have been reluctant to cede control of agriculturally productive land to civilian towns. Location within more densely settled rural landscapes (Roberts and Wrathmell, 2002), and better access to the road network, may have made it easier for the southern *vici* to reinvent their economies, perhaps as market centres for local small-scale producers. Those few settlements (Catterick, Malton, Doncaster) that persisted in the north (Allen, 2016a) were also located on major roads (Ordnance Survey, 2016). Unfortunately, longitudinal data from individual sites before and after their transition from *vicus* to civilian small town were not available, so we cannot be certain that those *vici* that survived changed their relationships with local farmers: they may have been sites which were always locally provisioned.

From the analysis of site-phase presence data no differences emerged between villa and non-villa rural sites. Only when sample contents are compared do differences appear; with comparatively fewer emmer-rich and fewer barley-rich samples at villas. The lack of evidence for emmer is consistent with the late (mostly mid and late Romano-British period) date of most villas, and with their function as centres of extensified farming, producing marketable surplus. At non-elite rural sites, extensified farming is associated with both spelt and barley (although barley remains the more minor crop) but villas may have specialised further. A narrow focus on producing a surplus of spelt is a strategy consistent with other examples of economic specialisation identified at some villas: fish farming at Shakenoak and Claydon Pike in the Thames Valley (Brodribb and Walker, 1978; Hurst *et al.*, 2016), pottery and metalworking at villas in the Nene Valley (Hingley and Miles, 2002), and oyster farming on the south-east coast (Tomalin, 2006).

6.3.2.2 Saxon and Medieval period

In the Saxon and Medieval periods sufficient data were collated for three potential elite consumer groups – the inhabitants of London, of rural manors ("rural secular elite sites"), and of Christian religious institutions ("religious elite sites") – to draw comparisons between records from each of these site types, and between them and non-elite sites. Although insufficient records were available from urban secular elite sites (castles and palaces) to allow their analysis as a discrete category, occasional reference is made below to cases when data from such sites conform to, or diverge from, trends identified at the better represented types of elite site.

There are several commonalities in the archaeobotanical data from the three types of elite site: compared to non-elite sites, the decline in glume wheats is completed earlier, the increase in free-threshing wheat-rich samples is more rapid, and the proportion of barley-rich and oat-rich samples is lower. In the Saxon period a relatively rapid increase in pea and bean presence occurs at rural secular elite and at religious sites, but in London only bean increases rapidly. Of the remaining taxa, the rye-richness of samples appears more strongly influenced by the urban (more rye-rich samples) or rural (fewer rye-rich samples) status of sites (Section 6.3.1.2) than by their socio-economic standing (although some Medieval religious sites did yield rye-rich samples). Flax presence is more common at rural secular elite sites than at any other (elite or non-elite) site type, but the number of presence records is so low that interpretation is not possible. Lentil is so rarely preserved that no socio-economic patterning in its presence is evident.

Glume wheats (almost always spelt) persist at low levels of presence throughout the whole post-Roman period but the decline in their presence is more rapid at elite rural sites than at non-elite ones (complete by the early-mid Saxon period as opposed to the High Medieval). The persistence of glume wheats as crop contaminants is a throw-back to Romano-British agriculture. Their relative absence from elite sites suggests that elite households were being provisioned by farms where there had been a clear break with past practice. This is consistent with the provisioning of aristocratic and monastic households from their own estates (with occasional exceptions in environmentally unfavourable areas, as at Dryslwyn and Eldbotle). There was no seamless transition from villa to manorial estate farming: the early Saxon reversion to subsistence farming and collapse of marked socio-economic stratification disrupted elite farming in Britain. When new elites asserted control over agricultural surplus in the later sixth and seventh centuries, their command of territory and people (i.e. of labour) would have allowed them to expand arable cultivation onto new ground. The ability of the larger manorial farms (especially those owned by monastic foundations) to innovate is recorded in accounts of investment in new technologies such as watermills and infrastructure projects such as canals and land reclamation from the mid-Saxon period onwards (Holt, 1988; Blair, 2007; Brunning, 2010). Another break with past practice may have occurred if these farms purchased rather than retained seed corn, as advised by Medieval agronomists such as Walter of Henley (Lamond, 1890, p. 19).

Free-threshing wheat became the predominant cereal in the majority of samples comparatively rapidly at rural secular elite sites (as well as in London). Although trends are less obvious within the very small set of Saxon samples from religious sites, by the High Medieval period most samples were also comprised mostly of free-threshing wheat. During the Saxon period, free-threshing wheat presence actually increased more rapidly at non-elite than at elite rural sites, but the importance of free-threshing wheat within samples increased more slowly at non-elite sites (where barley was the taxon that most often dominated early-mid Saxon samples) suggesting that the expansion of free-threshing wheat consumption by peasant households occurred relatively late. A transition, from growing free-threshing wheat for their landlords, to growing more for their own consumption having "got used to eating it" was proposed by Banham (2010, p. 185), who proposed a tipping point in peasant free-threshing wheat consumption occurred in the mid-tenth century, when climatic improvement and the expansion of ridge and furrow ploughing improved drainage on heavy soils during the winter. However, some free-threshing wheat-rich samples occur on early-mid Saxon non-elite rural sites, suggestive of deliberate cultivation and consumption. Based on this evidence, poor drainage does not appear to have been an impediment to the peasant cultivation of free-threshing wheat: these non-elite rural sites show no strong tendency to be located on free-draining soils. Naturally high soil fertility seems to have been more important (twelve of the fifteen sites were situated within areas of moderate to high fertility) than the risk of waterlogging; in any case all sites were located within central and southern England where winters tend to be dry.

In the Medieval period both religious elite and rural secular elite sites tend to have fewer barley-rich samples than non-elite rural sites. A preference for free-threshing wheat over barley in high status foodways is consistent with contemporary documentary accounts. Both wheaten and barley loaves were embedded in western Christian culture but consumed by different groups: wheaten bread was celebratory, used for the eucharist and monastic dining; barley bread was an inferior good given in alms and to servants, or consumed in dire straits as in the miracle of the feeding of the five thousand (Woolgar, 2006; Jotischky, 2011). Similar status based distinctions between the types of loaves given to family members, servants, and beggars are recorded in the accounts of secular aristocratic households (Hagen, 1992; Jotischky, 2011; Woolgar, 2016). Although higher levels of free-threshing wheat cultivation are associated with several increased risks (Section 6.1.2), elite landowners would have been less exposed to, and better able to mitigate, them: the largest landowners (especially the large religious institutions) would have drawn their household supplies from diverse, often geographically widespread, estates. Even on smaller demesnes, investments in new technologies such as mouldboard ploughs or drainage schemes provided alternative risk buffering strategies to the extensified cultivation of barley. In times of shortage, aristocratic households faced the lowest risk of starvation, with first call on the produce of their tenant farmers. In times of plenty, they would have had first call on the most culturally valuable, and therefore saleable, crop (free-threshing wheat), reducing its availability to the peasantry and increasing their reliance on substitute grains. Although a rise in oat cultivation has been associated with the rise in horse ownership over the late Saxon and Medieval periods (e.g. Dyer, 2002) and horse ownership (particularly for riding) was a sign of affluence (e.g. Hindmarch and Oram, 2012), in the present dataset there is no positive correlation between the incidence of oat-rich samples and higher-status sites. Rather, the opposite occurs, with a greater proportion of oat-rich samples at non-elite than elite rural sites. Oats used as horse-feed are unlikely to be well represented within fine-sieve by-product samples, which represent the final stages of crop-cleaning before human consumption. This is also likely true for fodder barley. Brewing offers an alternative explanation for the relatively high proportion of samples rich in oats and barley at non-elite rural sites. Brewing transforms inferior grains into an added-value product, and manorial court records show that commercial brewing was predominantly a rural enterprise.

The increase in pea and bean presence was more rapid at rural secular elite sites than at rural non-elite sites. Within the Saxon period, a rapid increase in pea and bean presence occurred at rural elite (both taxa present in c.30% of site-phases) and at religious sites (both taxa present in c.25% of site-phases) but it was not until the High Medieval period that levels of pea and bean presence reached similar levels at non-elite rural sites. Once record-keeping became a regular aspect of High Medieval demesne farm management, the role of legumes within crop rotation schemes is well attested, but this evidence suggests it was introduced earlier and that it was widespread on elite estates in the Saxon period. This early introduction of nitrogen fixing legumes into field cultivation is consistent with an early increase in free-threshing wheat cultivation on the farms provisioning aristocratic households and monastic institutions, where (due to the demands of the free-threshing wheat crop) soil nutrient depletion would have set in early.

For the remaining crop taxa, other factors appear to have a greater impact on their presence and/or abundance within samples than elite site status. The only elite site type at which rye-rich samples may occur quite frequently are religious institutions (at St. Giles by Brompton Bridge; St. Nicholas Yard, Carlisle; and Staunch Meadow). All three sites had rural settings (where rye-rich samples are generally less frequent from the late Saxon period onwards). The first two sites were hospitals and it is tempting to connect the presence of (fairly) large quantities of rye with the documentary record of rye-bread being given in alms and to hospitals, as for example at Canterbury Cathedral Priory (Woolgar, 2016). However, loaves rather than grain were given, and rye may have been less a symbol of charitable giving, and more a pragmatic choice at all three sites in this dataset: they were all situated upon sandy soils (Cardwell, 1995a; Howard-Davis and Leah, 1999; Tester *et al.*, 2014) where rye would have been more likely to succeed than wheat.

Although the two sites to which lentil must have been moved from its original place of cultivation (Eldbotle and Dryslwyn) both had evidence of elite occupation, there is no reason to conclude lentil was a high-status foodstuff in the Medieval period. Given the abundance of documentary references to the high monetary and cultural value of free-threshing wheat, and the absence of any such references to lentil, the accidental movement of lentil in association with wheat (which was definitely "imported" to both sites) is a more convincing explanation for its presence.

Although Medieval levels of flax presence on rural secular elite sites (present on 23% of sites, n=35) are double those on other types of site, flax seeds were never found in large quantities and there was little interpretation of these finds within the relevant archaeobotanical report. Only at West

Cotton was there non-archaeobotanical evidence for flax retting (in the form of stakes in the river, possibly used to secure bundles of flax stems), and although the production of linen for sale may have been undertaken on manorial estates, other uses for flax seeds (as a bread flavouring, or as a drug) must also be considered possibilities.

6.4 Summary

As regards the broad chronological changes in the cereal taxa cultivated in Britain, the patterns identified in this study are consistent with those described in previous studies: the initial predominance of glume wheats, their decline (emmer followed by spelt), and their replacement by free-threshing cereals (most markedly by free-threshing wheat). This study documents the continued presence and abundance of spelt into the Saxon period, supporting the often-asserted early Saxon date for the end of its cultivation, while the rise of free-threshing wheat to predominance was more protracted (extending into the High Medieval period) than is usually assumed. Free-threshing wheat (and oat) are also suggested to have been in very limited cultivation in Roman Britain.

By simultaneous analysis of temporal and spatial patterning in the archaeobotanical data, the possibility that changing crop-choices represent farmers' strategic responses to the environmental constraints they faced is evaluated. Overall, there is more evidence for regional responses to variations in local environments than for nationwide responses to large-scale climate change. The early introduction of, and later focus on, oat cultivation in Wales and Scotland, and the coastal distribution of *Avena strigosa* floret base identifications, are consistent with the climatic and edaphic constraints upon crop choices in these regions, as is the enduring emphasis on barley rather than wheat in the north of Britain. The concentration of evidence for rye cultivation in areas of sandy soils (East Anglia, the West Midlands, and at the northern religious institutions) suggests this was also, at least initially, a response to local environmental constraints; and offers an explanation for the introduction of this culturally inferior food grain into cultivation at the same time as (the culturally preferable) free-threshing wheat. The spatial restriction of the cultivation of several taxa is explicable on climatic grounds: evidence for the post-Roman cultivation of lentil and tetraploid free-threshing wheat, and for the expansion of bean cultivation, is all restricted to the warmer, dryer, regions of central and southern England. Most of the decline in emmer cultivation is not explicable as a response to climate change, but the disappearance of emmer as crop and crop weed between the mid Romano-British and the early-mid Saxon period is.

Other chronological and regional variations are more consistent with, and so better explained by socio-economic imperatives, such as the decline in emmer during the Romano-British period (the early to mid- Romano British decline in emmer-rich samples, and emmer's early disappearance in the north); the widespread, but slightly biased to the east, distribution of free-threshing wheat-rich samples in the Romano-British period, and the persistence of spelt cultivation in the east. The replacement of spelt by free-threshing wheat during a period of climatic deterioration, and the spatial expansion of oat into the warmest and driest areas of England (central and southern) during a period of climatic improvement, appear contrary. By then considering the social context of the sites from which archaeobotanical remains derive, other influences on farmers' and consumers' decision-making may be identified. For example, variations between different categories of elite site in the representation of cereal species believed to have possessed the highest cultural cachet (spelt in the Romano-British period, free-threshing wheat in the Saxon and Medieval) suggest that economic factors (such as the cost of grain transport) were exerting a stronger influence on elite consumption decisions than cultural values.

Roman authors associate high-status food consumption with a preference for wheat over barley. The archaeobotanical evidence from villas (relatively spelt-rich) most closely matches this expectation, but the evidence from forts (relatively barley-rich) is contrary to expectations. Forts share this characteristic with London and with other major towns. Common to all these categories of site, in sharp contrast with villas, is their spatial separation from the cultivation of their cereal supplies. The observed differences between villas and the other putative sites of elite consumption are therefore due not to differences in status, but to differences in their means of food provisioning. When long distance transport of grain from producer to consumer was necessary, pragmatism regarding its efficiency (favouring free-threshing barley over glume wheats when long-distance grain transport was necessary) overrode, to some extent, socio-cultural food preferences.

There is greater consistency between the various categories of Saxon and Medieval elite site. Secular and religious, rural and urban, elite sites are all characterised by an early predominance of free-threshing wheat-rich samples and by correspondingly lower proportions of barley and oat-rich samples. This patterning conforms to the elite consumption preferences documented in contemporary written sources. The lack of difference between secular elite and religious households is perhaps unsurprising: the senior clergy were drawn from the ranks of the aristocracy, monastic foodways were similar in other respects (especially in their meat consumption) to those of secular elites, and both elite groups were provisioned by similar mechanisms (from their own large estates) and enjoyed a high degree of control over their food supplies.

Considering production strategies, in the Romano-British period the transition away from intensive small-scale emmer cultivation to extensified spelt and barley cultivation was more complete in the north than the south. This suggests that the pressure on all farmers to produce surplus was high in this region, perhaps because there was a greater degree of compulsion to produce a grain surplus in the area under military rule. The army may have dictated the output they wanted from local farmers, but they are less likely to have concerned themselves with the means by which it was realised. The implementation of a uniform agricultural strategy across the region is more likely to result from the common constraints facing northern farmers. With their basic unit of production limited to the familial household level, and in the absence of local civilian urban settlements from which additional wage-labour might be obtained, the production of a larger grain surplus by intensification of cultivation would not have been practicable. In contrast, in southern England, the greater degree of variation in assemblage and sample contents may reflect the greater degree of choice enjoyed by farmers. Here the greater pressure on, and the likely higher purchase cost of, land would have encouraged villa owners to focus on the most valuable grain (i.e. spelt). The relative proximity of villas to urban markets would have made transport costs less of a disincentive to spelt cultivation. Conversely, in the north, far from urban markets and faced with military buyers powerful enough to drive prices down below the market rate, barley cultivation (with lower costs of transport, and very well-suited to low-input cultivation regimes) would have been a safer choice.

Lentil is the only crop in this study with sufficiently narrow ecological tolerances to infer that a particular find must have been imported or moved around Britain. Interpreted as an imported grain contaminant in Roman Britain, trends in the frequency of lentil presence suggest a change in military grain provisioning (from imports to domestic sources) between the early and mid sub-periods, and a similar change in London's grain provisioning between the mid and late Roman sub-periods. In the Romano-British and Saxon periods, higher levels of presence and abundance are observed for the least bulky cereal taxa (of those in widespread cultivation at the time) at consumer-only sites, compared to sites with high levels of auto-consumption. A concern with the efficiency of grain transport is therefore suggested by the higher levels of Romano-British barley at forts, in London, and in other major towns; of free-threshing wheat in early-mid Saxon London; and of free-threshing wheat and rye in late Saxon major towns.

New taxa were not introduced as cash-crops. As urbanisation developed, taxa already cultivated on rural sites were co-opted to this new use: spelt and barley for Romano-British urban and military consumers; free-threshing wheat, rye, and oat for the inhabitants of late Saxon and Medieval towns. In the post-Roman period, oat and rye were first introduced into cultivation on rural sites, probably as a risk-buffering strategy at sites where wheat cultivation was least likely to be successful. Their widening spatial and socio-economic distribution over time, concurrent with the development of urban markets, suggests that consumer demand drove their expansion. The increasingly stratified nature of urban society may have created a demand for cereals at a variety of price-points. Culturally "inferior" foodstuffs may still have made profitable cash-crops: while the focus on spelt (likely to have commanded a higher price than barley) at Romano-British villas suggests a strategy of revenue maximisation, a focus on barley (as seen at northern, native farms) suggests a strategy of cost minimisation (reducing costs of production and transport). The profitability of selling rye and oats to the Saxon and Medieval urban market would have been increased by their additional (non-food) uses and by the opportunity to sell the whole crop (not just the grain), thereby increasing revenue. The late Saxon substitution of free-threshing wheat, rye, and oat, for barley, in urban samples, is consistent with a preference for products suited to specific purposes (e.g. free-threshing wheat for baking, oat for fodder, rye for straw as well as grain) rather than for one multipurpose commodity (barley providing adequately, but less well, for all three needs).

Throughout this discussion, the patterning within the archaeobotanical data is shown to derive from the combined influences of environmental, cultural, and economic factors. In some cases, cultural values outweigh economic incentives as, for example, when profitable free-threshing wheat crops were kept back from market sale to be consumed by the Medieval landed aristocrats. In other cases, economic imperatives outweigh cultural preferences, as in the provisioning of the Roman military with relatively cheap, easily transportable, barley. The following chapter concludes the discussion of the causes of variation in cultivation and consumption practice by summarising how these findings address the research questions posed at the outset of this thesis.

Chapter 7. Conclusions

7.1 Summary of data and methods

This thesis addresses a lacuna in previous research by analysing the archaeobotanical remains of cereal, pulse, and flax crops as direct evidence for choices made by agricultural producers and consumers in Roman, Saxon and Medieval Britain.

Archaeobotanical data were collated and analysed from 947 sites of occupation on mainland Britain, Anglesey, and the Isle of Wight dating between AD c.43 and 1500. The bulk of the data (in all periods) derives from England, and within England from lowland central, eastern, and southern England. This bias results from a combination of factors: relatively low settlement density outside this region (in both the past and present); the poor archaeological visibility of the low-status rural settlements in the northern and Welsh uplands; and a lack of developer-led excavation in these areas. Consequently, the discussion within this thesis has focussed primarily on England, but some distinctive features of the Scottish and Welsh agricultural economies in the Roman and Medieval periods were identified. All three broad temporal periods – Roman, Saxon and Medieval – were well represented in the dataset, although a relative scarcity of precisely dated rural sites means the early-mid Saxon temporal sub-period covers a longer time-span than is ideal.

Two datasets were analysed. The site-phase presence dataset comprised 1381 records. The greatest advantage of this dataset was its large size, including the maximum number of site-phases, and various univariate, bivariate, and multivariate statistical methods successfully revealed temporal, spatial, and socio-economic patterning in the frequencies of crop taxa presence. However, from presence alone, we cannot determine the economic status of a taxon, i.e. whether it was deliberately cultivated or an accidental contaminant of another crop. Cultivated status can only be determined by considering the proportional contribution a taxon makes to samples, and the frequency with which samples rich in that taxon occur. The sample content dataset (for 1933 samples) was analysed using multivariate statistical methods: first to produce a coherent set of 1689 samples, which could be compared without the confounding effect of crop-processing stage on sample composition obscuring patterning due to factors more pertinent to this study, and then to identify such patterning.

By integrating the results of the analyses of the two datasets, the transitions of free-threshing wheat and rye from grain contaminant to cultivated crop were dated to the early-mid Saxon sub-period, and the corresponding transition for oat, dated to the late Saxon sub-period. The final withdrawal of emmer from cultivation occurred within the Romano-British period and the end of spelt cultivation between the late Romano-British and early-mid Saxon periods. Each of these changes was then analysed within its environmental and socio-economic context.

The long temporal scope of this study has permitted insights into the cultivation histories of crops outside the periods within which they are most commonly studied: into the circumstances of cultivation of spelt in the early-mid Saxon period, oat in the Romano-British period, and free-threshing wheat in the Romano-British and Medieval periods. By grouping site-phase and sample records according to broad temporal, spatial, and socio-economic categories, patterns emerge that cannot be discerned at the individual site level, and common causal factors were then identified. Thanks to the study's broad spatial scope, regional variations can be separated from nationwide trends, and decisions made in different environments compared. From this analysis, farming strategies implemented in response to environmental conditions can be distinguished from strategies implemented in response to social or economic conditions.

7.2 Summary of results relating to the research objectives

7.2.1 The introduction, retention, and discontinuation of crops

Between the Romano-British and Medieval period, three cereal taxa (free-threshing wheat, oat, and rye) and one pulse (lentil) were introduced into cultivation and consumption, while the cultivation and consumption of two other cereals (emmer and spelt) ended. The cultivation and consumption of barley and pea endured throughout. The archaeobotanical evidence for flax and bean is less easily interpreted. Flax cultivation probably also endured throughout: although there are no Medieval flax-rich samples, there is no decline in the frequency of flax presence during this period, and cultivation is attested in contemporary documentary sources. There is limited evidence relating to the status of bean in the Romano-British period. Although it appears as a contaminant of grain-rich samples, there are no samples rich in bean (and no useful contemporary documentary evidence referring specifically to Britain). Evidence for bean cultivation in Britain (in the form of increasingly spatially widespread presence, with occasional bean-rich samples) was, however, found from the Middle Bronze Age onwards in Treasure and Church's (2017) review of prehistoric data, and there is no reason to assume bean cultivation was temporarily discontinued in the Romano-British period. The absence of evidence is much more likely to reflect the rarity of bean preservation. In later periods, although there is evidence for the field cultivation of both pea and bean, there is insufficient evidence to draw conclusions about the identities of those who consumed them. The archaeobotanical evidence for lentil never follows the same temporal, spatial, or socio-economic trends as the evidence for the other pulses, leading to the suggestion that, whilst pea and bean became an important component of Saxon and Medieval crop rotations, lentil did not.

Introductions of new field crops into British farming practice are concentrated within the Saxon period. The introduction of rye and of widespread free-threshing wheat cultivation dates to the early-mid Saxon period; the introduction of widespread oat cultivation and of lentil cultivation dates to the late Saxon. The dramatic increase in bean finds in early-mid Saxon London suggests a change in either the utilisation or processing of bean that increased the likelihood of its preservation by charring. This could, for example, be an increase in the quantities cultivated and consumed, or a change in food preparation/storage, such as cooking or drying, increasing the likelihood of exposure to fire. The end of spelt cultivation also occurred (entirely) within the early-mid Saxon period. Other changes occur earlier. Only the very end of emmer cultivation in (Roman) Britain falls within the scope of this study. The onset of the widespread cultivation and redistribution to consumers of free-threshing wheat and oat was preceded by very occasional instances of Romano-British cultivation. There was no gradual expansion of cultivation of free-threshing wheat or oat over the Roman period, but rather there was an abrupt increase in the Saxon period. The first evidence for lentil cultivation dates to the late Saxon period but the first evidence for its consumption dates to the Romano-British period, when it is more likely to have been imported than locally grown. The Medieval period saw changes in the distribution of taxa between types of consumer site, but no change in the range of taxa in cultivation.

Archaeobotanical studies concerned with glume wheats usually end with the Romano-British period, and studies of Saxon archaeobotanical evidence mostly focus on the free-threshing cereals. Consequently, the end of spelt cultivation in Britain between the late Romano-British and early-mid Saxon periods is more often asserted than evidenced. Whilst confirming the timing, and the rapidity of the post-Roman withdrawal of spelt from British farming, it is suggested that localised (possibly culturally motivated) cultivation of spelt for household consumption continued at a few rural sites, but this did not endure beyond the mid-Saxon. The history of free-threshing wheat cultivation is also clarified, by the identification of occasional cultivation and consumption in Roman Britain, and also by the finding that the expansion of free-threshing wheat consumption, begun in the Saxon period, continued into the Medieval, and this expansion was both protracted and socio-economically variable.

Romano-British oat cultivation was spatially restricted to areas of predominantly wet, acidic soils and socially restricted to native rural sites. It is thereby interpreted as an adaptation to local environmental conditions by farmers (mostly in Wales and Scotland) growing for their own subsistence. The later introduction of rye cultivation appears to have been similarly motivated: with the evidence for early-mid Saxon rye cultivation concentrated on rural sites in areas where droughty soils are common. The early (Romano-British) history of free-threshing wheat cultivation and consumption is different: there is no clear spatial restriction of cultivation to a particular environment, and no restriction of arable production to sites of particular socio-economic status. The presence of both imported and domestically cultivated free-threshing wheat in Roman Britain may be obscuring patterns in both cultivation and consumption. It is possible that some free-threshing wheat was grown in Britain (and that this occurred on native rural sites), but that some of the rich samples found at urban and military consumer sites (with international trading connections, and with lentil present) are comprised of imported grain. There is no evidence, however, that importation preceded the domestic cultivation of free-threshing wheat.

Local environmental circumstances exerted less significant influences on the decision to end the cultivation of taxa, than on the decision to introduce them. Although there are spatial variations in the rapidity with which emmer and spelt cultivation ended, these correspond to regional socio-economic rather than environmental differences. As with the first instances of oat and rye cultivation, the last instances of emmer and spelt cultivation seems to relate purely to (non-elite) farmers growing for auto-consumption.

7.2.2 Influences on cultivation and consumption.

In most cases, a farmer's decision to cultivate a particular crop taxon (or not) will be based on a combination of environmental, socio-cultural, and economic factors. In this study, spatial variations in the taxa under cultivation were often influenced by environmental variables, but temporal changes (i.e. the timing of introductions and withdrawals of taxa from cultivation) were not.

Across most of Britain farmers had a choice of cereal cultivars. Edaphic and climatic conditions in Wales and south-western England, and in Scotland, exerted the greatest limiting effects on this choice. In both regions, and in both periods (Romano-British and Medieval) for which there is sufficient sample content data for analysis, the range of taxa under cultivation is restricted, and one taxon dominates the archaeobotanical record. In Wales and south-western England, the combination of acidic, poorly draining soils, and the wet climate resulted in a focus on spelt cultivation in the Romano-British, and oat cultivation in the Medieval periods. In Scotland, with a similar (but less acute) shortage of good arable soils, but a colder climate, barley was the mainstay of Romano-British cultivation, and oat the mainstay of Medieval farming. Innovation was not stifled in these regions: as elsewhere in Britain, in both regions one of the new free-threshing cereals replaced an established Romano-British crop.

Environmental challenges may even have stimulated agricultural innovation: most of the pre-Saxon evidence for oat cultivation comes from Wales and south-western England and from Scotland. Elsewhere, the introduction of rye cultivation also appears to have been a response to local environmental conditions: the earliest evidence for rye cultivation centres on East Anglia, where there are large tracts of sandy soils. What is not explicable by reference to environmental (climatic) change is the timing of either introduction. In the climate of the Romano-British period, the need for a substitute for spelt or barley would not have been pressing. The onset of more widespread cultivation of oat in the late Saxon (possibly another period of climatic amelioration) is similarly unexplained. Rye was introduced onto droughty soils at a time when the climate was wetter.

Likewise, the restriction of tetraploid free-threshing wheat cultivation to central and southern England is consistent with the warmer climate in this area, but the timing of the widespread introduction of free-threshing wheats (hexaploid and tetraploid) in the early-mid Saxon period is not explicable by reference to climate change. The late Saxon introduction of lentil into cultivation is another case where the spatial distribution of the crop (restricted to the warmer regions of central and southern England) is explained by environmental factors, but the timing of introduction is not. Although the late Saxon period was one of climatic warming, conditions would have been similar during the early to mid Romano-British period when lentil appears to have been imported rather than domestically cultivated. Neither the timing nor the (admittedly slight) spatial variations in the withdrawal of emmer and spelt from cultivation, can be attributed to environmental influences.

Climate and soils affect the supply of cereals (both the taxa it is possible to grow, and the yields that are achievable) but they are not the only relevant supply-side factors in farmers' decision making, and they had no discernible impact upon consumer demand in the periods under review here. The impacts of these other social and economic factors are summarised below.

7.2.3 Group diets and differential access to foodstuffs

Each site from which archaeobotanical data originated was allocated to a socio-economic category. Several aspects of socio-economic status are combined in each category: elite status (power over land and/or people), socio-cultural affiliations (for example, to the Roman army or to the Christian Church), wealth, and the location of settlement (rural or urban; and if urban, the size of the town). For example: the Roman army, represented by sites in the "forts" category enjoyed power over land

and people, but the status of individuals would have varied according to military rank. There may have been a common military food culture, and diets may have been modelled on Roman cultural values, but individual soldiers and units may, additionally, have retained culinary traditions from their home provinces. Although wealth varied with rank, all soldiers would have been cash-rich in comparison to the local native agricultural communities within which many forts were established. Not all aspects of socio-economic status are represented by the site-type categorisations used here: sites were categorised according to the status and/or wealth of heads of households, so, within each site-type category and within each site, variations in socio-economic status and therefore differences in cereal consumption would have occurred.

The same range of cereals was used at all contemporary site categories: but there are significant differences in the composition of samples from different types of site. Contemporary literary sources (including agronomic, culinary, and military texts) agree that a culturally Roman diet would have privileged the consumption of wheat over barley. However, forts (as a site category) are characterised by a surprisingly high proportion of samples evidencing the deliberate use of barley (in comparison to civilian settlements of similar size), whilst there are very few samples evidencing the consumption of spelt at these sites. This does not suggest stereotypically Romanised consumption, but neither does it suggest a distinctive pattern of military consumption (whether that would involve the consumption of barley as food or as fodder for cavalry horses). The pattern is repeated in Roman London, and in the other major towns. Common to all these categories of site is that they are *consumer-only* sites, not that they are associated with a particular type of consumer. Villas are the one Romano-British site type for which the archaeobotanical evidence conforms to expectations of Romanised, high-status, foodways. Here, almost all the evidence for deliberate cereal cultivation and on-site use pertains to spelt rather than barley. Amongst the Roman high-status sites within this dataset, villas are the only ones with a dual nature as both producer and consumer sites. This gave them the capacity not just to provide for their own household food *needs* but also for their *preferences*. At the consumer-only sites, the availability of cereals is determined by the decision-making of others (i.e. farmers deciding what to produce, and what to market), and additional costs and constraints resulting from the need to transport crops from farm to consumer.

In the Saxon and Medieval periods, despite the replacement of glume wheats by a range of free-threshing cereals, wheat (now free-threshing rather than spelt) retains its association with elite foodways. The other introductions, rye and oat, have inferior connotations, of peasant cuisine and animal fodder. These socio-economic connotations are consistent with the distribution of the archaeobotanical evidence for cultivated cereals on Saxon and (especially) Medieval rural sites. The bulk of archaeobotanical samples from manorial sites evidence the use of free-threshing wheat, whilst samples from non-elite rural households suggest a more mixed consumption strategy: with free-threshing wheat, oat, and barley-rich samples all common, although the use of rye is rarely evidenced (and restricted to the early-mid Saxon period).

The predominance of evidence for free-threshing wheat consumption at aristocratic manors has some parallels with the predominance of spelt at villas. In both cases the elite households were directly provisioned from their own estates, with control over what was cultivated, but with their high-status occupants freed from the labour of cereal cultivation. It seems unsurprising that it was in those Saxon and Medieval farming households where the agricultural decision-makers were spared the effort of implementing their decisions that the most labour-intensive cereal was most completely adopted. Although their accounts show that Medieval manors did sell some of their free-threshing wheat, the majority of demesne production was reserved for household use. Peasant farmers would have been less able to retain their free-threshing wheat. When rents were paid in kind, free-threshing wheat (whether in the form of grain, flour, or bread) was most in demand in English food renders. When rents were commuted to cash, free-threshing wheat commanded the highest market price, and may therefore have been preferentially marketed rather than eaten. Many peasants with small land holdings were themselves dependent on the market to provide sufficient food for their families: the sale of a quantity of free-threshing wheat that was too small to fulfil their subsistence needs, may have raised enough cash to obtain larger quantities of culturally inferior grains, that did provide sufficient calories.

7.2.4 The separation of producers and consumers

As urbanisation develops, so may differences between the crops grown and consumed on rural sites and the crops consumed on urban sites. If a wide range of taxa are grown in the countryside not all of them may be selected for onward movement to towns. Some will be better suited to transport than others, although “better suited” can be defined in several ways: the most robust, the least bulky, the lightest, or the most profitable when sold. The demands of urban consumers (less focussed on livestock raising, possibly more focussed on craft production) are also likely to differ from those of rural consumers, potentially influencing the proportions in which cereal taxa are demanded at urban and rural sites. Consequently, a more restricted range of cereals may be consumed in towns.

The broad chronological trend in crop cultivation, from glume wheats to free-threshing cereals, and within the free-threshing cereals from barley to free-threshing wheat, are consistent with the prioritisation of bulk-reduction rather than protection from damage in transport. During the

Romano-British period, the high proportion of samples rich in barley (rather than spelt) in London and other major towns and in forts and *vici* (all sites to which crops must have been moved) is consistent with this prioritisation of transport efficiency. Comparisons of the variety of cereals utilised at urban and rural sites differ in their results depending on whether "small towns", i.e. small roadside settlements, are considered to have had primarily rural (agriculturally self-sufficient) or urban (consumer) economies. In terms of material culture (Burnham and Wacher, 1990; Burnham, 1995; Allen and Smith, 2016), finds from small towns correspond more closely to non-villa rural than to urban sites, and this is also true of their archaeobotanical remains. At small towns and non-elite rural settlements there is evidence for the deliberate utilisation of a wide range of cereals (spelt, barley, free-threshing wheat, and very occasionally emmer); at London and other major towns there is comparatively little evidence for the use of free-threshing wheat, and no evidence for the consumption of emmer. The higher proportion of barley-rich samples in London and other major towns is consistent with the preferential movement of barley to urban sites.

During the late Saxon to Medieval period, the archaeobotanical remains tell a different story. Now there is evidence of the utilisation of a wider range of crops at urban sites compared to rural ones, and for greater utilisation of low-status cereals: the archaeobotanical evidence for rye consumption is almost entirely restricted to urban sites, and oat-dominated samples are more frequent in towns than in the countryside. Large towns and cities were socio-economically stratified communities, so there would have been demand for cereals at various prices; and the price of all grains would have been higher in towns due to the additional haulage costs incurred in bringing them to market. The rural poor, on the other hand, provisioning themselves directly, may have been better able to indulge a culinary preference for free-threshing wheat. Saxon London does not conform to the broader urban-rural pattern, with a very early focus on free-threshing wheat. Again, provisioning by a non-market mechanism may partially explain this. If the mid-Saxon *wic* was provisioned directly by the redistribution of manorial surplus and food rents accumulated by its aristocratic patrons, its inhabitants could have benefited from their privileged access to free-threshing wheat. Such connections with manorial estates may have persisted into the late Saxon period.

The broad ecological tolerances of the major cereal taxa cultivated in Britain make it usually impossible to infer where crops found at a particular consumer site were originally grown. Although the specific origins of cereals cannot be identified, changes in the grain contaminants found at consumer sites can be used to infer broad changes in provisioning strategy. In the Romano-British period, lentil, emmer, and rye are all grain contaminants with particular associations: the presence of lentil suggests the importation of grain from southern Europe, the presence of emmer suggests provisioning from non-elite farms, and the presence of rye suggests provisioning from farms in areas of sandy soil. From these associations, changing sources of grain supplied to Roman London can be inferred. Imports decline over time, and provisioning from an increasingly wide range of British sites is suggested by a late Romano-British rise in the presence of rye (and simultaneously in the presence of other taxa with less specific environmental associations: pea, bean, and free-threshing wheat). In the Saxon period, the conversion of many of these grain contaminants to cultivated crops means that similar inferences about the origins of crops are no longer possible.

7.2.5 Market-orientated farming strategies

No taxa, in any temporal period, were introduced into cultivation to serve purely as cash crops; usually cash-crops were selected from those taxa already in cultivation. In the Romano-British period, barley, which appears to have been preferentially moved to urban sites, was already long-established in cultivation. Likewise, spelt may have been the focus of commercially orientated villa farming but was not an innovation of these sites. In the post-Roman period, rye may have been primarily a cash-crop from the late Saxon onwards, but it was first cultivated (and consumed) on rural sites in the early-mid Saxon sub-period. The early-mid Saxon introduction of free-threshing wheat precedes the widespread marketisation of the English economy and seems more likely to have been motivated by the demand from aristocratic (and Christian) elites, who provisioned themselves directly. Oats are the most rapidly commercialised crop: appearing on both urban and rural sites during the late Saxon period.

The three taxa most strongly associated with urban markets, barley in the Romano-British period, oats and rye in the late Saxon to Medieval periods, are culturally inferior grains associated with low-status foodways, and (in post-Roman documents) sold for lower prices than wheat. Low priced cereals would have been demanded by poor urban consumers, and demand may have been higher in towns as all grain prices would have been increased by the addition of haulage costs.

Romano-British farmers who sold barley, and Saxon/Medieval farmers who sold oats and rye, in preference to wheat, may have been prioritising their own consumption preferences over the opportunity to maximise sales revenue. A low price, however, does not necessarily mean that a crop was unprofitable. All three taxa make low demands on soil fertility and are well suited to outfield farming. They can be added to cultivation, or their cultivation expanded, without adding significantly to the labour burden on farmers. A further benefit is their role as risk-buffering crops with relatively wide ecological tolerances. Both benefits would have been particularly valued by small-scale, low-status farmers. The expectation that farmers would receive lower revenues from the sale of these “inferior” crops, which is based upon the low status of the cereal grains within contemporary foodways, also overlooks the value of their straw. Whilst wheat grains were most valued for food, wheat straw is the least valued fodder. The cultivation of barley, rye, or oat gives farmers two saleable products. The late Saxon substitution of oats for barley, is likely to have been motivated by oat's higher nutritional value as fodder (which became increasingly important as horses were substituted for oxen as draught animals), whilst it fulfils the same risk-buffering function. Rye, which in the Medieval period provided the second highest priced grain, and the highest priced straw (valued for its craft use), may have been a particularly profitable cash-crop, especially for those farmers located close to urban markets. In the Medieval period, barley did not revert to a role as a purely subsistence crop: manorial court rolls record of sales of malt for brewing. However, if ale was brewed and sold locally (it was primarily a rural side-line), these sales are likely to be archaeologically invisible.

The relationship between increasing agricultural production for market and the range of taxa cultivated remains debated. For Iron Age France, Matterne (2001) associates a focus on one crop at rural sites as a sign of specialisation for market sale, and in the Netherlands Bakels (1996, 2014) associates an expansion of the range of taxa present during Roman occupation with the introduction of cash-cropping. In this study of British data, no support is found for either assertion. The introduction of cash-cropping is rejected as an explanation for the introduction of new cereal taxa in the Saxon period. Instead each new cereal fulfils a specific household need (free-threshing wheat was the "best" bread-making grain, oat the most nutritious animal-feed supplement, and rye and tetraploid free-threshing wheat produced the best straw for craft-working and construction) better than the multipurpose crops (barley and spelt) of the Romano-British period. The relative homogeneity of samples from secular elite rural sites (of all periods) is interpreted not as evidence for specialisation in wheat for market sale, but for the independence of rural elites (villa owners and aristocrats) from the market when provisioning their own households. The wheat-dominated samples that predominate at both types of site evidence on-site consumption, i.e. what was retained from the market, not what was sold or otherwise redistributed.

7.3 Further research potential

The extensive cultivation of crops, in particular those taxa serving the dual purpose of risk-buffering against household food shortage, whilst increasing the total quantity of saleable produce, has been inferred from the characteristics of the cereal species. Further evidence, to corroborate these inferences, could be obtained through analyses that explicitly aim to identify the conditions under which cereals were cultivated, either by the analysis of the functional attributes of the weed taxa found alongside cereals, or by isotopic analyses of the cereal grains themselves. The first approach could be implemented using the weed seeds from the sample-by-sample data already collected for this study (the weed content of samples was used here only for the purpose of inferring the crop processing stage from which samples derived). This would allow the interpretation of the weed seed content of samples from rural sites in terms of the husbandry practices applied to the crops and cultivated soils. However, there seems little potential for the comparisons of evidence from rural and urban sites, as many urban samples are of particularly mixed composition. If original archaeobotanical material were available, it would also be possible to use the isotopic analysis of the cereal grains themselves to overcome the problem of mixing at both urban and rural sites,

Closer dating of Saxon sites, based on radiocarbon rather than artefactual analyses, would enable the identification of a more refined chronology for the introduction of free-threshing wheat and rye, and the end of spelt, cultivation; establishing whether these innovations occurred contemporaneously or sequentially. The Saxon period also has the most pronounced spatial gaps in the dataset, so analysis for this period has been restricted to central, eastern, and southern England. More archaeobotanical evidence for cereal cultivation outside this region would more closely date and contextualise the transitions from spelt to oat in Wales and from barley to (predominantly) oat in Scotland, and the introduction of free-threshing wheat into northern England. The relative under-excavation of these regions notwithstanding, grey-literature reports could provide some additional data for these regions. As developer-funded excavations are concentrated in urban areas (i.e. areas with high levels of construction activity), grey literature reports are more likely to yield useful data from the category of “major town” sites, and more sample data from major towns would enable more secure conclusions to be drawn about characteristic patterns of urban consumption. The limited scope of archaeobotanical sampling and analysis conducted for many developer-funded projects means, however, it is likely that the bulk of additional data would contribute to the site-phase presence dataset but not to the quantified sample contents dataset that is used to infer the cultivation status of crops.

7.4 Concluding remarks

This thesis shows the value of the “commonplace” archaeobotanical sample: preserved by the most common means (charring) and containing the most common taxa (mostly cereals). At the individual site level, such samples, unremarkable within their temporal and environmental context (unlike exotic and luxury foodstuffs), may appear to be of little significance. However, when collated and analysed at the broad scale of this study, variations between them, relating to the social and economic circumstances of their production and consumption, emerge. The diversity of cereal taxa consumed increases with the separation of consumer from producer and, within those groups able to directly provision themselves, consumption varies according to socio-economic status, higher status individuals enjoy a particularly homogenous cereal diet because of their ability to reserve the most valuable grain from the market. This thesis is an illustration of the need for the full reporting of archaeobotanical data, or at least the need for the results of analyses to be easily accessible as electronic supplementary material. Although variations within the data were visible in both the site-phase presence and sample contents datasets, it was only from analysis of the sample contents dataset that deliberate human intent could be inferred.

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Corn Exchange:

archaeobotanical evidence for the impact of social and economic change on agricultural production and consumption in Roman, Saxon and Medieval Britain.

Volume 2

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Tables

Chapter 3

Table 3.1. Site names, locations, and bibliographic references for all sites included in the archaeobotanical analyses. Listed in alphabetical order of site name.

Site	**Town**	**County**	**Latitude**	**Longitude**	**Reference**
St Barnabas' Hospital	Thetford	Norfolk	52.40595	0.746902	(Rogerson and Dallas, 1984)
11-12 Queen Street	Oxford	Oxfordshire	51.75166	-1.25868	(Halpin, 1983)
13-21 Castle Street	Inverness	Highland	57.47902	-4.23254	(Wordsworth, 1982)
16-22 Coppergate	York	North Yorkshire	53.9579	-1.0804	(Kenward and Hall, 1995)
16 Fenchurch Street	City of London	Greater London	51.51192	-0.08467	(Dunwoodie, 2004)
199 Borough High Street	London	Greater London	51.50005	-0.09519	(Hinton *et al.*, 1988)
1 Poultry	City of London	Greater London	51.51331	-0.09078	(Hill and Rowsome, 2011)
25 Cannon Street	London	Greater London	51.51309	-0.0957	(Elsden, 2002)
27 James Street	Westminster, London	Greater London	51.51067	-0.12448	(Haslam, Riddler and Trzaska-Nartowski, 2012)
28-34 Queen Street	Kings Lynn	Norfolk	52.75284	0.393954	(Richmond, Taylor and Wade-Martins, 1982)
31-51 Pottergate	Norwich	Norfolk	52.6304	1.290215	(Atkin, Carter and Evans, 1985)
Site 31, Hatfield Heath-Matching Tye rising main	Matching, Epping Forest	Essex	51.79363	0.196615	(Guttmann, 2000)
Site 32, Hatfield Heath-Matching Tye rising main	Matching, Epping Forest	Essex	51.79131	0.196683	(Guttmann, 2000)
33 St Aldates	Oxford	Oxfordshire	51.74776	-1.2564	(Durham, 1984)
37 High Street, Pershore	Pershore	Worcestershire	52.11167	-2.07413	(Hughes and Litherland, 1994)
Three Locks Golf Course	Stoke Hammond	Buckinghamshire	51.94967	-0.705	(Ford, 2000)
41 Eastcheap	City of London	Greater London	51.51073	-0.0834	(Pitt, 2014)
42 St Paul Street	Aberdeen	Aberdeenshire	57.14934	-2.09915	(Murray, 1982)
46-54 The Close	Newcastle upon Tyne	Tyne & Wear	54.96766	-1.6112	(Platell, 2013)
Site 506, south of Bainesse	Catterick	North Yorkshire	53.9415	-1.35511	(Wilson, 2007b)
Site 511, Cataractonium	Catterick	North Yorkshire	53.94376	-1.35782	(Wilson, 2007a)
5 John Street, Shoreham-by-Sea	Shoreham-by-Sea	West Sussex	50.83253	-0.27668	(Stevens, 2009b)

64-70 Borough High Street	London	Greater London	51.50379	-0.0913	(Graham, 1988)
Lloyds Bank, 6-8 Pavement	York	North Yorkshire	53.9583	-1.07996	(Hall *et al.*, 1983)
Six Dials, Southampton	Southampton	Hampshire	50.90772	-1.39833	(Andrews and Bayley, 1997)
Lloyd's Register, 71 Fenchurch Street	City of London	Greater London	51.51207	-0.07857	(Bluer, 2006)
80 Fishbourne Road	Fishbourne	West Sussex	50.83664	-0.81908	(Cunliffe, Down and Rudkin, 1996)
Zone 8A Whitefriars	Canterbury	Kent	51.27719	1.082872	(Hicks, 2015)
Monument 97, Orton Longueville	Peterborough	Cambridgeshire	52.54262	-0.28136	(Mackreth, 2001)
A27 Polegate Bypass	Polegate	East Sussex	50.83019	0.240517	(Stevens, 2007)
A27 Westhampnett Bypass	Westhampnett	West Sussex	50.85289	-0.72907	(Fitzpatrick, Powell and Allen, 2008a, 2008b)
Ash Plantation: A428 Caxton-Hardwick.	Cambourne	Cambridgeshire	52.2216	-0.05023	(Abrams and Ingham, 2008)
Bourn Airfield: A428 Caxton-Hardwick.	Cambourne	Cambridgeshire	52.21693	-0.03497	(Abrams and Ingham, 2008)
Childerley Gate: A428 Caxton-Hardwick	Cambourne	Cambridgeshire	52.22127	-0.0081	(Abrams and Ingham, 2008)
A63 Melton	Melton	East Yorkshire	53.72463	-0.52023	(Fenton-Thomas, 2010)
Site 3, A6 Rushden-Higham Ferrers Bypass	Higham Ferrers	Northamptonshire	52.30342	-0.58324	(Mudd, 2004)
Allied Brewery	London	Greater London	51.52381	-0.10231	(Tyler, 1998)
Abbotts Wood	Frith End	Hampshire	51.15081	-0.84043	(Graham, 2000)
Abbots Worthy	nr Winchester	Hampshire	51.09104	-1.2803	(Fasham and Whinney, 1991)
Abercairny	Crieff	Perth & Kinross	56.38114	-3.77648	(Gibson, 1989)
54-80 Abingdon Road	Drayton	Oxfordshire	51.64736	-1.31026	(Anthony and Taylor, 2006)
Abingdon West Central	Abingdon	Oxfordshire	51.66977	-1.28389	(Brady, Smith and Laws, 2007)
Abbey Wharf, Reading	Reading	Berkshire	51.4557	-0.96491	(Hawkes and Fasham, 1997)
Aston Clinton Bypass	Aston Clinton	Buckinghamshire	51.80543	-0.70607	(Masefield, 2008)
Abingdon Court Farm	Cricklade	Wiltshire	51.64192	-1.85183	(Longman, 2013)
Hutchison site, Addenbrookes	Cambridge	Cambridgeshire	52.17703	0.137444	(Evans, 2008)
Arthur John Carpark	Cowbridge	Vale of Glamorgan	51.46278	-3.44749	(Parkhouse and Evans, 1996)

Alington Avenue	Fordingham, Dorchester	Dorset	50.70797	-2.42339	(Davies *et al.*, 2002)
Site A, Birch Abbey	Alcester	Warwickshire	52.21115	-1.87409	(Cracknell, Mahany and Bailey, 1994; Mahany and Alabaster, 1994)
Alchester (extramural)	Bicester	Oxfordshire	51.88419	-1.17109	(Booth, 2002)
Aldbrough Gas Storage Facility	Aldbrough	East Yorkshire	53.81359	-0.08882	(Bradley and Steedman, 2013)
1-6 Aldersgate	London	Greater London	51.51703	-0.09646	(Butler, 2002)
Aller Cross (1993 excavations)	Kingskerswell	Devon	50.50885	-3.58933	(Hearne and Seager Smith, 1993)
Aller Cross (2012-13 excavations)	Kingskerswell	Devon	50.50917	-3.58988	(Hughes, 2015)
Alnhamsheles	Alnham	Northumberland	55.43248	-2.05686	(Dixon, 2014)
Althrey Hall	Bangor-on-Dee	Wrexham County	52.99454	-2.91666	(Carruthers, 1991)
Ambleside Roman Fort	Ambleside	Cumbria	54.42215	-2.9686	(Carruthers, 1993a; Pearson, 1999)
Aston Mill Farm	Kemerton	Worcestershire	52.017	-2.07135	(Dinn and Evans, 1990)
Ampthill Road	Shefford	Bedfordshire	52.03506	-0.3439	(Luke, Preece and Wells, 2010)
Anchor Brewery	Salisbury	Wiltshire	51.06798	-1.79155	(Barber, 2005)
Annetwell Street	Carlisle	Cumbria	54.89598	-2.94173	(Huntley, 1989a, 1995)
Appleford Sidings	Didcot	Oxfordshire	51.6289	-1.24726	(Booth and Simmonds, 2008)
Arddleen	Llandrinio	Powys	52.73565	-3.0974	(Britnell and Musson, 1984)
Anderson’s Road	Southampton	Hampshire	50.9005	-1.39274	(Ellis and Andrews, 2006)
12 Arthur Street	City of London	Greater London	51.51024	-0.08828	(Swift, 2008)
ASDA, Crawley	Crawley	West Sussex	51.11396	-0.19286	(Stevens, 2008)
Ashville Trading Estate	Abingdon	Oxfordshire	51.6724	-1.30294	(Parrington, 1978)
Site 2, Aston Tirrold	Didcot	Oxfordshire	51.57118	-1.19439	(Ford, 1990)
Atlantic House	City of London	Greater London	51.51793	-0.10573	(Watson, 2003)
Aylesbury Saxo-Norman Minster Prebendal	Aylesbury	Buckinghamshire	51.81759	-0.81673	(Farley, 2012)
Dunston’s Clump	Babworth	Nottinghamshire	53.30836	-1.01395	(Garton, 1987)
A505 Baldock Bypass	Baldock	Hertfordshire	51.99509	-0.19388	(Phillips, Duncan and Mallows, 2009)
Balksbury Camp	Balksbury	Hampshire	51.19865	-1.50046	(Wainwright, 1995)

Balkerne Lane	Colchester	Essex	51.88861	0.900506	(Brooks and Crummy, 1984)
Baltic House	City of London	Greater London	51.5146	-0.08091	(Howe, 2002)
84-104 Bancroft	Hitchin	Hertfordshire	51.95165	-0.27635	(Ashworth, 2008)
Bancroft Roman Villa	Milton Keynes	Buckinghamshire	52.05492	-0.7953	(Williams, 1994)
Banbury East-West Link Road	Banbury	Oxfordshire	52.06547	-1.33039	(Allen, 1989)
Bantham Ham Surf Club	Bantham	Devon	50.27691	-3.87886	(Reed, Bidwell and Allan, 2011)
Banwell Moor	Banwell	Somerset	51.35109	-2.87732	(Rippon, 2000)
Abbey Road, Barking	Barking	Greater London	51.53458	0.073757	(Hull, 2002)
Barnard Castle	Barnard Castle	County Durham	54.53565	-1.92733	(Donaldson, Jones and Rackham, 1980)
Barrow Road	Barton-on-Humber	Lincolnshire	53.68221	-0.43502	(Bradley, 2002)
Barton Court Farm	Abingdon	Oxfordshire	51.67576	-1.26384	(Miles and Armitage, 1986)
143-5 Bartholomew Street	Newbury	Berkshire	51.39739	-1.32669	(Vince, Adam and James, 1997)
Bath Road, Harmondsworth (Site T)	Hillington	Greater London	51.48244	-0.46041	(Cowie and Blackmore, 2008)
Bath Street	Bath	Somerset	51.38086	-2.36061	(Davenport, 1999)
Bays Meadow Roman Villa	Droitwich	Worcestershire	52.27316	-2.15091	(Hurst, 2006)
Bamburgh Castle	Bamburgh	Northumberland	55.60889	-1.70917	(Kirton and Young, 2017)
Battle Bridge Lane	Southwark	Greater London	51.50551	-0.0829	(Grainger, 2000)
Burgh by Sands	Burgh by Sands	Cumbria	54.92006	-3.05089	(Masser and Evans, 2005)
Baths Basilica, Wroxeter	Wroxeter	Shropshire	52.67401	-2.64417	(Barker, 1975, 1997)
Stoke Road, Bishop’s Cleeve	Bishop's Cleve	Gloucestershire	51.94733	-2.06615	(Enright and Watts, 2002)
Brightwell-cum-Sotwell	Didcot	Oxfordshire	51.61587	-1.18104	(Wilson, 2008)
Billingley Drive	Thurnscoe	South Yorkshire	53.54151	-1.3194	(Neal and Fraser, 2004)
Beck Row	Mildenhall	Suffolk	52.37403	0.478247	(Bales, 2004)
Bedford Academy	Bedford	Bedfordshire	52.11753	-0.45082	(Ingham, 2017)
The Bedern	York	North Yorkshire	53.96173	-1.07882	(Kenward, Hall and Jones, 1986)
Berrington Street	Hereford	Herefordshire	52.05484	-2.71982	(Shoesmith, 1982)
4-8 Ber Street	Norwich	Norfolk	52.62572	1.296958	(Woolhouse, 2013)
Park House, Bridge End	Warwick	Warwickshire	52.27881	-1.58222	(Cracknell, 1988)
Bewell House	Hereford	Herefordshire	52.05728	-2.7197	(Shoesmith, 1982)
Battersea Flour Mills	Battersea	Greater London	51.47693	-0.17501	(Cooke, 2001)

Bowling Green, Carlisle	Carlisle	Cumbria	54.89332	-2.937	(Huntley, 1995)
Brackley Hatch Site 4	Syresham	Northamptonshire	52.08024	-1.04138	(Mudd, 2007)
Berry Hill Close	Culworth	Northamptonshire	52.11866	-1.20677	(Auduoy, 1994)
Brighton Hill South, Site A	Basingstoke	Hampshire	51.23608	-1.1348	(Fasham, 1995)
Birch Heath	Tarporley	Cheshire	53.1547	-2.69876	(Fairburn, 2002)
Bicester Park	Bicester	Oxfordshire	51.89683	-1.12915	(Westgarth and Carlyle, 2008)
Biddenham Loop (1990s excavation)	Bedford	Bedfordshire	52.1299	-0.51132	(Luke, 2008)
Biddenham Loop (2005-2012 excavation)	Great Denham	Bedfordshire	52.12449	-0.51003	(Luke, 2016)
Bierton	Aylesbury	Buckinghamshire	51.82915	-0.78682	(Allen, 1986)
Biglis	Barry	Vale of Glamorgan	51.4171	-3.23522	(Parkhouse, 1988)
Billingsgate Buildings / Triangle	London	Greater London	51.50949	-0.08475	(Jones and Rhodes, 1980)
Billericay Secondary School	Billericay	Essex	51.6181	0.418056	(Rudling, 1990)
Birdoswald		Cumbria	54.98979	-2.60322	(Huntley, 1991a, 1995; Wilmott, 2001)
Site 3 Birdlip	Cowley	Gloucestershire	51.82728	-2.10007	(Parry, 1998)
Rookery Hill	Bishopstone	East Sussex	50.78516	0.080141	(Bell, 1977)
Bishopstone	Bishopstone	East Sussex	50.79006	0.0875	(Thomas, no date)
201 Bishopsgate	City of London	Greater London	51.52111	-0.07954	(Swift, 2003)
The Bittoms (Site Z)	Kingston upon Thames	Greater London	51.40688	-0.3063	(Cowie and Blackmore, 2008)
Baker’s Wood	Sevenhampton	Gloucestershire	51.9012	-1.92946	(Hart *et al.*, 2016)
Blacklands	Staverton	Wiltshire	51.3425	-2.20669	(Barber, Schuster and Holbrook, 2013)
Blenheim Farm	Moreton-in-Marsh	Gloucestershire	51.99326	-1.69848	(Hart and Alexander, 2013)
Birdlip Quarry (A419/A417 excavations)	Cowley	Gloucestershire	51.81978	-2.07395	(Mudd, 1999)
Bishop of Aberdeen’s Manor	Old Rayne	Aberdeenshire	57.34594	-2.54032	(Murray and Murray, 2012)
Bank Newton	Craven District	North Yorkshire	53.97163	-2.16864	(Casswell and Daniel, 2010)
Bonny Grove Farm	Nunthorpe, Midlesborough	Tees Valley	54.52038	-1.19046	(Annis, 1996)
Bonners Lane	Leicester	Leicestershire	52.63016	-1.13683	(Finn, 2004)

Bordesley Abbey (Industrial Complex)	Redditch	Worcestershire	52.31495	-1.93424	(Astill and Allen, 1993)
Boreham Airfield	Chelmsford	Essex	51.78036	0.528213	(Clarke, 2003)
Boteler's Castle	Alcester	Warwickshire	52.20127	-1.87558	(Jones *et al.*, 1997)
Botolph Bridge	Peterborough	Cambridgeshire	52.56129	-0.27325	(Spoerry, 2015)
Boxfield Farm	Stevenage	Hertfordshire	51.91724	-0.16066	(Going, 1999)
The Elms	Brackley	Northamptonshire	52.03253	-1.14459	(Atkins, Chapman and Holmes, 1999)
Bradley Street	Castleford	West Yorkshire	53.72767	-1.35354	(Crocket and Fitzpatrick, 1998)
Brampton	Brampton	Norfolk	52.76386	1.289467	(Green, 1977)
Broom	Arrow Valley	Warwickshire	52.1752	-1.88443	(Palmer, 1999)
Brayford Pool	Lincoln	Lincolnshire	53.22939	-0.54402	(Carlyle and Atkins, 2009)
Broad Street, Ely	Ely	Cambridgeshire	52.39527	0.267887	(Cessford, Alexander and Dickens, 2006)
90-93 Broad Street, Reading	Reading	Berkshire	51.45527	-0.9735	(Norton and Poore, 2007)
Bremetenacum	Ribchester	Lancashire	53.81056	-2.53225	(Buxton and Howard-Davies, 2000)
St Michael's House, Brent Knoll	Brent Knoll	Somerset	51.25156	-2.95566	(Young, 2008)
Areas 8 & 9, Brent Knoll	Highbridge	Somerset	51.25713	-2.93675	(Powell, 2017)
The Pavement, Brewood	Brewood	Staffordshire	52.67408	-2.17003	(Ciaraldi *et al.*, 2004)
Brough Field	Carsington	Derbyshire	53.06735	-1.62538	(Dearne, Anderson and Branigan, 1995)
Bruce House	London	Greater London	51.51392	-0.11947	(Cowie and Blackmore, 2012)
43 South Street	Bridport	Dorset	50.73177	-2.75772	(Godden, Grove and Smith, 2000)
Brixworth	Brixworth	Northamptonshire	52.32207	-0.89957	(Ford, 1995)
MOD site, Brockley Hill	Stanmore	Middlesex	51.62438	-0.29821	(Smith, Brown and Brady, 2008)
Bromfield	Bromfield	Shropshire	52.39309	-2.75823	(Hughes, Leach and Stanford, 1995)
Bromham	Clapham	Bedfordshire	52.15945	-0.50156	(Tilson, 1973)
Blanket Row	Hull	East Yorkshire	53.73996	-0.33523	(Cardwell, 2011)
Brandon Road, Thetford	Thetford	Norfolk	52.41534	0.72616	(Atkins and Connor, 2010)
Brandon Road (1964-66 excavation)	Thetford	Norfolk	52.40999	0.733501	(Dallas, 1993)
Site 4, Bowden Reservoir Link Pipeline	nr Templecombe	Somerset	51.00924	-2.41616	(Newman, Morris and Bonner, 1999)
Brixwold	Bonnyrigg	Midlothian	55.86882	-3.09139	(Crone and O'Sullivan, 1997)

Bryn Eyr Farm	Menai Bridge	Isle of Anglesey	53.25906	-4.19019	(Longley *et al.*, 1998)
Berrick Salome	Berrick Salome	Oxfordshire	51.63967	-1.11558	(Wilson, 2008)
Burystead	Raunds	Northamptonshire	52.34792	-0.5325	(Auduoy and Chapman, 2009)
Broadeye	Stafford	Staffordshire	52.80719	-2.1216	(Cuttler, Hunt and Ratkai, 2009)
25 Bridge Street	Chester	Cheshire	53.1888	-2.8911	(Garner, 2008)
Brough St Giles	Swaledale	North Yorkshire	54.39146	-1.67965	(Cardwell, 1995b)
Bishopstone Road	Stone	Buckinghamshire	51.8033	-0.8622	(Mustchin, Summers and Thompson, 2018)
Bath Street, Stafford	Stafford	Staffordshire	52.80669	-2.12066	(Carver, 2010)
Buckden	Buckden	Cambridgeshire	52.29851	-0.25035	(Cuttler, 2011)
Burgess Hill	Burgess Hill	West Sussex	50.95407	-0.15623	(Sawyer, 1999)
Bury Road	Thetford	Norfolk	52.41205	0.743825	(Gibson, 2015)
Bush Farm	Y Felinheli	Gwynedd	53.1842	-4.20284	(Longley *et al.*, 1998)
Bestwall Quarry	Wareham	Dorset	50.69111	-2.09215	(Ladle, 2012)
Cabot Circus	Bristol	Somerset	51.45737	-2.58792	(Ridgeway, Watts and Boyer, 2013)
Cadley Road	Collingbourne Ducis	Wiltshire	51.28462	-1.6508	(Pine, 2001)
Crown and Anchor Lane	Carlisle	Cumbria	54.89537	-2.93457	(Huntley, 1992; McCarthy, 2000)
Caldicott Farm Quarry	Lydd	Kent	50.96954	0.915136	(Barber, 2008)
Caldecote DMV	Caldecote	Hertfordshire	52.03112	-0.19826	(Beresford, 2009)
Calstock Roman Fort	Calstock	Cornwall	50.50166	-4.20674	(Smart, 2014)
Calvestone Road	Rugby	Warwickshire	52.35933	-1.30687	(Powell and Mudd, 2017)
Cams Hill School	Fareham	Hampshire	50.85011	-1.15659	(Eddisford, 2009)
Cannards Grave	Shepton Mallet	Somerset	51.17736	-2.53497	(Birbeck, 2000)
Capo Quarry	Breedon Capo Quarry	Aberdeenshire	56.79752	-2.61394	(Gibson, 1989)
Carlisle Castle	Carlisle	Cumbria	54.89598	-2.94173	(Zant and Howard-Davies, 2009)
Carmarthen Greyfriars	Carmarthen	Carmarthenshire	51.85519	-4.31056	(James, 1997)
Castle Acre Castle	Castle Acre	Norfolk	52.70321	0.691404	(Coad and Streeten, 1982)
Castle Acre Priory	Castle Acre	Norfolk	52.70051	0.68394	(Wilcox, 2005)
Castle Street, Carlisle	Carlisle	Cumbria	54.89545	-2.93954	(McCarthy, 1991)
Castle Street, Cambridge	Cambridge	Cambridgeshire	52.21495	0.108494	(Evans and Ten Harkel, 2010)

Castleford Roman Fort	Castleford	West Yorkshire	53.72687	-1.35582	(Cool and Philo, 1998; Abramson, Berg and Fossick, 1999)
Castleford Vicus	Castleford	West Yorkshire	53.72447	-1.35569	(Cool and Philo, 1998; Abramson, Berg and Fossick, 1999)
Catsgore Roman Village	Somerton	Somerset	51.03548	-2.70262	(Leech, 1982)
City Arcade, Worcester	Worcester	Worcestershire	52.19122	-2.21984	(Griffin *et al.*, 2004)
Caythorpe	Rudston, nr Driffield	East Yorkshire	54.09399	-0.29356	(Huntley, 1995)
Whittington	Whittington, W	Worcestershire	52.16882	-2.18272	(Hurst, 2000)
Cambridge and County Folk Museum	Cambridge	Cambridgeshire	52.21078	0.114836	(Cessford and Dickens, 2005)
Castle Copse	Great Bedwyn	Wiltshire	51.36491	-1.59417	(Hostetter and Howe, 1997)
Castlecliffe	St Andrews	Fife	56.34193	-2.79102	(Lewis, 1996)
Cefn Cwmwd	Rhostrehwfa	Isle of Anglesey	53.24107	-4.34604	(Davidson, Hughes and Cuttler, 2012)
Cedars Park (1999-2011 excavation)	Stowmarket	Suffolk	52.18854	1.014266	(Woolhouse and Nicholson, 2016)
Cedars Park (2004-2012 excavation)	Stowmarket	Suffolk	52.18989	1.010846	(Woolhouse, 2016)
Cefn Du	Gaerwen	Isle of Anglesey	53.22617	-4.26132	(Davidson, Hughes and Cuttler, 2012)
Church End, Kempston	Kempston	Bedfordshire	52.12034	-0.51943	(Dawson, 2004)
Castle Garth	Newcastle-upon-Tyne	Tyne & Wear	54.96876	-1.61039	(Snape and Bidwell, 2002)
Coln Gravel	Fairford	Gloucestershire	51.69666	-1.74097	(Stansbie *et al.*, 2008)
Chalk Roman Villa	Gravesend	Kent	51.43119	0.411049	(Johnston, 1972)
County Hall, Colliton Park	Dorchester	Dorset	50.71699	-2.44033	(Smith, 1993)
Chester Roman Amphitheatre	Chester	Cheshire	53.18905	-2.8867	(Wilmott and Gardner, 2018)
Chantry Fields	Gillingham	Dorset	51.02683	-2.27814	(Heaton, 1992)
Concangis	Chester-le-Street	County Durham	54.85575	-1.57208	(Huntley, 1991b; Bishop, 1993)
Church Close, Hartlepool	Hartlepool	County Durham	54.69592	-1.18171	(Huntley, 1987; Daniels, 1988)
2-4 South Parks Road	Oxford	Oxfordshire	51.75859	-1.25235	(Bradley *et al.*, 2005)

Scotland Road / Union Lane	Cambridge	Cambridgeshire	52.21845	0.138847	(Mackay, 2009)
Chew Park	Chew Magna	Somerset	51.34658	-2.59294	(Rahtz and Greenfield, 1977)
Church Field, Puxton	Puxton, nr Weston-Super-Mare	Somerset	51.36525	-2.85228	(Rippon, 2007)
Chopdike Grove	Gosberton, South Holland	Lincolnshire	52.84966	-0.22099	(Crowson, 2005)
Site A, Chignall St James	nr Chelmsford	Essex	51.76494	0.414592	(Brooks, 1992)
Site B, Chignall St James	nr Chelmsford	Essex	51.76526	0.41229	(Brooks, 1992)
Church Hill Farm	Burnham Overy Town	Norfolk	52.95154	0.741275	(Mustchin, 2016)
Chicheley Hall	Newport Pagnell	Berkshire	52.10358	-0.67937	(Phillips, 2012)
Wickham Barn	Chiltington	West Sussex	50.91865	-0.02531	(Butler and Lyne, 2001)
Newbury Community Hospital	Newbury	Berkshire	51.4063	-1.2921	(Simmonds, 2008)
Cherry Orton Road	Peterborough	Cambridgeshire	52.55199	-0.2953	(Wright, 2006)
Banson’s Lane	Chipping Ongar	Essex	51.70431	0.243177	(Ennis, 2011)
Cheap Street	Newbury	Berkshire	51.39948	-1.32252	(Vince, Adam and James, 1997)
Chesters Roman Bridge	nr Hexham	Northumberland	55.02515	-2.13583	(Huntley, 1993)
The Deanery, Southampton	Southampton	Hampshire	50.90185	-1.39414	(Birbeck, 2012)
The Deanery School, Southampton	Southampton	Hampshire	50.90123	-1.39458	(Russell, 2012)
6-7 Church Street	Waltham Abbey	Essex	51.68718	-0.00362	(Clarke, Gardner and Huggins, 1993)
Chapel Street	Bicester	Oxfordshire	51.89669	-1.33501	(Harding and Andrews, 2002)
Church View	Bampton	Oxfordshire	51.72629	-1.54838	(Mayes, Hardy and Blair, 2000)
Cheviot Quarry	Milfield	Northumberland	55.58746	-2.08326	(Johnson *et al.*, 2008)
City Literary Institute	London, EC2	Greater London	51.51494	-0.12012	(Jeffries and Watson, 2012)
Clatterford Roman Villa	Carisbrooke	Isle of Wight	50.68437	-1.32221	(Busby *et al.*, 2001)
Claxton	nr Billingham	Tees Valley	54.64304	-1.25775	(Huntley, 1995)
Claypath	Durham	County Durham	54.77847	-1.57554	(Huntley, 1995)
Church Road, Bishop’s Cleeve	Bishop's Cleeve	Gloucestershire	51.94652	-2.06171	(Cullen and Hancocks, 2007)

Town Wall, Close Gate	Newcastle upon Tyne	Tyne & Wear	54.96668	-1.61308	(Fraser, Maxwell and Vaughan, 1994)
Close Gate East – Old Mansion House	Newcastle upon Tyne	Tyne & Wear	54.96668	-1.61308	(Fraser, Jamfrey and Vaughan, 1995)
Canal Lane	Pocklington	East Yorkshire	53.92066	-0.78701	(Tabor, 2009)
Claypit Lane	Westhampnett	West Sussex	50.85217	-0.74557	(Chadwick, 2006)
Cleveland Farm	Ashton Keynes	Wiltshire	51.64926	-1.90384	(Powell, Jones and Mepham, 2008)
Crooks Marsh	nr Severn Beach	Gloucestershire	51.53777	-2.6645	(Masser, Jones and McGill, 2005)
County Museum, Aylesbury	Aylesbury	Buckinghamshire	51.81735	-0.81514	(Bonner, 1996)
Carr Naze	Filey	North Yorkshire	54.2177	-0.27006	(Ottaway *et al.*, 2000)
Colham Mill Road	West Drayton	Middlesex	51.50959	-0.47845	(Knight, 1998)
Coney Street	York	North Yorkshire	53.95843	-1.08342	(Kenward and Williams, 1979)
Copsehill Road	Lower Slaughter	Gloucestershire	51.90233	-1.76159	(Kenyon and Watts, 2006)
Coppice Street	Shaftesbury	Dorset	51.00713	-2.19094	(Carew, 2008)
15-35 Copthall Avenue	London	Greater London	51.51694	-0.08773	(Maloney, de Moulins and Davies, 1990)
Coston Hall	Coston	Leicestershire	52.78871	-0.74432	(Dransfield, Bell and O’Neill, 2015)
Coulter’s Garage	Alcester	Warwickshire	52.21446	-1.872	(Booth, 1986)
Courage Brewery, Bristol	Bristol	Bristol	51.45386	-2.59001	(Jackson, 2006)
Courage Brewery, Southwark	London	Greater London	51.50528	-0.09437	(Cowan, 2003)
Cowdery’s Down	Basingstoke	Hampshire	51.27417	-1.05954	(Millett and James, 1983)
Cow Drove Hill	King's Somborne	Hampshire	51.079	-1.48719	(Pine and Preston, 2004)
144-6 Cowgate	Edinburgh	City of Edinburgh	55.94853	-3.18926	(Dalland, 2017)
Cowl Lane	Winchcombe	Gloucestershire	51.95346	-1.96518	(Hardy, 2017)
Cowper Tannery	Olney	Buckinghamshire	52.15017	-0.70503	(Thompson and Chapman, 2014)
Coxwell Road	Farringdon	Oxfordshire	51.64986	-1.59496	(Cook, Guttmann and Mudd, 2004)
Cramond	Cramond, Edinburgh	City of Edinburgh	55.97779	-3.29846	(Masser, 2006)
Craven Arms Business Park	Craven Arms	Shropshire	52.44441	-2.83974	(Malim and Welicome, 2016)
21 Church Road, Bishop’s Cleeve	Bishop's Cleeve	Gloucestershire	51.94769	-2.0615	(Cullen and Hancocks, 2007)
Creedy’s Yard	London	Greater London	51.48485	-0.00383	(Cooke and Phillpotts, 2002)
Institute of Criminology	Cambridge	Cambridgeshire	52.20243	0.109833	(Dodwell, Lucy and Tipper, 2004)

Crookhorn	Widley, Waterlooville	Hampshire	50.86205	-1.02664	(Soffe, Nicholls and Moore, 1989)
Castle Road, Sittingbourne	Sittingbourne	Kent	51.35043	0.7561	(Sygrave, 2008)
Crow Hall Park	Downham Market	Norfolk	52.59361	0.37458	(Percival and Trimble, 2008)
College Street, Higham Ferrers	Higham Ferrers	Northamptonshire	52.30894	-0.59391	(Jones and Chapman, 2003)
Chadwell St Mary	Chadwell St Mary	Essex	51.4819	0.367633	(Lavender, 1998)
35-43 Canal Street	Perth	Perth & Kinross	56.3937	-3.43036	(Coleman, 1996)
Castle Street, Reading	Reading	Berkshire	51.45285	-0.97528	(Pine, 2005)
Central Trading Estate	Staines	Middlesex	51.43531	-0.51314	(McKinley, 2004)
Cherry Tree Farm	Wortham	Suffolk	52.35214	1.059465	(Atkins, 2015)
Cue’s Lane	Bishopstone	Wiltshire	51.55346	-1.64803	(Coles, 2011)
Culver Street	Colchester	Essex	51.88911	0.900627	(Crummy, 1992)
Cups Hotel	Colchester	Essex	51.88897	0.899033	(Crummy, 1992)
Causeway Lane	Leicester	Leicestershire	52.6379	-1.13756	(Connor, Boyer and Buckley, 1999)
Dairy Lane	Nursling, Southampton	Hampshire	50.94363	-1.48042	(Adam, Seager Smith and Smith, 1997)
Dalladies	Kincardineshire	Angus	56.79573	-2.61391	(Watkins, 1980)
Dalton Parlours	Collingham	West Yorkshire	53.89548	-1.38899	(Wrathmell and Nicholson, 1990)
Damson Parkway	Solihull	West Midlands	52.43662	-1.75283	(Daniel, 2017)
Darlington Market Place	Darlington	County Durham	54.52406	-1.55192	(Huntley, 1995)
Darent Valley A2/A282	Dartford	Kent	51.42933	0.238647	(Simmonds, 2011)
Days Road	Capel St Mary	Suffolk	52.00612	1.040021	(Tabor, 2016)
Dragonby	Scunthorpe	Lincolnshire	53.61294	-0.6335	(May, 1996)
Dean Court Farm	Cumnor	Oxfordshire	51.75092	-1.31423	(Allen, 1994)
Deansway	Worcester	Worcestershire	52.1915	-2.22187	(Dalwood and Edwards, 2004)
Deer’s Den	Kintore	Aberdeenshire	57.23421	-2.35945	(Alexander, 2000)
Derventio	Malton	North Yorkshire	54.13578	-0.79007	(Buckland, 1982)
Derngate	Northampton	Northamptonshire	52.23479	-0.89148	(Hillier, Hardy and Blinkhorn, 2002)
Dollis Hill	London	Greater London	51.56214	-0.23631	(Sankey, 2003)
Dod Law	nr Wooler	Northumberland	55.57895	-1.99521	(Smith, 1990; van der Veen, 1992)
Dolphin Yard	Hertford	Hertfordshire	51.79717	-0.07887	(Prosser and Wotherspoon, 2008)

Dornoch	Dornoch, Sutherland	Highland	57.87866	-4.03054	(Coleman and Photos-Jones, 2008)
Dragon Hall	Norwich	Norfolk	52.62532	1.301509	(Anderson and Shelley, 2005)
Drury Lane	London	Greater London	51.51374	-0.11945	(Cowie and Blackmore, 2012)
Old Bowling Green	Droitwich	Worcestershire	52.26956	-2.14914	(Woodwiss, 1992)
Drumyocher	Arbuthnott	Aberdeenshire	56.88324	-2.35656	(Johnson, 2017)
Dryslwyn Castle	Dryslwyn	Carmarthenshire	51.86249	-4.10135	(Caple, 2007)
Depot Site, Neatham	Holybourne nr Alton	Hampshire	51.1644	-0.94593	(Millett, 1986b)
Duckpool	Morwenstow	Cornwall	50.87618	-4.55846	(Ratcliffe, 1995)
Dundrennan Abbey	Kirkcudbright	Dumfries & Galloway	54.80671	-3.94759	(Ewart, 2001)
Dundurn	Strathearn	Perth & Kinross	56.38135	-4.1069	(Alcock, Alcock and Driscol, 1989)
Dunstaffnage	Dunbeg	Argyll & Bute	56.45087	-5.44362	(Ellis, 2016)
Duxford	Duxford	Cambridgeshire	52.0912	0.159616	(Lyons, 2011)
Dan-y-Coed	Llawhaden	Pembrokeshire	51.83499	-4.7919	(Williams, 1998)
Eastfield House	Oxford	Oxfordshire	51.7397	-1.19734	(Challis, 2005)
Eastern Cemetery, Whitechapel	London	Greater London	51.51257	-0.07519	(Bowsher and Barber, 2000)
Eckweek	Peasedown St John	Somerset	51.31677	-2.41606	(Carruthers, 1995)
Eden Park	Littlehampton	West Sussex	50.82238	-0.5317	(Dinwiddy, 2012)
70-76 Eden Street	Kingston-upon-Thames	Surrey	51.40952	-0.30232	(Miller, 1999)
East End	Great Barford	Bedfordshire	52.16743	-0.35799	(Timby and Allen, 2007)
Eastgate Centre	Inverness	Highland	57.47951	-4.22197	(Ellis, 2002)
Eldbottle	Dirleton	East Lothian	56.05522	-2.80601	(Hindmarch and Oram, 2012)
Elsenham Quarry	Elsenham	Essex	51.91585	0.260251	(Hammond and Preston, 2010)
Elstow Lower School	Elstow	Bedfordshire	52.11258	-0.46443	(Carlyle, 2017)
Enwick Shaw Pit	Aldworth	Berkshire	51.51409	-1.2054	(Timby *et al.*, 2005)
East Stagsden	Stagsden	Bedfordshire	52.12351	-0.5758	(Dawson, 2005)
Ewanrigg	nr Maryport	Cumbria	54.70344	-3.49906	(Bewley, 1992; Huntley, 1995)
Elton West Garth	Stockton-on-Tees	County Durham	54.55029	-1.38621	(Huntley, 1995)

Eynsham Abbey	Eynsham	Oxfordshire	51.7789	-1.37377	(Hardy, 2001)
Eyewell Farm	Chilmark	Wiltshire	51.08875	-2.04307	(Fitzpatrick and Crocket, 1998)
Faccenda Chicken Farm	Chesterton, nr Alchester	Oxfordshire	51.88328	-1.16965	(Foreman and Rahtz, 1984)
Farmoor	Cumnor	Oxfordshire	51.74761	-1.36065	(Lambrick and Robinson, 1979)
Farrier Street	Worcester	Worcestershire	52.1956	-2.22384	(Dalwood, Buteux and Darlington, 1994)
Site XX15 Lunnfields Lane	Fairburn	North Yorkshire	53.74578	-1.27342	(Brown *et al.*, 2007)
Former Marshalling Yards, Feltham	Hounslow	Greater London	51.45064	-0.38655	(Howell, 2007)
Fenchurch / Lime Street	City of London	Greater London	51.51165	-0.08369	(Boyd, 1980; Marsden and Museum of London, 1987)
Fengate Farm	Weeting	Suffolk	52.4594	0.614792	(Gregory, 1996)
60-63 Fenchurch Street	City of London	Greater London	51.51234	-0.07935	(Birbeck, 2009)
Field Farm	Burghfield, Reading	Berkshire	51.4286	-1.03048	(Butterworth, 1992)
Frogs Hall Borrow Pit	Takeley	Essex	51.87992	0.297479	(Ennis, 2006)
Site A Figheldean	Figheldean	Wiltshire	51.222	-1.78659	(Graham and Newman, 1993)
Figheldean (1995 excavations)	Figheldean	Wiltshire	51.222	-1.78659	(McKinley, 1999)
Fir Hill	Bossington	Hampshire	51.07751	-1.53959	(Brown, 2009)
Fishbourne Roman Palace (Area C)	Chichester	West Sussex	50.83619	-0.80749	(Manley and Rudkin, 2006)
Fishbourne Roman Palace (Gardens)	Fishbourne, nr Chichester	West Sussex	50.83655	-0.80975	(Carruthers, 1992a)
Fishergate	Norwich	Norfolk	52.63314	1.308306	(Ayers, 1994)
Fishers Road East	Port Seton	East Lothian	55.96793	-2.9473	(Haselgrove and McCullagh, 2000)
Fairy Knowe	Buchlyvie	Stirling	56.12006	-4.27664	(Main, 1998)
Farm Lane, nr Easter Compton	nr Easter Compton	Gloucestershire	51.54008	-2.62804	(Masser, Jones and McGill, 2005)
Hinksley Road	Flitwick	Bedfordshire	52.00986	-0.49149	(Luke, 1999)
Friars Oak	Hassocks	West Sussex	50.93382	-0.14548	(Butler, 2000)
Folly Lane, Verulamium	St Albans	Hertfordshire	51.75831	-0.34803	(Niblett, 1999)
Forbury House	Reading	Berkshire	51.45594	-0.96801	(Edwards, 2008)

Fosse Lane (Tesco excavation)	Shepton Mallet	Somerset	51.18211	-2.53094	(Ellis and Leach, 2011)
Fosse Lane (1990 excavation)	Shepton Mallet	Somerset	51.18142	-2.53216	(Leach and Evans, 2001)
Foxes House	Stonehouse	Gloucestershire	51.74143	-2.26093	(Brett, 2013)
Friends Provident Stadium	Southampton	Hampshire	50.90583	-1.39007	(Birbeck, 2005)
Freckenham Road	Worlington	Suffolk	52.33281	0.475859	(Fletcher, 2013a)
Fringford	Fringford	Oxfordshire	51.95532	-1.12248	(Blinkhorn, Bloor and Thomason, 2000)
Frocester Court	Frocester	Gloucestershire	51.7244	-2.31266	(Gracie, 1970; Price, 1984, 2000a, 2000b)
Ford Street	Derby	Derbyshire	52.92397	-1.48389	(Hewitson, 2012)
Friar Street	Reading	Berkshire	51.45636	-0.97534	(Ford and Ford, 2005)
Fuller's Hill	Great Yarmouth	Norfolk	52.61079	1.724464	(Rogerson, 1976)
Fulston Manor	Sittingbourne	Kent	51.33185	0.736608	(Powell, Barnett and Grimm, 2009)
Furnells Manor	Raunds	Northamptonshire	52.34947	-0.53426	(Auduoy and Chapman, 2009)
Gatcombe Roman Villa	Gatcombe	Somerset	51.42522	-2.68313	(Branigan, 1977)
165 Great Dover Street	Southwark	Greater London	51.49751	-0.089	(Mackinder, 2000)
Gells Garage	Raunds	Northamptonshire	52.34703	-0.53349	(Auduoy and Chapman, 2009)
Hill Farm, Gestingthorpe	Halstead	Essex	52.01416	0.806633	(Draper, 1985)
Great Fosters Hotel	Egham	Surrey	51.41704	-0.54456	(Leary, Lythe and Brown, 2010)
Grange Farm, Norton	Norton	County Durham	54.58221	-1.30527	(Huntley, 1995)
Gravelly Guy Field	Stanton Harcourt	Oxfordshire	51.74496	-1.4177	(Lambrick and Allen, 2004)
Gas House Lane	Alcester	Warwickshire	52.21429	-1.86896	(Cracknell, 1996)
Great Holts Farm	Boreham	Essex	51.77969	0.538324	(Germany, 2003)
Gilberd School	Colchester	Essex	51.89044	0.894554	(Crummy, 1992)
38-44 Eastgate Street, Gloucester	Gloucester	Gloucestershire	51.86398	-2.24361	(Heighway, 1983)
39-45 Northgate Street, Gloucester	Gloucester	Gloucestershire	51.86634	-2.24487	(Heighway, 1983)
Glyn House	Ewell	Surrey	51.35029	-0.24951	(Stansbie and Score, 2004)
West of Gogar Mains	Edinburgh	City of Edinburgh	55.94048	-3.35005	(James and Will, 2017)
Aldi, Goldthorpe	Goldthorpe	South Yorkshire	53.52627	-1.32719	(Ross *et al.*, 2017)
Goldicote	Stratford-on-Avon	Warwickshire	52.15943	-1.64181	(Thompson and Palmer, 2012)
Gorhambury	St Albans	Hertfordshire	51.75866	-0.38301	(Neal, Wardle and Hunn, 1990)

Third Drove, Gosberton	Gosberton, South Holland	Lincolnshire	52.84457	-0.25357	(Crowson, 2005)
Grange Park, Courteenhall	Courteenhall	Northamptonshire	52.18802	-0.88971	(Jones, Woodward and Buteux, 2006)
93-95 Gresham Street	City of London EC2	Greater London	51.51517	-0.09086	(Watson, 2014)
Greyhound Yard	Dorchester	Dorset	50.71448	-2.43614	(Woodward, Davies and Graham, 1993)
The Grange, Cambourne	Cambourne	Cambridgeshire	52.21131	-0.0509	(Wright *et al.*, 2009)
Ball Mill Quarry	Grimley	Worcestershire	52.25006	-2.25043	(Webster and Jackson, 2016; Webster, 2017)
Grantown Road	Forres	Moray	57.59608	-3.63069	(Cook, 2016)
Gateway Supermarket	Alcester	Warwickshire	52.2143	-1.87262	(Cracknell, 1996)
GlaxoSmithKline	Ware	Hertfordshire	51.8127	-0.03889	(O'Brian and Roberts, 2005)
Great Common Farm	Cambourne	Cambridgeshire	52.21355	-0.05037	(Wright *et al.*, 2009)
83 High Street, Great Dunmow	Great Dunmow	Essex	51.86961	0.366156	(Sparrow, 2009)
St Nicholas' Church, Great Wakering	Great Wakering	Essex	51.55312	0.811764	(Dale, Maynard and Tyler, 2010)
Great Weldon Roman Villa	Weldon	Northamptonshire	52.5	-0.63291	(Smith, Hird and Dix, 1989)
London Guildhall	London	Greater London	51.51548	-0.09295	(Bowsher *et al.*, 2007; Howell *et al.*, 2007)
Hunt's House	London	Greater London	51.5029	-0.08877	(Taylor-Wilson, 2002)
Goch Way	Charlton, Andover	Hampshire	51.21947	-1.49164	(Wright, 2004)
Guildhall Yard	London	Greater London	51.51563	-0.0917	(Bateman, Cowen and Wroe-Brown, 2008)
Great Yard, Ilchester	Ilchester	Somerset	51.00299	-2.68527	(Broomhead, 1998)
A1/A605 Haddon	Haddon	Cambridgeshire	52.5311	-0.32471	(Hinman, 2003)
Church Lane, Hallow	Hallow	Worcestershire	52.22045	-2.2498	(Miller *et al.*, 2008)
Site H, Distillery Wharf	London	Greater London	51.48753	-0.22597	(Cowie and Blackmore, 2008)
Royal George Buildings	Droitwich	Worcestershire	52.26876	-2.1443	(Hughes, 2006)
Hardings Field	Chalgrove	Oxfordshire	51.66658	-1.08325	(Page, Atherton and Hardy, 2005)
Harradine's Farm	Woodhurst	Cambridgeshire	52.3669	-0.06962	(Williams, 2011)
Harston Mill	Harston	Cambridgeshire	52.13641	0.070471	(O'Brien, 2016)
Hatford Quarry	Hatford	Oxfordshire	51.65868	-1.5265	(Booth and Simmonds, 2004)
Hayes Farm	Clyst Honiton	Devon	50.73952	-3.43131	(Simpson, Griffith and Holbrook, 1989)
Haynes Park House	Haynes Church End	Bedfordshire	52.05867	-0.4269	(Luke and Shotliff, 2004)

44-48 High Bridge, Newcastle	Newcastle-upon-Tyne	Tyne & Wear	54.97158	-1.61277	(Brogan, 2010)
	#N/A	#N/A	#N/A	#N/A	
Playing Field, Heelands	Milton Keynes	Buckinghamshire	52.05109	-0.77221	(Zeepvat, Williams and Mynard, 1987)
29 Heigham Street	Norwich	Norfolk	52.63486	1.28508	(Atkin, 2002a)
Hemp Croft	Thurvaston	Derbyshire	52.93705	-1.63989	(Challis, 1999)
Hemington Quarry	Castle Donington	Leicestershire	52.86733	-1.3196	(Cooper and Ripper, 2017)
Hengistbury Head	Bournemouth	Dorset	50.71748	-1.75914	(Cunliffe, 1987)
Henly's Garage	Winchester	Hampshire	51.06042	-1.31756	(Maltby, 2010)
Elms Farm	Maldon	Essex	51.74206	0.673836	(Atkinson and Preston, 2015)
Hall Farm, Baston	Baston	Lincolnshire	52.71041	-0.35249	(Taylor, 2003)
Roman Roadside Settlement, Higham Ferrers	Higham Ferrers	Northamptonshire	52.31271	-0.60142	(Lawrence, Smith and Allen, 2009)
Saxon Settlement, Higham Ferrers	Higham Ferrers	Northamptonshire	52.31434	-0.59462	(Hardy, Charles and Williams, 2007)
Halifax House	Oxford	Oxfordshire	51.75886	-1.25235	(Antony, 2005)
High House	West Thurrock	Essex	51.48017	0.255146	(Andrews, 2009b)
Hillesley Farm	Hillesley	Gloucestershire	51.60565	-2.33639	(Longman, 2005)
Hirsel House	Coldstream	Scottish Borders	55.65862	-2.27175	(Cramp, 2014)
Holy Island Village	Holy Island	Northumberland	55.66995	-1.80152	(O'Sullivan, 1985)
Hillside Meadow	Fordham	Cambridgeshire	52.30926	0.39247	(Patrick and Ratkai, 2011)
Churchills Farm	Hemyock	Devon	50.91095	-3.22998	(Smart, 2018)
Hockley Chemical Works	Alcester	Warwickshire	52.21295	-1.87116	(Mudd and Booth, 2001)
Hoddom	Hallguards Quarry, Annandale	Dumfries & Galloway	55.04153	-3.30555	(Lowe, 1991)
Site R, Holloway Lane	Hillingdon, Greater London	Greater London	51.48986	-0.46646	(Cowie and Blackmore, 2008)
Site O, Holloway Close	Hillington	Greater London	51.49477	-0.45827	(Cowie and Blackmore, 2008)
Site A, Holywell Priory	London	Greater London	51.52424	-0.07799	(Bull *et al.*, 2011)
Site B, Holywell Priory	London	Greater London	51.52337	-0.07456	(Bull *et al.*, 2011)
Holyrood	Edinburgh	City of Edinburgh	55.95198	-3.17537	(Barclay and Ritchie, 2010)
Holyrood Road	Edinburgh	City of Edinburgh	55.95134	-3.17618	(Gooder, 2013)

Home Ground, Puxton	Puxton, nr Weston-Super-Mare	Somerset	51.36788	-2.85576	(Rippon, 2007)
Howard’s Lane	Wareham	Dorset	50.68719	-2.10824	(Harding, Mepham and Smith, 1995)
Hurst Park	East Molesley	Surrey	51.40758	-0.35516	(Andrews, 1996)
Heathrow, Perry Oaks	Hounslow	Middlesex	51.46954	-0.48251	(Lewis and Framework Archaeology, 2006)
High Post	Durnford, nr. Salisbury	Wiltshire	51.13327	-1.79558	(Andrew B. Powell, 2011)
Horticultural Research International	Littlehampton	West Sussex	50.82076	-0.52068	(Lovell, 2002)
High Street, Alton	Alton	Hampshire	51.1466	-0.97778	(Millett, 1986a)
47-53 High Street, Burford	Burford	Oxfordshire	51.8085	-1.63531	(Coles, Lowe and Preston, 2007)
34 High Street, Pershore	Pershore	Worcestershire	52.11109	-2.07554	(Wainright *et al.*, 2008)
80-86 High Street, Perth	Perth	Perth & Kinross	56.39645	-3.42873	(Moloney and Coleman, 1997)
1-3 High Street, Seaford	Seaford	East Sussex	50.77089	0.101726	(S. Stevens, 2004)
55-7 High Street, Windsor	Windsor	Berkshire	51.48124	-0.60598	(Taylor and Preston, 2005)
Heathrow Terminal 5	Hounslow	Middlesex	51.46954	-0.48251	(Framework Archaeology, 2010)
Holy Trinity Churchyard	Dartford	Kent	51.44406	0.220579	(Priestley-Bell and Barber, 2004)
Holy Trinity, Tidworth	Tidworth	Wiltshire	51.2397	-1.66475	(Milward *et al.*, 2010)
Hillyfields	Upper Holway, Taunton	Somerset	51.00766	-3.0832	(Leach, 2001)
Huntworth Business Park	Huntworth, nr Bridgewater	Somerset	51.10538	-2.99152	(Powell, Mepham and Stevens, 2008)
Huntingdon Street	St Neots	Cambridgeshire	52.22935	-0.26523	(Cessford and Dickens, 2013)
The Hive	Worcester	Worcestershire	52.19365	-2.22627	(Bradley *et al.*, 2018)
Harley Way	Benefield	Northamptonshire	52.47979	-0.52003	(Finn, 2017)
High Wold	Bridlington	East Yorkshire	54.10603	-0.19441	(Roberts, 2009)
Hyde Street	Winchester	Hampshire	51.06733	-1.31492	(Birbeck and Moore, 2004)
Ickfield Road	Shabbington	Buckinghamshire	51.7573	-1.03795	(Coles and Preston, 2008)
Inveresk Gate	Inveresk	Midlothian	55.93682	-3.04819	(Bishop and Allen, 2004)
Royal Manor Arts College, Weston Road	Isle of Portland	Dorset	50.54421	-2.44662	(Palmer, 2000)
Irby	Birkenhead	Merseyside	53.35928	-3.12388	(Huntley, 2002)

Irthlingborough	Irthlingborough	Northamptonshire	52.3271	-0.60889	(Chapman, Atkins and Lloyd, 2003)
Finsbury Pavement	London	Greater London	51.51951	-0.08721	(Malcolm, 1997)
Ivy Street	Salisbury	Wiltshire	51.06735	-1.79301	(Rawlings, 2000)
Jubilee Hall	London	Greater London	51.51154	-0.12228	(Cowie, Whytehead and Blackmore, 1988)
Jennett's Park	Bracknell	Berkshire	51.40341	-0.78475	(Simmonds *et al.*, 2009)
Jennings Yard	Windsor	Berkshire	51.48487	-0.60846	(Hawkes and Heaton, 1993)
35-37 Jesus Lane	Cambridge	Cambridgeshire	52.2085	0.122175	(Alexander, Dodwell and Evans, 2004)
28-31 James Street	London	Greater London	51.51252	-0.12367	(Leary, 2004)
Jenner & Simpson Mill	Battle	East Sussex	50.91727	0.484692	(James, 2008)
Jugglers close	Banbury	Oxfordshire	52.07217	-1.32256	(C. Stevens, 2004)
Jeavons Lane	Cambourne	Cambridgeshire	52.21372	-0.06602	(Wright *et al.*, 2009)
Jersey Way	Middlewich	Cheshire	53.19476	-2.44151	(Zant, 2016)
Jewsons Yard, Uxbridge	Uxbridge	Middlesex	51.5493	-0.47999	(Barclay *et al.*, 1995)
Kelso Abbey	Kelso	Scottish Borders	55.59662	-2.43293	(Lowe, 2005)
St Mary's Church, Kempsey	Kempsey	Worcestershire	52.13899	-2.22439	(Vaughan and Webster, 2016, 2017)
Kenn Moor	Pedwell	Somerset	51.13568	-2.82177	(Rippon, 2000)
Kents Hill	Milton Keynes	Buckinghamshire	52.03041	-0.70543	(Jones *et al.*, 2017)
Keston	Bromley, London	Greater London	51.35029	0.029091	(Philp, 1991)
Kingshams Field	Ilchester	Somerset	51.00081	-2.67973	(Leach, 1982)
Kinglsey Fields	Nantwich	Cheshire	53.06856	-2.52976	(Arrowsmith and Power, 2012)
Kilverstone	Thetford	Norfolk	52.42018	0.769114	(Garrow, Lucy and Gibson, 2006)
Kingsborough Farm	Eastchurch, Isle of Sheppey	Kent	51.41372	0.841951	(Stevens, 2009a)
Kintbury Square	Kintbury	Berkshire	51.39984	-1.44954	(Ford, 1997)
Union Street, Kirkintilloch	Kirkintilloch	East Dunbartonshire	55.93962	-4.16083	(Keppie *et al.*, 1995)
Knapwell Plantaion	Cambourne	Cambridgeshire	52.2244	-0.06746	(Wright *et al.*, 2009)
King Stable Street	Eton	Berkshire	51.48656	-0.60769	(Blinkhorn and Pugh, 2000)
King Street, Middlewich	Middlewich	Cheshire	53.1952	-2.44496	(Williams and Reid, 2008)
Kirkby Thore	Penrith	Cumbria	54.62513	-2.56374	(Huntley, 1995)
King William Road, Kempston	Kempston	Bedfordshire	52.11535	-0.50523	(Walker and Maull, 2010)

67-8 Long Acre	London	Greater London	51.51406	-0.12261	(Cowie and Blackmore, 2012)
Leavesden Aerodrome	Abbots Langley, Watford	Hertfordshire	51.69075	-0.41436	(Brossler, Laws and Welsh, 2009)
Langham Road	Raunds	Northamptonshire	52.34774	-0.53698	(Auduoy and Chapman, 2009)
Langwood Farm	Chatteris Island	Cambridgeshire	52.44637	0.084977	(Evans, 2003)
Latimer Street	Romsey	Hampshire	50.99002	-1.49686	(A.B. Powell, 2011b)
Low Borrowbridge	Penrith	Cumbria	54.40566	-2.60232	(Huntley, 1995)
Lower Cambourne	Cambourne	Cambridgeshire	52.21777	-0.08268	(Wright *et al.*, 2009)
Little Chester	Derby	Derbyshire	52.93374	-1.47537	(Sparey-Green, 2002)
Lodge House	Smalley	Derbyshire	53.00272	-1.37748	(Lievers and Harrison, 2013)
Lea Farm	Hurst	Berkshire	51.4559	-0.86298	(Manning and Moore, 2011)
Lewthwaites Lane	Carlisle	Cumbria	54.89537	-2.93457	(Huntley, 1992; McCarthy, 2000)
Leylandii House Farm	Harvington	Worcestershire	52.13179	-1.9211	(Jackson, Hurst and Pearson, 1996)
Low Fisher Gate	Doncaster	South Yorkshire	53.52697	-1.13397	(McComish *et al.*, 2010)
Lodge Farm, St Osyth	St Osyth	Essex	51.79691	1.095547	(Germany, 2013)
Little Hay Grange Farm	Ockbrook	Derbyshire	52.93313	-1.3513	(Palfreyman, 2001)
Lhanbryde	Elgin	Moray	57.63341	-3.21984	(Alexander, 1997)
Leadenhall Court	City of London	Greater London	51.51316	-0.08356	(Milne and Wardle, 1993)
Lichfield Friary	Lichfield	Staffordshire	52.68056	-1.83089	(Tuck, 2018)
Lincoln College	Oxford	Oxfordshire	51.75315	-1.25596	(Kamash *et al.*, 2002)
Lindisfarne Midden	Holy Island	Northumberland	55.66865	-1.80125	(Van der Veen, 1984; Huntley, 1995)
Linton	Linton	Cambridgeshire	52.0957	0.272984	(Fletcher, 2013b)
Lion Plaza	City of London, EC2	Greater London	51.51455	-0.08522	(McKenzie, 2011)
Lion Walk	Colchester	Essex	51.88861	0.900506	(Brooks and Crummy, 1984)
Site B2, Long Itchington	Stratford-on-Avon	Warwickshire	52.29791	-1.42147	(Thompson and Palmer, 2012)
Long Lane Playing Fields	Ickenham	Middlesex	51.55567	-0.44647	(Lakin, 1994)
Laigh Newton North West	Darvel	East Ayrshire	55.60479	-4.23382	(James, 2017)
Lockerbie Academy	Lockerbie	Dumfries & Galloway	55.13134	-3.35993	(Kirby, 2011)
Loftus	Loftus	North Yorkshire	54.56669	-0.85855	(Sherlock, 2012)
Longdon Marsh	Longdon	Worcestershire	52.01225	-2.25639	(Simmonds, Thacker and Shepherd, 2010)

Longdales Road	Kings Norton, Birmingham	Warwickshire	52.39648	-1.92309	(Jones, 2008)
Home Farm, Longstanton	Longstanton	Cambridgeshire	52.28349	0.040669	(Ellis and Ratkai, 2001)
Long Street, Newport	Newport	Pembrokeshire	52.01841	-4.83247	(Murphy, 1994)
Lordship Lane	Cottenham	Cambridgeshire	52.29193	0.123175	(Mortimer, 2000)
Loughor Castle	Loughor	Swansea	51.6622	-4.07744	(Lewis, 1993)
Lower Close	Norwich	Norfolk	52.63087	1.302518	(Atkin, 2002b)
Low Farm	Thornton, Middlesbrough	Tees Valley	54.51661	-1.26097	(Vyner, 2003)
Little Paxton Quarry	St Neots	Cambridgeshire	52.27866	-0.24082	(A. E. Jones, 2011a)
London Road, Overton	Overton	Hampshire	51.24493	-1.2577	(A. Taylor, 2012)
Lewes Road	Ringmer	East Sussex	50.89127	0.050313	(Wallis, 20123)
London Road, Wallington	Wallington, Sutton	Greater London	51.37703	-0.15222	(Howe, 2004)
London Road, Godmanchester	Godmanchester	Cambridgeshire	52.31341	-0.16902	(Jones, 2003)
Langford Road	Heybridge	Essex	51.74525	0.674404	(Langton and Holbrook, 1997)
Little Spittle	Ilchester	Somerset	50.99896	-2.68825	(Leach, 1982)
Lullingstone Roman Villa	Sevenoaks	Kent	51.36418	0.196533	(Meates, 1979)
Luton Road	Wilstead	Bedfordshire	52.07608	-0.45109	(Luke and Preece, 2010)
Lewisvale Park, Inveresk	Musselburgh	East Lothian	55.93773	-3.04082	(Hunter *et al.*, 2016)
Land west of Kempston (2005-12 excavations)	Great Denham	Bedfordshire	52.10927	-0.51492	(Luke, 2016)
Lyceum Theatre	London	Greater London	51.51146	-0.12006	(Brown and Rackham, 2004)
Letch's Yard	Braintree	Essex	51.87742	0.547895	(Ennis, 2014)
Lydd Quarry	Lydd	Kent	50.94746	0.881404	(Barber, 2008)
Leazes Bowl	Durham	County Durham	54.77721	-1.57509	(Carne, 2001)
Marks & Spencer, 75-95 High Street, Perth	Perth	Perth & Kinross	56.39705	-3.42842	(Perry, 2010)
Junction 15 M40/A46	Warwick	Warwickshire	52.26455	-1.62045	(Joyce and Mudd, 2015)
Macallan Distillery	Craigellachie	Moray	57.48676	-3.20594	(Dunbar, 2017)
Maddington Farm	Shrewton	Wiltshire	51.1997	-1.93125	(McKinley, 1996)
Magna Park	Milton Keynes	Buckinghamshire	52.04089	-0.66154	(Chapman and Chapman, 2017)

21-22 Maiden Lane	London	Greater London	51.51039	-0.12362	(Cowie, Whytehead and Blackmore, 1988)
Malmesbury	Malmesbury	Wiltshire	51.58453	-2.09583	(Longman, 2006)
Manor Farm, Harmondsworth	Hillingdon, Greater London	Greater London	51.4899	-0.47956	(Cowie and Blackmore, 2008)
Manston Road	Ramsgate	Kent	51.3395	1.389524	(Andrews, Allen and Goller, 2009)
Mansfield College	Oxford	Oxfordshire	51.75752	-1.25382	(Booth and Hayden, 2000)
Mantles Green	Amersham	Buckinghamshire	51.67299	-0.63116	(Yeoman and Stewart, 1992)
Mariner House	City of London	Greater London	51.51096	-0.07845	(Lerz and Holder, 2015)
The Marlipins	Shoreham-by-Sea	West Sussex	50.83202	-0.27624	(Thomas, 2005)
Marygate	Berwick-upon-Tweed	Northumberland	55.77061	-2.0046	(Heawood and Howard-Davies, 2004)
Mill Cottage	Nonington	Kent	51.21945	1.247726	(Helm and Carruthers, 2011)
Millenium Country Park	Marston Moretaine	Bedfordshire	52.05934	-0.54867	(Wells and Edwards, 2017)
Maiden Castle Road	Dorchester	Dorset	50.70324	-2.45854	(Smith, 1997)
Middlegate, Hartlepool	Hartlepool	Tees Valley	54.69592	-1.18373	(Huntley, 1988a, 1995)
Meales Farm	Sulhamstead	Berkshire	51.41103	-1.0819	(Lobb, Mees and Mepham, 1990)
Melford Meadows	Thetford	Norfolk	52.40916	0.7596	(Mudd, 2002)
Bath Road, Melksham	Melksham	Wiltshire	51.3652	-2.11486	(Powell, 2018)
Melton	North Ferriby	East Yorkshire	53.7249	-0.52377	(Fenton-Thomas, 2010)
Membury	Membury	Devon	50.82376	-3.03351	(Tingle, 2006)
Enclosed Settlement, Meole Brace	Meole Brace	Shropshire	52.68621	-2.74999	(Bain and Evans, 2011)
Roadside Settlement, Meole Brace	Meole Brace	Shropshire	52.68257	-2.75732	(Ellis *et al.*, 1994)
High Street, Meppershall	Meppershall	Bedfordshire	52.01467	-0.34358	(Wilson and Zeepvat, 2010a)
4A Merton Street	Oxford	Oxfordshire	51.75157	-1.25218	(Poore, Score and Dodd, 2006)
Metchley (1960s & 1997 excavations)	Birmingham	West Midlands	52.45214	-1.93668	(Jones, 2001)
Metchley (2004-5 excavations)	Birmingham	Warwickshire	52.4506	-1.93832	(Jones, 2012)
Metchley area M9	Birmingham	Warwickshire	52.4506	-1.93832	(A. E. Jones, 2011b)
Manor Farm, Drayton	Drayton	Oxfordshire	51.64528	-1.35509	(Challinor *et al.*, 2003)

Manor Farm, Monk Sherborne	Monk Sherborne	Hampshire	51.29683	-1.12979	(Teague, 2005)
Michelmersh	Michelmersh, Romsey	Hampshire	51.03629	-1.50962	(Mepham and Brown, 2007)
Middleton Stoney	Middleton Stoney	Oxfordshire	51.90482	-1.22958	(Rowley and Rahtz, 1984)
Mill Farm, Cambourne	Cambourne	Cambridgeshire	52.20868	-0.07166	(Wright *et al.*, 2009)
Site 5761, Mill Lane, Thetford	Thetford	Norfolk	52.41019	0.750253	(Wallis, 2005)
Mill Street, Perth	Perth	Perth & Kinross	56.39756	-3.4316	(Bowler, Cox and Smith, 1995)
Mitchell's Brewery	Lancaster	Lancashire	54.0495	-2.80029	(Huntley, 1995)
Mitcham Vicarage	Mitcham	Greater London	51.40221	-0.17464	(Ford, 2004)
Grove Farm, Market Lavington	Market Lavington	Wiltshire	51.28735	-1.98096	(Williams and Newman, 2006)
Market Way, Canterbury	Canterbury	Kent	51.28818	1.082134	(Helm, 2010)
Marsh Leys Farm	Kempston	Bedfordshire	52.09531	-0.1621	(Luke and Preece, 2011)
Midland Road	Raunds	Northamptonshire	52.34846	-0.53208	(Auduoy and Chapman, 2009)
Merrill Lynch Financial Centre	City of London	Greater London	51.51636	-0.09891	(Lyon, 2007)
Mills Mount	Edinburgh	City of Edinburgh	55.94907	-3.20108	(Driscoll and Yeoman, 1997)
Marston Moretaine	Marston Moretaine	Bedfordshire	52.06135	-0.55123	(Crick, 1999)
Mornington House	Gosberton, South Holland	Lincolnshire	52.86996	-0.25626	(Crowson, 2005)
Area 6C/D, Mawsley New Village	Kettering	Northamptonshire	52.37964	-0.80999	(Harvey, 2015)
Monkston Park	Milton Keynes	Buckinghamshire	52.03532	-0.71191	(Bull and Davis, 2006)
Monmouth	Monmnouth	Monmouthshire	51.81132	-2.71688	(Marvell, 2001)
Moor Street	Birmingham	West Midlands	52.47797	-1.89218	(Rátkai, 2009)
Moraunt Drive	Middleton-on-Sea	West Sussex	50.79694	-0.62487	(Barber, 1994)
Morison Hall	Hartlepool	County Durham	54.69589	-1.18084	(Huntley, 1990, 1995)
Morlands Brewery	Abingdon	Oxfordshire	51.6687	-1.28564	(Taylor and Pine, 2006)
Mortimer Hill Farm	Mortimer	Berkshire	51.37664	-1.05457	(Taylor, 2011)
Mount House	Witney	Oxfordshire	51.78105	-1.48391	(Allen and Hiller, 2002)

Moxhill Farm	Cople	Bedfordshire	52.09835	-0.36929	(Wilson and Zeepvat, 2010b)
Mount Roman Villa	Maidstone	Kent	51.27794	0.518017	(Houliston, 1999)
Meal Vennel	Perth	Perth & Kinross	56.39548	-3.43205	(Cox, 1996)
National Gallery (Basement & Extension)	London	Greater London	51.50885	-0.12873	(Whytehead, Cowie and Blackmore, 1989)
Castle Mall, Norwich	Norwich	Norfolk	52.62861	1.296436	(Popescu, 2009a, 2009b)
North Caxton Bypass	Cambourne	Cambridgeshire	52.21792	-0.09775	(Wright *et al.*, 2009)
Newcastle Crown Court	Newcastle upon Tyne	Tyne & Wear	54.96991	-1.60337	(O'Brien *et al.*, 1989)
New Cemetery, Rocester	Rocester	Staffordshire	52.9516	-1.83698	(Esmonde Cleary and Ferris, 1996)
Newbridge, Edinburgh	Edinburgh	City of Edinburgh	55.94467	-3.40896	(Engl and Dunbar, 2016)
19-20 New Elvet	Durham	County Durham	54.77354	-1.57133	(Fraser, Speed and Costley, 1995)
Newgate Street, Newcastle-upon-Tyne	Newcastle-upon-Tyne	Tyne & Wear	54.972	-1.61881	(Young, 2006)
Newhaven	Newhaven	East Sussex	50.79324	0.050277	(Bell, 1976)
New Inn Court, Queen Street	Oxford	Oxfordshire	51.75105	-1.25859	(Halpin, 1983)
Needles Eye	Berwick-upon-Tweed	Northumberland	55.7919	-2.02071	(Proctor, 2012)
Neath Farm, Cherry Hinton	Cambridge	Cambridgeshire	52.19527	0.176643	(Cessford and Slater, 2014)
Netherfield Farm	South Petherton	Somerset	50.96221	-2.80519	(Mudd *et al.*, 2012)
Northfleet Villa	Northfleet	Kent	51.44248	0.324004	(Andrews *et al.*, 2011)
Needlehole	Withington	Gloucestershire	51.85087	-2.02362	(Hart *et al.*, 2016)
Norton-Juxta-Kempsey	Wychavon	Worcestershire	52.16572	-2.18693	(Jackson *et al.*, 1996)
Nalgo Lodge	Middleton-on-Sea	West Sussex	50.79455	-0.6188	(Griffin, 2005)
Greyfriars (Mann Egerton site)	Norwich	Norfolk	52.62923	1.30003	(Emery and Rutledge, 2007)
Norse Road	Bedford	Bedfordshire	52.15852	-0.40964	(Meckseper, Abrams and Preece, 2017)
National Portrait Gallery	London	Greater London	51.50923	-0.12823	(Pickard, 2004)
New Quay, Berwick-upon-Tweed	Berwick-upon-Tweed	Northumberland	55.76709	-2.00444	(Griffiths, 1999)
Newbridge Quarry	Pickering	North Yorkshire	54.259	-0.7811	(Richardson, 2012)
New Radnor	New Radnor	Powys	52.23926	-3.15761	(Jones *et al.*, 1998)

Newarke Street	Leicester	Leicestershire	52.63163	-1.13622	(Cooper, 1996)
Oaklands	Exeter	Devon	50.70502	-3.54143	(Caine and Valentin, 2011)
The Sage	Gateshead	Tyne & Wear	54.96422	-1.60279	(Nolan and Vaughan, 2006)
Old Bush Lane	Carlisle	Cumbria	54.89537	-2.93457	(Huntley, 1992; McCarthy, 2000)
Ocean Boulevard	Southampton	Hampshire	50.89695	-1.40274	(Smith, 2010)
Old Council House, Bristol	Bristol	City of Bristol	51.45491	-2.59367	(Jackson, 2007)
Ock Street	Abingdon	Oxfordshire	51.66998	-1.28794	(Hull, 2006)
Old Estate Office, Conway	Conway	Conwy County	53.28068	-3.83008	(Kelly, 1979)
Old Grapes Lane	Carlisle	Cumbria	54.89537	-2.93457	(Huntley, 1992; McCarthy, 2000)
Osborne House	Chichester	West Sussex	50.82919	-0.7831	(Sulikowska, 2014)
Themelthorpe	Themelthorpe	Norfolk	52.78098	1.049111	(Clay and Wilson, 2012)
Okehampton Castle	Okehampton	Devon	50.73062	-4.00895	(Higham, Allan and Blaylock, 1982)
Old Kempshott Lane	Basingstoke	Hampshire	51.25859	-1.13868	(Haslam, 2012)
Old Post Office, Crawley	Crawley	West Sussex	51.11368	-0.18989	(Stevens, 1997)
Old Warden	Ickwell	Bedfordshire	52.09036	-0.31265	(Wilson and Zeepvat, 2010b)
Oil Mill Lane	Berwick-upon-Tweed	Northumberland	55.76708	-2.00169	(Hunter, 1982)
The Orchard, Walton Road	Walton, Aylesbury	Buckinghamshire	51.81209	-0.80642	(Ford, Howell and Taylor, 2004)
The Orchard, Brighthampton	Brighthampton	Oxfordshire	51.72935	-1.44468	(Ford and Preston, 2002)
Orchard Lane, Huntingdon	Huntingdon	Cambridgeshire	52.32845	-0.17887	(Oakey and Spoerry, 1997)
Orton's Pasture	Rocester	Staffordshire	52.9516	-1.83698	(Ferris, 2000)
The Old Showground	Cheddar	Somerset	51.276	-2.78015	(Evans and Hancocks, 2005)
The Old Schools, Cambridge	Cambridge	Cambridgeshire	52.20537	0.116704	(Newman and Evans, 2011)
Ower Farm	Newton Bay	Dorset	50.66957	-2.00354	(Cox and Hearne, 1991)
Oxford Road, Bicester	Bicester	Oxfordshire	51.89264	-1.15858	(Mould, 1997)
Oxleaze Wood	Tewkesbury	Gloucestershire	51.90812	-1.92247	(Hart *et al.*, 2016)
Pallant House gallery	Chichester	West Sussex	50.83525	-0.77769	(Godden, 2008)
Pang Valley Settlement	Bradfield	Berkshire	51.45319	-1.12631	(Raymond, 1997)
Papcastle	Cockermouth	Cumbria	54.6689	-3.37994	(Huntley, 1988b, 1995)
Park Street, Birmingham	Birmingham	West Midlands	52.47741	-1.89155	(Rátkai, 2009)
Parlington Hollins East	Garforth	West Yorkshire	53.80508	-1.35918	(Roberts, Burgess and Berg, 2001)
Parnwell	Peterborough	Cambridgeshire	52.59401	-0.20036	(Webley, 2007)

Parson Drove	Parson Drove	Cambridgeshire	52.65645	0.030495	(Andrews, 2006)
Paston	Peterborough	Cambridgeshire	52.61158	-0.23833	(Coates, Hancocks and Ellis, 2001)
Paternoster Square	London	Greater London	51.51456	-0.0992	(Watson and Heard, 2006)
Parc Bryn Cegin	Bangor	Gwynedd	53.21285	-4.10995	(Kenney, 2008)
Patchett's Cliff	Willoughton, nr Gainsborough	Lincolnshire	53.42006	-0.59397	(Cooke and Seager Smith, 1998)
Parsonage Cross	Littlehempston	Devon	50.45961	-3.67587	(Reed and Turton, 2005)
Puxton, Dolemoor	Puxton, nr Weston-Super-Mare	Somerset	51.36464	-2.84368	(Rippon, 2007)
Peabody Site	London	Greater London	51.51024	-0.12536	(Whytehead, Cowie and Blackmore, 1989)
Peel Gap	nr Hexham	Northumberland	55.00127	-2.38719	(Huntley, 1995)
Peninsular House	London	Greater London	51.50964	-0.0853	(Jones, Straker and Davis, 1991)
Penlee House	Tregony	Cornwall	50.2674	-4.9109	(S. R. Taylor, 2012)
Pennyland	Great Linford, Milton Keynes	Buckinghamshire	52.06158	-0.74406	(Williams and Zeepvat, 1993)
Penhale Round	Fraddon	Cornwall	50.3783	-4.94371	(Johnston, Moore and Fasham, 1999)
Pepper Hill Lane	Northfleet	Kent	51.42782	0.333187	(Hardy and Bell, 2001)
Pershore Abbey (Nave)	Pershore	Worcestershire	52.11046	-2.0775	(Dalwood *et al.*, 2000)
Perceton House	Perceton, nr Irvine	North Ayrshire	55.63253	-4.61735	(Stronach, 2004)
Percy Street	Newcastle upon Tyne	Northumberland	54.97837	-1.61453	(Swann, 2013)
Pevensey Castle	Pevensey	East Sussex	50.81913	0.333094	(Fulford and Rippon, 2011)
Park Farm, Binfield	Binfield	Berkshire	51.4271	-0.77448	(Roberts, 1995)
Paddock Hill, Octon	Thwing, nr Driffield	East Yorkshire	54.12888	-0.3487	(Carruthers, 1993b)
Pitstone	Pitstone	Buckinghamshire	51.82638	-0.64004	(Phillips, 2005)
Pound Lane	Canterbury	Kent	51.28185	1.076547	(Carruthers, 1990)
Plas Coch	Wrexham	Wrexham County	53.05828	-3.00711	(N. W. Jones, 2011)
Pleshey Castle	Pleshey, Chelmsford	Essex	51.80342	0.414908	(F. Williams, 1977)
Plantation Place	City of London	Greater London	51.51121	-0.08227	(Pitt, 2013)
Pontefract Castle	Pontefract	West Yorkshire	53.69601	-1.30328	(Roberts, 2002)
36-39 Poultry	City of London	Greater London	51.51382	-0.09077	(Pitt and Seeley, 2013)

Poundbury	Dorchester	Dorset	50.71883	-2.45111	(Sparey-Green, Davies and Ellison, 1987)
Poundbury Farm	Poundbury	Dorset	50.71768	-2.46278	(Dinwiddy and Bradley, 2011)
Poyle House	Poyle	Berkshire	51.47809	-0.51823	(Foreman, Hardy and Mayes, 2001)
Site N, Prospect Park	Hillingdon	Greater London	51.53733	-0.48736	(Cowie and Blackmore, 2008)
Park Prewett Hospital	Basingstoke	Hampshire	51.27821	-1.1168	(Coles, Lowe and Ford, 2011)
Prior's Gate	Eaton Socon	Cambridgeshire	52.20875	-0.29207	(Gibson, 2005)
Melyd Avenue	Prestatyn	Denbighshire	53.32388	-3.40972	(Blockley, 1989)
Prudhoe Castle	Prudhoe	Northumberland	54.96515	-1.85784	(Vaughan, 1983; Huntley, 1995)
Prickwillow Road	Ely	Cambridgeshire	52.40767	0.281638	(Atkins and Mudd, 2003)
Site 007, Priory Farm	Preston St Mary	Suffolk	52.11986	0.826342	(Anderson *et al.*, 2010)
105-111 Priory Street	Carmarthen	Carmarthenshire	51.86138	-4.29703	(James, 2003)
Wellow Lane	Peasedown St John	Somerset	51.31183	-2.41458	(Rowe and Alexander, 2010)
Queen Street Midden	Aberdeen	Aberdeenshire	57.14755	-2.09584	(Greig, 1982)
Queen Street, Stotfold	Stotfold	Bedfordshire	52.01368	-0.22214	(Gibson and Powell, 2007)
Quarry Farm	Ingleby Barwick, Stockton-on-Tees	County Durham	54.52841	-1.32628	(Collins and Allason-Jones, 2010; Archaeological Services Durham University, 2013)
RAF Catterick	Catterick	North Yorkshire	54.36704	-1.62674	(Busby *et al.*, 1996)
RAF Fairford	Fairford	Gloucestershire	51.68236	-1.78444	(Hoad, 2006)
Ramsey Abbey	Ramsey	Cambridgeshire	52.44875	-0.09871	(Spoerry *et al.*, 2008)
Permanex Site, Ramsey Road	St Ives	Cambridgeshire	52.32631	-0.07799	(Nicholson, 2005)
Ravenglass	Ravenglass	Cumbria	54.34955	-3.40476	(Potter, 1979)
Park School, Rayleigh	Rayleigh	Essex	51.60081	0.596208	(Ennis, 2008)
Raymoth Lane	Worksop	Nottinghamshire	53.32725	-1.13063	(Palmer Brown and Munford, 2004)
The Rectory, Dymock	Dymock	Gloucestershire	51.97875	-2.43806	(Simmonds, 2007)
Reading Abbey Stables	Reading	Berkshire	51.45522	-0.96775	(Hawkes, 1990)
Reawla	Gwinear	Cornwall	50.17821	-5.35585	(Appleton-Fox, 1992)
Redcastle Furze	Thetford	Norfolk	52.41377	0.735622	(Andrews, 1995)
Lunan Bay	Lunan Bay	Angus	56.64841	-2.51073	(Alexander, 2005)
Renny Lodge Hospital	Newport Pagnell	Berkshire	52.08058	-0.70751	(Budd and Crockett, 2009)
Roughground Farm	Lechlade	Gloucestershire	51.70616	-1.68881	(Allen *et al.*, 1993)
Rose Hall Farm	Walpole St Andrew	Norfolk	52.72121	0.200831	(Crowson, 2005)
Rhuddlan (Cledemutha)	Rhuddlan	Denbighshire	53.28442	-3.45417	(Manley *et al.*, 1985; Manley, 1987)

Site A, Abbey Nurseries, Rhuddlan	Rhuddlan	Denbighshire	53.28659	-3.45852	(Quinnell, Blockley and Berridge, 1994)
Site T, Ysgol-y-Castell, Rhuddlan	Rhuddlan	Denbighshire	53.28906	-3.4624	(Quinnell, Blockley and Berridge, 1994)
Riby Cross Roads	nr Grimsby	Lincolnshire	53.55639	-0.20989	(Steedman, 1994)
Richmond Market Place	Richmond	North Yorkshire	54.40328	-1.73809	(Huntley, 1995)
Riggs Hall	Shrewsbury	Shropshire	52.7025	-2.76208	(Colledge, 1979b)
Riverbank House	London	Greater London	51.50938	-0.08879	(Mackinder, 2015)
Red Lion Street	Aylsham	Norfolk	52.79504	1.25234	(Bates and Shelley, 2005)
RNAS Yeovilton	nr Ilchester	Somerset	51.0163	-2.64431	(Lovell, 2005)
Roecliffe	Dishforth	North Yorkshire	54.1497	-1.43502	(Huntley, 1995)
Royal Opera House	London	Greater London	51.51287	-0.12254	(Malcolm and Bowsher, 2003)
Rossington Grange Farm	Rossington	South Yorkshire	53.47077	-1.09004	(Roberts and Weston, 2016)
Rowe’s Garage	Chichester	West Sussex	50.83669	-0.76941	(Seager Smith *et al.*, 2007)
Roxburgh (Time Team Excavations)	Roxburgh	Scottish Borders	55.56882	-2.47721	(Martin and Oram, 2007)
Redcliff Farm, Poole Harbour	Poole	Dorset	50.67992	-2.09336	(Lyne, 2002)
Roxton Road West	Great Barford	Bedfordshire	52.18127	-0.31945	(Timby and Allen, 2007)
Rougier Street	York	North Yorkshire	53.95874	-1.08705	(Hall and Kenward, 1990)
Rumney Castle	Rumney	Cardiff	51.50377	-3.13916	(Lightfoot, 1992)
Ruxox	Flitton	Bedfordshire	52.01743	-0.46779	(Dawson, 2004)
Sackler Library	Oxford	Oxfordshire	51.75525	-1.26122	(Poore and Wilkinson, 2001)
Sadberge	Darlington	County Durham	54.54711	-1.47283	(Huntley, 1995)
Salisbury Street	Amesbury	Wiltshire	51.17118	-1.77968	(Powell *et al.*, 2009)
Ropetackle Arts Centre	Shoreham-by-Sea	West Sussex	50.83263	-0.27908	(Stevens, 2011)
School Road	Alchester	Warwickshire	52.21773	-1.87258	(Cracknell and Jones, 1986)
Scole	Diss	Norfolk	52.3633	1.154845	(Rogerson, 1977)
Area 6, Scole	Scole	Norfolk	52.36483	1.146068	(Ashwin, 2014)
Scotney Castle	Lydd	Kent	50.93886	0.865212	(Barber, 1998)
Scarcewater Tip	Pennance, St Stephen-in-Brannel	Cornwall	50.34937	-4.9138	(Jones and Taylor, 2010)

Segontium Roman Fort	Caernarfon	Gwynedd	53.13724	-4.26589	(Casey and Davies, 1993)
Southampton French Quarter	Southampton	Hampshire	50.89787	-1.40557	(Richard Brown and Hardy, 2011)
2-26 Shorts Gardens / 19-41 Earlham Street	London	Greater London	51.51399	-0.12591	(Cowie and Blackmore, 2012)
Southgate, Hartlepool	Hartlepool	County Durham	54.69561	-1.18697	(Young, 1987)
Shakenoak Roman Villa	North Leigh	Oxfordshire	51.82158	-1.45878	(Brodribb and Walker, 1978)
Shoreditch High Street	London	Greater London	51.52592	-0.07758	(Boyer, 2013)
Sherborne House	Lechlade	Gloucestershire	51.69601	-1.6938	(Bateman, Enright and Oakey, 2003)
Old Shifford farm	Standlake	Oxfordshire	51.71723	-1.44845	(Hey, 1995)
South Hook	Herbranston	Pembrokeshire	51.719	-5.08187	(Crane and Murphy, 2010)
Shotton	Shotton	Northumberland	55.09233	-1.65057	(Muncaster, McKelvey and Birdwell, 2014)
Showell Farm	Chippenham	Wiltshire	51.43972	-2.13519	(Young and Hancocks, 2009)
Springhead Roadside Settlement	Dartford	Kent	51.42807	0.325143	(Andrews *et al.*, 2011; Barnett *et al.*, 2011)
Springhead Sanctuary	Dartford	Kent	51.42806	0.32543	(Andrews *et al.*, 2011; Barnett *et al.*, 2011)
Springhead (Anglo-Saxon settlement)	Northfleet	Kent	51.43091	0.326726	(Andrews *et al.*, 2011)
Stone House	West Thurrock	Essex	51.4776	0.260838	(Andrews, 2009b)
Sidbury site, Worcester	Worcester	Worcestershire	52.18854	-2.21791	(Colledge, 1979a)
Sidbury/Friar Street	Worcester	Worcestershire	52.18854	-2.21791	(Darlington and Evans, 1992)
Land south of Silbury Hill	Avebury	Wiltshire	51.41376	-1.85756	(Crosby and Hembrey, 2013)
Insula IX, Silchester	Silchester	Hampshire	51.358	-1.08511	(Fulford, Clarke and Eckardt, 2006)
St John's College	Oxford	Oxfordshire	51.75827	-1.25902	(Wallis, 2014)
St John's Square	Daventry	Northamptonshire	52.25925	-1.15994	(Soden, 1997)
Skenfrith Castle	Skenfrith	Monmouthshire	51.87833	-2.79021	(Evans, Trott and Pannett, 2007)
Skerne Road	Kingston upon Thames	Greater London	51.41403	-0.30316	(Bradley, 2005)
Slaughterhouse Lane	Newark-on-Trent	Nottinghamshire	53.07815	-0.8096	(Kinsley, 1993)
Maltings Academy	Witham	Essex	51.79806	0.631025	(Reynolds, 2011)
South Manor, Wharram Percy	Wharram, Ryedale	North Yorkshire	54.06661	-0.69047	(Stamper and Croft, 2000)

Smeaton Roman Temporary Camp	nr Dalekeith	Midlothian	55.91142	-3.04939	(Cameron *et al.*, 2010)
St Mary's Grove	Stafford	Staffordshire	52.80685	-2.11792	(Carver, 2010)
Grange Farm, Snetterton	Snetterton	Norfolk	52.48047	0.95333	(Robertson, 2004)
Sol Central	Northampton	Northamptonshire	52.23731	-0.90196	(Miller, Wilson and Harward, 2006)
St Andrew's Church Vicarage, Sonning	Sonning	Berkshire	51.47415	-0.91389	(Hull and Hall, 2003)
Site V, Melbourne Street	Southampton	Hampshire	50.90386	-1.39221	(Holdsworth, 1980)
Langage Energy Park	South Hams	Devon	50.38098	-4.00702	(Salvatore and Quinnell, 2011)
Areas C1-3, Salford Priors	Arrow Valley	Warwickshire	52.16622	-1.89907	(Palmer, 1999)
Spong Hill	North Elmham, Dereford	Norfolk	52.73683	0.93286	(Rickett, 1995)
Springfield (Romano-British site)	Chelmsford	Essex	51.72741	0.502086	(Hedges and Buckley, 1983)
Springfield (Anglo-Saxon site)	Springfield Lyons	Essex	51.74474	0.511736	(Tyler and Major, 2005)
Sutton Poyntz Water Treatment Works	Sutton Poyntz	Dorset	50.65511	-2.41768	(Rawlings, 2007)
The Granary, South Shields Fort	South Shields	Tyne & Wear	55.00474	-1.43109	(van der Veen, 1992)
South Street, St Neots	St Neots	Cambridgeshire	52.22718	-0.26917	(Martin-Bacon, 2011)
Sheep Street, Petersfield	Petersfield	Hampshire	51.00352	-0.93866	(Fox and Hughes, 1993)
Sussex Street, Winchester	Winchester	Hampshire	51.06585	-1.31866	(Maltby, 2010)
Stansted Airport	Stansted Mountfitchet	Essex	51.8843	0.236144	(Cooke, Brown and Phillpotts, 2008)
Stanford Wharf	Stanford-le-Hope	Essex	51.5033	0.446557	(Allison, Biddulph and Collins, 2012)
St Andrew's Road / Lower Coombe Street	Croydon	Greater London	51.36764	-0.10141	(Taylor *et al.*, 2011)
St Andrew's School	Ashtead	Surrey	51.3036	-0.31584	(Priestley-Bell, 2014)
RAF St Athan	Barry	Vale of Glamorgan	51.40829	-3.43268	(Barber, Cox and Hancocks, 2006)
Staunch Meadow	Brandon	Suffolk	52.44813	0.611917	(Tester *et al.*, 2014)

St Birinus Primary School	Dorchester-on-Thames	Oxfordshire	51.64605	-1.16445	(Torrance and Durden, 1998)
Stebbingford Farm	Felsted	Essex	51.87593	0.431141	(Medlycott, 1996)
Stebbing Green Reservoir	Dunmow	Essex	51.88112	0.454839	(Bedwin and Bedwin, 1999)
38-44 Stert Street	Abingdon	Oxfordshire	51.67149	-1.28175	(Parrington, 1979)
Street Farm, Latton	Latton	Wiltshire	51.65936	-1.87172	(Mudd, Williams and Lupton, 1999)
St Faith's Lane	Norwich	Norfolk	52.63002	1.300681	(Soden, 2010)
15-23 Southwark Street	London	Greater London	51.50455	-0.09173	(Cowan, 1992)
St John's Hospital	Northampton	Northamptonshire	52.23481	-0.89426	(Carlyle, Geber and Armitage, 2017)
St John of Jerusalem	Clerkenwell, London	Greater London	51.52121	-0.103	(Sloane and Malcolm, 2004)
St John's Vicarage	Old Malden, Kingston upon Thames	Greater London	51.38147	-0.25982	(Andrews, 2001)
Swanpool Walk	Worcester	Worcestershire	52.18716	-2.23326	(Wainwright, 2014)
St Mary Abbots Hospital	London	Greater London	51.49742	-0.19101	(Howe, 1998)
St Mary Merton	Merton	Surrey	51.41507	-0.18184	(Miller and Saxby, 2007)
Cathedral & Priory of St Mary, Coventry	Coventry	Warwickshire	52.40888	-1.50749	(Rylatt and Mason, 2003)
St Mary Graces	Tower Hamlets, London	Greater London	51.50928	-0.07208	(Grainger and Philpotts, 2011)
St Martin-at-Palace Plain	Norwich	Norfolk	52.63415	1.300992	(Ayers, 1988)
St Mary Spital	London	Greater London	51.52071	-0.07794	(Thomas, Sloane and Phillpotts, 1997)
Hospital of St Nicholas	Lewes	East Sussex	50.87333	-0.00449	(Barber and Sibun, 2010)
Stanbridge Manor	Stanbridge	Bedfordshire	51.90903	-0.5951	(Abrams, 2010)
70 Station Road, West Drayton	Hillingdon	Greater London	51.50715	-0.47196	(Boyer, 2016)
St Nicholas' Street	Thetford	Norfolk	52.41532	0.746307	(Andrews, 1999)
St Nicholas Yard	Carlisle	Cumbria	54.88666	-2.92671	(Howard-Davis and Leah, 1999)
Stockbridge	Newcastle-upon-Tyne	Tyne & Wear	54.97061	-1.60539	(Truman, 2001)
St Patrick's Church, Cowgate	Edinburgh	City of Edinburgh	55.94918	-3.18462	(E. Jones, 2011)

Stepstairs Lane	Cirencester	Gloucestershire	51.70923	-1.96026	(Brett and Watts, 2008)
26-27 Staple Gardens	Winchester	Hampshire	51.06447	-1.31693	(Moore and Preston, 2008)
Castlehill, Strachan	Strachan	Aberdeenshire	57.01878	-2.55829	(Yeoman, 1984)
Stricklandgate	Kendal	Cumbria	54.33154	-2.7502	(Huntley, 1989b, 1995)
Strensham	Wychavon	Worcestershire	52.06289	-2.13323	(Jackson *et al.*, 1996)
55-60 St Thomas Street, Redcliffe	Bristol	Gloucestershire	51.45064	-2.5881	(Davenport, Leech and Rowe, 2011)
Hoo St Werburgh	Hoo St Werburgh	Kent	51.41647	0.560582	(Moore, 2002)
Summersfield	Papworth Everard	Cambridgeshire	52.24569	-0.11927	(Patten, 2012)
1-5 Sun St.	Waltham Abbey	Essex	51.6868	-0.00236	(Brown, 1995)
Sutton Courtenay	Sutton Courtenay	Berkshire	51.63637	-1.29193	(Hamerow *et al.*, 2007)
Sewage Treatment Works, Dymock	Dymock	Gloucestershire	51.97873	-2.43469	(Catchpole, 2007)
Springwood Park	Kelso	Scottish Borders	55.59324	-2.4441	(Dixon, 1998)
Sywell Aerodrome	Sywell	Northamptonshire	52.31069	-0.79277	(Foard-Colby, 2010)
Tackley Church	Tackley	Oxfordshire	51.87834	-1.30993	(Blair and McKay, 1985)
Tamworth Mill	Tamworth	Staffordshire	52.63301	-1.69169	(Rahtz, 1992)
Tanners' Hall	Gloucester	Gloucestershire	51.86851	-2.24308	(Vallender, 2009)
Tanyard Lane	Steyning	West Sussex	50.89018	-0.32646	(Freke, 1979)
Taplow Court	Taplow	Buckinghamshire	51.53233	-0.6938	(Allen, Hayden and Lamdin-Whymark, 2009)
Tattenhoe	Milton Keynes	Buckinghamshire	51.99827	-0.79391	(Ivens, 1995)
Townsend Close	Ilchester	Somerset	50.99898	-2.6854	(Leach, 1982)
Worcester Technical College	Worcester	Worcestershire	52.19149	-2.22278	(Sworn *et al.*, 2008)
Tempsford Park	Tempsford	Bedfordshire	52.17062	-0.2999	(Shotliff, 1996)
Tempsford Park 1999 excavations	Tempsford	Bedfordshire	52.17062	-0.2999	(Maull and Chapman, 2005)
Tetbury Hill	Malmesbury	Wiltshire	51.59521	-2.1101	(Leonard and Massey, 2017)
Site 1 Tewkesbury	Tewkesbury	Gloucestershire	51.99716	-2.14386	(Walker, Thomas and Bateman, 2004)
Site 2 Tewkesbury	Tewkesbury	Gloucestershire	51.98206	-2.139	(Walker, Thomas and Bateman, 2004)
Tort Hill East	Sawtry	Cambridgeshire	52.45116	-0.27552	(Ellis *et al.*, 1998)
Tort Hill West	Sawtry	Cambridgeshire	52.44699	-0.28092	(Ellis *et al.*, 1998)
Tesco, Hereford	Hereford	Herefordshire	52.05704	-2.71935	(Thomas and Boucher, 2002)

Thornborough	Corbridge	Northumberland	54.96433	-1.98435	(van der Veen, 1992)
Thornborough Farm, Catterick	Catterick	North Yorkshire	54.3878	-1.65812	(Huntley, 1997; Wilson, 2002)
A253 Isle of Thanet	Thanet	Kent	51.34358	1.297539	(Bennett, 2008)
Thrislington	Ferryhill	County Durham	54.69381	-1.52523	(Huntley, 1995)
33 Thrapston Road	Spaldwick	Cambridgeshire	52.34274	-0.34593	(Clelland and Mepham, 2014)
Thorpe Thewles	Stockton on Tees	County Durham	54.61231	-1.38837	(van der Veen, 1992)
Tibbet's Close	Alcester	Warwickshire	52.21606	-1.86697	(Cracknell, 1986)
Thorp Leas Nursery	Egham	Surrey	51.41908	-0.5375	(Jones, Poulton and Hayman, 2012)
Thorpe Malsor	Kettering	Northamptonshire	52.40374	-0.76612	(Carlyle, Clarke and Chapman, 2017)
Totterdown Lane	Fairford	Gloucestershire	51.69764	-1.78147	(Pine, Preston and Preston, 2004)
Tolpuddle Ball	Tolpuddly	Dorset	50.7525	-2.26503	(Hearne and Birbeck, 1999)
Turnpike School	Newbury	Berkshire	51.40534	-1.30125	(Pine, 2010)
Tranmer House	Bromeswell	Suffolk	52.09507	1.341772	(Fern, 2015)
Combined Universities Campus, Tremough	Penryn	Cornwall	50.1705	-5.12443	(Gossip and Jones, 2007)
Trent Lane	Newark	Nottinghamshire	53.08431	-0.80334	(Cutler and Ramsey, 2005)
Tribe's Yard	Bognor Regis	West Sussex	50.79434	-0.67149	(Stevens, 2006)
Tremough	Penryn	Cornwall	50.16861	-5.1857	(Gossip and Jones, 2010)
Truckle Hill	North Wraxhall	Wiltshire	51.48487	-2.23613	(Andrews, 2009a)
Court St./Fore St. Trowbridge	Trowbridge	Wiltshire	51.32043	-2.20937	(Graham *et al.*, 1993)
General Accident Site, Tanner Row	York	North Yorkshire	53.95846	-1.08768	(Hall and Kenward, 1990)
Site 17 Terrington St Clement	Hay Green	Lincolnshire	52.73682	0.278943	(Crowson, 2005)
Site 23 Terrington St Clement	Hay Green	Lincolnshire	52.73866	0.276669	(Crowson, 2005)
Tipping Street	Stafford	Staffordshire	52.80633	-2.11479	(Carver, 2010)
Tipping Street (2009-10 excavations)	Stafford	Staffordshire	52.80585	-2.11492	(Dodd *et al.*, 2014)
Site F, Tulse Hill	London	Greater London	51.44533	-0.11647	(Cowie and Blackmore, 2008)

Tutbury Castle	Tutbury	Staffordshire	52.85962	-1.69105	(Hislop, 2011)
Townwall Street	Dover	Kent	51.12505	1.317397	(Corke, Cotter and Parfitt, 2006)
Twinyeo Quarry	Chudleigh Knighton	Devon	50.57357	-3.63091	(Farnell, 2015)
Tyttenhanger Manor	St Albans	Hertfordshire	51.72568	-0.27704	(Hunn, 2004)
Ultra Pontem, Caerleon	Caerleon, Newport	Monmouthshire	51.60592	-2.94576	(Reynold, 2015)
City Campus, University of Worcester	Worcester	Worcestershire	52.19527	-2.22599	(Sworn *et al.*, 2014)
Upper Bognor Road	Bognor Regis	West Sussex	50.78998	-0.66778	(Priestley-Bell, 2006)
Upton	Upton	Northamptonshire	52.23347	-0.94422	(Walker and Maul, 2010)
Vancouver Court	Kings Lynn	Norfolk	52.75427	0.396917	(R. Brown and Hardy, 2011)
58-62 Scotch Street	Carlisle	Cumbria	54.89644	-2.93551	(Donaldson, 1977)
Verulamium Insula XIII	St Albans	Hertfordshire	51.75292	-0.35858	(Niblett, Manning and Saunders, 2006)
Vexillation Fortress, Alchester	Alchester	Oxfordshire	51.87789	-1.1699	(Sauer *et al.*, 2000)
Vinegar Hill	Alconbury Weston	Cambridgeshire	52.3854	-0.25881	(Ellis *et al.*, 1998)
Victoria Road East, Winchester	Winchester	Hampshire	51.06735	-1.31698	(Maltby, 2010)
Victoria Street, Hereford	Hereford	Herefordshire	52.05591	-2.72037	(Shoesmith, 1982)
The Vineyard, Abingdon	Abingdon	Oxfordshire	51.67348	-1.27874	(Devaney, 2007)
Victoria Road, Stowmarket	Stowmarket	Suffolk	52.19023	1.00443	(Plouviez, 1999)
West Angle Bay	NA	Pembrokeshire	51.68449	-5.11165	(Groom *et al.*, 2011)
Wainscott by-pass (Four Elms Roundabout)	Frindsbury Extra	Kent	51.41459	0.515885	(Sparey-Green, Rady and Clark, 2009)
51-53 St Mary's Street, Wallingford	Wallingford	Oxfordshire	51.5991	-1.12503	(Pine, 2012)
82-84 Walton Street, Aylesbury	Aylesbury	Buckinghamshire	51.81184	-0.80832	(Stone, 2011)
A419 Covingham Noise Barrier	Wanborough	Wiltshire	51.56661	-1.72295	(A.B. Powell, 2011a)
Wanborough Green Lane	Wanborough	Surrey	51.23731	-0.68642	(Carruthers, 1992b)
Wardrobe Place	London	Greater London	51.51281	-0.10073	(Tyler, 2000)
Watchfield Triangle	Watchfield	Oxfordshire	51.61484	-1.63745	(Heawood, 2004)

Wavendon Gate	Milton Keynes	Buckinghamshire	52.02318	-0.68539	(Williams, Hart and Williams, 1995)
Barrel Latrine, Worcester	Worcester	Worcestershire	52.18814	-2.21839	(Carver, 1980; Greig, 1981)
Wicken Farm	Wicken Bonhunt	Essex	51.97942	0.198649	(Wade, 1980)
Site 46, Willingham by Stow	nr Gainsborough	Lincolnshire	53.33627	-0.69117	(Cooke and Seager Smith, 1998)
Site 16, Wetherby Lane	NA	North Yorkshire	53.96167	-1.37121	(Brown *et al.*, 2007)
Westbury-by-Shenley	Milton Keynes	Buckinghamshire	52.01265	-0.79352	(Ivens, 1995)
West Cotton	Raunds	Northamptonshire	52.34225	-0.56953	(Chapman, 2010)
Weedon Hill	Aylesbury	Buckinghamshire	51.83402	-0.82297	(Wakeham and Bradley, 2013)
Well Court, Cheapside	London	Greater London	51.51314	-0.09368	(Allen and Milne, 1988)
Wellington Quarry	Marden	Herefordshire	52.12721	-2.72011	(Jackson and Miller, 2011)
Water End East	Great Barford	Bedfordshire	52.15162	-0.38489	(Timby and Allen, 2007)
Water End West	Great Barford	Bedfordshire	52.14898	-0.38937	(Timby and Allen, 2007)
Ashwell site, West Fen Road	Ely	Cambridgeshire	52.40385	0.246157	(Regan, Lucy and Mortimer, 2005)
Consortium site, West Fen Road	Ely	Cambridgeshire	52.40469	0.249141	(Mudd, 2011)
William Grant & Sons Distillery	Girvan	South Ayrshire	55.26758	-4.83054	(Banks, Duffy and McGregor, 2008)
1 Westgate Street, Gloucester	Gloucester	Gloucestershire	51.86541	-2.24628	(Heighway and Vince, 1979)
White Hart, Ely	Ely	Cambridgeshire	52.39987	0.266535	(Jones, 1994)
Whitemoor Haye	Alrewas	Staffordshire	52.71436	-1.73499	(Coates, 2002)
West Heslerton (settlement site)	Ryedale	North Yorkshire	54.17431	-0.59668	(Powlesland, 1998)
Westhawk Farm, Kingsnorth	Kingsnorth	Kent	51.12346	0.856616	(Booth, 2001)
Whitehouse Road, Oxford	Oxford	Oxfordshire	51.74406	-1.25766	(Mudd, 1993)
Windmill Hill Golf Club	Milton Keynes	Buckinghamshire	51.99714	-0.77209	(Zeepvat, Williams and Mynard, 1987)
Whithorn Priory	Whithorn	Dumfries & Galloway	54.73366	-4.41697	(Huntley, 1995; Hill, 1997)
Whitelands Farm	Bicester	Oxfordshire	51.89364	-1.17164	(Martin, 2011)
Friary site, Whitefriars, Canterbury	Canterbury	Kent	51.27694	1.081401	(Hicks, 2015)

Whitefriars St. Carpark, Norwich	Norwich	Norfolk	52.63381	1.300375	(Ayers and Murphy, 1983)
Wickhams Field, Reading	Reading	Berkshire	51.4223	-1.03061	(Crockett, 1996)
Wigmore Castle	Wigmore	Herefordshire	52.3186	-2.86992	(Rátkai, 2015)
Loushers Lane, Wilderspool	Warrington	Cheshire	53.3768	-2.57779	(Hinchliffe, 1992)
Wilton Autos	Wilton	Wiltshire	51.08158	-1.8669	(De'Athe, 2012)
29 High Street, Wimborne Minster	Wimborne Minster	Dorset	50.79918	-1.98757	(Coe and Hawkes, 1992)
Wing Church (All Saints)	Wing	Buckinghamshire	51.89446	-0.72155	(Holmes and Chapman, 2008)
Winchester Palace, Southwark	London	Greater London	51.50689	-0.09108	(Seeley, Phillpotts and Samuel, 2006)
Winterton Roman Villa	Winterton Cliff	Lincolnshire	53.65051	-0.62532	(Stead, 1976)
Southworth Quarry, Winwick	Winwick	Cheshire	53.44368	-2.5699	(Moore, 2014)
Market Mews, Wisbech	Wisbech	Cambridgeshire	52.66519	0.161929	(Popescu and Hinman, 2012)
Wixoe	Wixoe	Suffolk	52.0621	0.494639	(Clarke and Atkins, 2018)
Warren Lane, Ashford	Ashford	Kent	51.15645	0.861658	(Atkins and Webster, 2012)
Walton Lodge, Aylesbury	Aylesbury	Buckinghamshire	51.81173	-0.80643	(Dalwood *et al.*, 1989)
Winery Lane, Walton-le-Dale	Preston	Lancashire	53.74751	-2.68187	(Huntley, 1995)
Weatherlees Hill	Ebbsfleet	Kent	51.31661	1.343143	(Hearne, Perkins and Andrews, 1995)
Dorter Undercroft, Westminster Abbey	London	Greater London	51.49884	-0.12742	(Mills, 1993)
Football Field, Worth Matravers	Worth Matravers	Dorset	50.60001	-2.03739	(Ladle, 2018)
Area B1, West Malling by-pass	Leybourne	Kent	51.30417	0.41522	(Ellis, 2009)
West Mead, Bere Regis	Bere Regis	Dorset	50.75569	-2.24307	(Hearne and Birbeck, 1999)
Woolmonger Street, Northampton	Northampton	Northamptonshire	52.23633	-0.89864	(Soden, 1999)
West Mercia Police HQ	Hindlip	Worcestershire	52.22791	-2.17213	(Wainright, 2015)
Post Office Training Establishment, Wolverton Mill	Milton Keynes	Buckinghamshire	52.06068	-0.83161	(Chapman, Chapman and Thompson, 2015)

Wolverton Turn	Stony Stratford, nr Milton Keynes	Buckinghamshire	52.05852	-0.83094	(Preston, 2007)
The Walnuts, Woodston	Peterborough	Cambridgeshire	52.56491	-0.25095	(Thomas and Jones, 2011)
Wortley	Wotton-under-Edge	Gloucestershire	51.62273	-2.33941	(Wilson, 2014)
Westminster Palace	Westminster, London	Greater London	51.50001	-0.127	(Thomas, Cowie and Sidell, 2006)
Wraysbury	NA	Berkshire	51.4556	-0.56027	(Astill and Lobb, 1988)
Worcester Road, Droitwich	Droitwich	Worcestershire	52.26777	-2.14649	(Bretherton *et al.*, 2002)
Wrekin hillfort	Telford	Shropshire	52.67114	-2.5486	(Stanford, 1984)
Waitrose, Gillingham	Gillingham	Dorset	51.03573	-2.27805	(Valentin and Robinson, 2001)
West Stagsden	Stagsden	Bedfordshire	52.12499	-0.57683	(Dawson, 2005)
45-53 West Street, Bedminster	Bristol	City of Bristol	51.4387	-2.60233	(Young and Young, 2015)
40-43 Water Street, Leith	Leith	City of Edinburgh	55.97467	-3.16968	(Stronach, 2002)
West Stow	Lark Valley	Suffolk	52.31085	0.634635	(West, 1985)
White Swan, Westcott	Westcott	Buckinghamshire	51.84798	-0.95864	(Keir and Ingham, 2010)
Great Witcombe Roman Villa	Great Witcombe	Gloucestershire	51.82723	-2.14796	(Leach, 1998)
12 Watergate Street, Chester	Chester	Cheshire	53.18973	-2.8953	(Ward, 1988)
37-55 Friar Street, Worcester	Worcester	Worcestershire	52.18899	-2.2182	(Jackson *et al.*, 2002)
West Walton	Ingleborough	Norfolk	52.71092	0.17855	(Crowson, 2005)
West Wick	Weston-Super-Mare	Somerset	51.35254	-2.90515	(Powell, 2008)
Wyndyke Furlong, Abingdon	Abingdon	Oxfordshire	51.67618	-1.3036	(Muir and Roberts, 1999)
Yarnton	Yarnton	Oxfordshire	51.79568	-1.31989	(Hey, 2004; Hey, Booth and Timby, 2011)
Yewden Roman Villa	Hambleden	Buckinghamshire	51.56382	-0.86891	(Eyers, 2011)
Ysgol yr Hendre	Caernarfon	Gwynedd	53.13688	-4.26186	(Kenny and Parry, 2012)

Table 3.2. Nomenclature standardisations for wheats (standard names applied and the synonyms encountered in reports): (a) wheat grain identifications, (b) glume wheat chaff identifications, (c) free-threshing cereal chaff identifications.

a

Standardised botanical name	Common name	Nomenclature encountered in reports
Triticum L. (free-threshing)	Free-threshing wheat	*Triticum* (free-threshing compact)
		Triticum aestivo-compactum
		Triticum aestivum
		Triticum aestivum/compactum
		Triticum aestivum sl.
		Triticum aestivum ssp. *compactum*
		Triticum aestivum/turgidum
		Triticum aestivum-type
		Triticum compactum
		Triticum durum/aestivum
		Triticum sp. (free-threshing)
		*Triticum sp. (*hexaploid, free-threshing)
		Triticum sp. (free-threshing, short grain)
		Triticum sp. (naked)
		Triticum sp. (small grained 3.5-4mm)
		Triticum turgidum
		Triticum turgidum type
		Triticum turgidum/durum
Triticum dicoccum Schübl.	Emmer	*Triticum dicoccum*
		Triticum dicoccum (short grain)
		Triticum monococcum/dicoccum (see Section 3.3.3.1)
Triticum spelta L.	Spelt	*Triticum spelta*
		Triticum spelta (long grain)
		Triticum spelta (short grain)
Triticum monococcum L.	Einkorn	*Triticum monococcum* (see Section 3.3.3.1)
Triticum dicoccum Schübl./*spelta* L.	Glume wheat	*Triticum* sp. (glume wheat)
		Triticum spelta/dicoccum
		Triticum spelta/dicoccum (short grain)
Triticum L. (free-threshing)/*spelta* L.	Free-Threshing/Spelt wheat	*Triticum* (hexaploid)
		Triticum aestivum/spelta
		Triticum aestivum/spelta (short grain)
		Triticum sp. (compact grains)
		Triticum sp. (rounded grain)
Triticum L.	Wheat	*Triticum dicoccum/aestivum*
		Triticum sp.
		Triticum sp. (short grain)

b

Standardised botanical name	Common name	Nomenclature encountered in reports
Triticum dicoccum Schübl.	Emmer	*Triticum dicoccon*
		Triticum dicoccum
		Triticum cf. *monococcum*
		Triticum monococcum/dicoccum
Triticum spelta L.	Spelt	*Triticum spelta*
Triticum dicoccum Schübl./*spelta* L.	Glume wheat	*Triticum* sp. (glume wheat)
		Triticum sp. (hulled)
		Triticum sp.
		Triticum spelta/dicoccum
Triticum monococcum L.	Einkorn	*Triticum monococcum* (see section 3.3.3.1)

c

Standardised botanical name	Common name	Nomenclature encountered in reports
Triticum L. (free-threshing)	Free-threshing wheat	*Triticum aestivum sl.*
		Triticum aestivum/turgidum
		Triticum durum/aestivum
		Triticum sp. (free-threshing)
		Triticum sp. (tough rachis)
		Triticum sp.
		Triticum sp. (dense rachis)
Triticum aestivum L./*compactum* Host.	Hexaploid free-threshing wheat	*Triticum* (hexaploid free-threshing)
		Triticum aestivo-compactum
		Triticum aestivum/compactum
		Triticum sp. (hexaploid, tough rachis)
		Triticum aestivum/spelta
Triticum turgidum L./*durum* Desf.	Tetraploid free-threshing wheat	*Triticum* (tetraploid free-threshing)
		Triticum durum
		Triticum turgidum
		Triticum turgidum/durum

Table 3.3. Nomenclature standardisations for non-wheat cereals (standard botanical names and the synonyms encountered in reports): (a) oat, (b) rye, (c) barley.

a

Standardised Name	**Common name**	**Nomenclature encountered in reports**	**Comments**
Avena L.	Oat	*Avena* sp.	allocated to this category if no chaff permitting identification to species level was attached to the grains
		Avena fatua/ludoviciana	
		Avena fatua	
		Avena strigosa	
		Avena sativa	
		Avena sativa/fatua	
		Avena sp. (large grain 7 x 2.5 mm)	
		Avena sp. (small grain 5.5 x 2 mm)	
		Avena sativa/strigosa	
Avena sativa	Common oat	*Avena sativa*	only allocated to this category if the identification was based on chaff attached to grains
Avena strigosa	Bristle oat	*Avena strigosa*	only allocated to this category if the identification was based on chaff attached to grains

b

Standardised term	**Common name**	**Nomenclature encountered in reports**	**Comments**
Secale cereale L.	Rye	*Secale*	
		Secale cereale	
		Secale cereale ssp. *cereale*	

c

Standardised Name	Common name	Nomenclature encountered in reports	Comments
Hordeum vulgare L.	Barley	*Hordeum distichum/hexastichum*	
		Hordeum sativum	
		Hordeum sp.	
		Hordeum sp. (lax eared)	
		Hordeum sp. (straight grain)	
		Hordeum vulgare	classified as this when the report contained no evidence that "*vulgare*" was being used to mean 6 row barley
		Hordeum vulgare (straight grain)	
		Hordeum vulgare sl.	
		Hordeum vulgare/distichon	
Hordeum vulgare L. (hulled)	Hulled barley	*Hordeum* sp. (hulled)	
		Hordeum vulgare (hulled)	classified as this when the report contained no evidence that "*vulgare*" was being used to mean 6 row barley
		Hordeum vulgare (hulled, straight grain)	
		Hordeum vulgare/distichon (hulled)	
Hordeum vulgare L. (naked)	Naked barley	*Hordeum* sp. (naked)	
		Hordeum sp. (naked, straight grain)	
		Hordeum vulgare var. *nudum*	classified as this when the report contained no evidence that "*vulgare*" was being used to mean 6-row barley
Hordeum vulgare L. (2-row)	2-row barley	*Hordeum distichon*	
		Hordeum distichum	
		Hordeum sp. (2 row)	
		Hordeum sp. (2 row, lax-eared)	
Hordeum vulgare L. (2-row, hulled)	Hulled 2-row barley	*Hordeum* sp. (2 row hulled)	
Hordeum vulgare L. (6-row)	6-row barley	*Hordeum hexastichum*	
		Hordeum sp. (4 row)	
		Hordeum sp. (6 row)	

Standardised Name	Common name	Nomenclature encountered in reports	Comments
		Hordeum sp. (dense-eared)	
		Hordeum sp. (6 row lax-eared)	
		Hordeum sp. (twisted)	
		Hordeum vulgare	classified as this when the report described the grains as twisted, or rachis as 6-row
		Hordeum vulgare (6 row)	
		Hordeum vulgare (twisted/lateral grain)	
		Hordeum vulgare var. *vulgare*	
Hordeum vulgare L. (6-row, hulled)	Hulled 6-row barley	Hordeum hexastichum (hulled grain)	
		Hordeum sp. (6 row, hulled)	
		Hordeum sp. (hulled, twisted grain)	
		Hordeum vulgare (hulled, twisted/lateral grain)	
		Hordeum vulgare var. *vulgare* (hulled grain)	classified as this when the report described the grains as twisted
Hordeum vulgare L. (6-row, naked)	Naked 6-row barley	*Hordeum vulgare* (naked, twisted grain)	

Table 3.4. Nomenclature standardisations for non-cereal crops (standard botanical names and the synonyms encountered in reports).

Standard term	Common Name	Nomenclature encountered in reports
Lens culinaris Medik.	Lentil	*Lens culinaris*
		Lens culinaris var. *microsperma*
		Lens esculenta
Linum usitatissimum L.	Flax	*Linum usitatissimum*
Pisum sativum L.	Garden Pea	*Pisum sativum*
Vicia faba L.	Celtic Bean	*Vicia faba*
		Vicia faba var. *major*
		Vicia faba var. *minor*
		Vicia faba var. *minuta*

Table 3.5. Standard plant parts used in quantitative analyses: (a) cereals, (b) non-cereal taxa.

a

Standard Plant Part	**Terms encountered in reports**	**Quantification notes**
Grain	Floret	1 grain
	Floret & Grain	1 grain
	Floret & Germinated grain	1 grain
	Germinated grain	
	Grain	
	Grain (embryo lost prior to charring)	
	Grain + lemma	
	Grain fragment (embryo end)	
	Tail grain	
	Tail grain (germinated)	
Glume base	Glume base	
	Glume base/glume	
	Spikelet base	Counted as 2 glume bases
	Spikelet fork	Counted as 2 glume bases
Glume base + Grain	Immature spikelet & rachis	Found at one site – Stanford Wharf (Hunter, 2012) and relates to spelt. Count as 2 glume bases and 2 grains (rachis node not counted as spelt is a glume wheat)
	Spikelet	Depends on cereal species: 2 glume bases + 2 grains (emmer or spelt), 2 grains + 1 rachis node (rye), 2 grains (oat)
	Spikelet fork with grain	Occurs at 3 sites. At Bancroft (Pearson and Robinson, 1994) where specific information is given each instance equates to 2 spelt glume bases and 1 grain. At Northfleet Roman Villa (Barnett *et al.*, 2011) and Baker's Wood no information is given so the quantification methodology for spelt spikelets described above is used.
Rachis internode	Articulated rachis	Counted as 2 internodes (this represents the minimum possible number) unless otherwise specified in the report.
	Basal rachis	
	Basal rachis internode	
	Basal rachis node	
	Primary rachis node	
	Rachis	1 internode (minimum possible number) unless otherwise specified in report.

Standard Plant Part	Terms encountered in reports	Quantification notes
	Rachis fragment	1 internode (minimum possible number) unless otherwise specified in report.
	Rachis internode	
	Rachis internode base	
	Rachis node	
	Terminal rachis	
Culm node	Culm base	
	Culm base/rhizome	
	Culm node	

b

Standard Plant Part	Term encountered in report	Quantification notes
Seed	Achene	
	Capsule	
	Caryopsis	
	Seed capsule	Total number of whole capsules or fragments described as containing seed added to the total number of seeds
	Cotyledon	Converted to a minimum number of pulse seeds
	Fruit	Only quantified if whole
	Fruit clusters	Counts as 2 seeds unless specified in report
	Germinated caryopsis	Counts if whole or if embryo end present
	Germinated seed	Counts if whole or if embryo end present
	Immature seed	Counts if whole or if embryo end present
	Internal structure	Only counted if internal structure is intact, do not count if fragmented.
	Internal structure of achene	Only counted if internal structure is intact, not counted if fragmented.
	Kernel	
	Mericarp	
	Nutlet	
	Pappus and seed	
	Pod	Total number of whole pods or fragments described as containing seed added to the total number of seeds
	Seed	
	Seed pod	Total number of whole pods or fragments described as containing seed added to the total number of seeds
	Seed/internal structure	Only counted if internal structure is intact, not counted if fragmented.
	Seedhead	Count as 2 seeds unless specified in report
	Seedhead (seeds counted)	total number of seeds entered
	Siliqua	Total number of whole pods or fragments described as containing seed added to the total number of seeds

Table 3.6. Sites with identifications of *Triticum monococcum/dicoccum* or *Triticum cf monococcum* that were reclassified as *Triticum dicoccum*.

Site	**Publication reference**
Fishers Road West, Port Seton	Haselgrove and McCullagh, 2000
St Mary Abbots Hospital, Kensington	Howe, 1998
Melyd Avenue, Prestatyn	Blockley, 1989
Billingley Drive, Thurnscoe	Neal and Fraser, 2004
Raymoth Lane, Worksop	Palmer Brown and Munford, 2004
Rosebank, A96 Kintore and Blackburn Bypass	Alexander, 2000
Catsgore Roman Village	Leech, 1982
Michelmersh, Hampshire	Mepham and Brown, 2007
Elstow Lower School, Bedfordshire	Carlyle, 2017
Lime Street, Irthlingborough	Chapman, Atkins and Lloyd, 2003
Broad Street, Ely	Cessford, Alexander and Dickens, 2006
Area B1, West Malling by-pass	Ellis, 2009
Stansted Ariport	Cooke, Brown and Phillpotts, 2008
1 Poultry, City of London	Hill and Rowsome, 2011

Table 3.7. Taxa in archaeobotanical reports allocated to the “large legume” category (i.e. potentially cultivated).

Taxon encountered in report
Cultivated legume
Fabaceae (big)
Fabaceae (pea/v. sativa)
Fabaceae >4mm
Large Fabaceae
Large Legume
Lathyrus sativus
Legume (4mm)
Legume >4mm
Lens/Vicia
Pisum sativum/Vicia sativa ssp. *sativa*
Pisum sativum/Vicia sp.
Pisum/Lathyrus
Vicia faba/Pisum sativum
Vicia faba/sativa
Vicia sativa
Vicia sativa (cultivated)
Vicia sativa (small)
Vicia sativa ssp. *nigra*
Vicia sativa ssp. *sativa*
Vicia sativa/Pisum sp.
Vicia sativa/tetrasperma
Vicia sativa/Vicia faba/Pisum sativum
Vicia sp. (large)
Vicia sp./*Pisum sativum*
Vicia villosa/Pisum sativum
Vicia/Lathyrus (4mm)
Vicia/Lathyrus (large)
Vicia/Pisum
Vicia/Pisum >4mm
Vicia/Pisum/Lathyrus
Vicia/Pisum/Lathyrus 5mm

Table 3.8. Wild taxa categorised by the physical properties of their seeds that relate to crop processing stage.

BFH: Big, free, heavy
Aethusa cynapium
Agrostemma githago
Anisantha sterilis
Bromus hordaceus/secalinus
Bromus secalinus
Bromus sp.
Centaurea cyanus
Centaurea nigra
Daucus carota
Fallopia convolvulus
Fumaria officinalis
Galeopsis speciosa
Galeopsis tetrahit
Galium aparine
Lathyrus nissolia
Lathyrus sp. 2-4mm
Lolium temulentum
Ranunculus acris/repens/bulbosus
Rhinanthus minor
Scandix-pecten veneris
Torilis sp.
Veronica hederifolia
Vicia hirsuta
Vicia sativa
Vicia/Lathyrus 2-4mm
BHH: Big, headed, heavy
Raphanus raphanistrum
Sparganium erectum
SFH: Small, free, heavy
Anagallis arvensis
Anthemis arvensis
Anthemis cotula
Aphanes arvensis
Aphanes australis
Atriplex patula
Atriplex prostrata
Brassica rapa/nigra
Bupleurum rotundifolium
Bupleurum tenuissimum
Carex sp.

Cerastium arvense
Cerastium fontanum
Chenopodium album
Chenopodium ficifolium
Chenopodium sp.
Chenopodium/Atriplex
Cladium mariscus
Conium maculatum
Cynosurus cristatus
Danthonia decumbens
Eleocharis palustris
Euphorbia sp.
Festuca/Schedonorus
Galium palustre
Hyoscyamus niger
Isolepis setacea
Lapsana communis
Leucanthemum vulgare
Lithospermum arvense
Lolium perenne
Lolium sp. (not *temulentum*)
Mentha arvensis/aquatica
Montia fontana
Persicaria lapathifolia/maculosa
Persicaria sp.
Phleum pratense
Phleum sp. *pratense/bertolonii*
Plantago lanceolata
Plantago major
Plantago sp.
Poa annua
Poa spp.
Polygonum arenastrum
Polygonum aviculare
Polygonum/Persicaria/Fallopia spp.
Potentilla sp.
Prunella vulgaris
Ranunculus flammula
Ranunculus reptans
Rumex acetosa
Rumex acetosella
Rumex crispus
Rumex obtusifolius
Rumex sp.

Scleranthus cf annuus
Sherardia arvensis
Silene uniflora
Silene vulgaris
Silene sp.
Sinapis arvensis
Solanum nigrum
Spergula arvensis
Stachys sp.
Stellaria graminea/palustris
Stellaria media
Stellaria sp.
Thlaspi arvense
Tripleurospermum inodorum
Tripleurospermum maritimum
Urtica dioica
Urtica urens
Valerianella dentata
Veronica sp.
Vicia tetrasperma
Vicia/Lathyrus <2mm
Viola sp.
SFL: Small, free, light
Cirsium/Carduus
Euphrasia/Odontites
Linum sp.
Odontites vernus
SHH: Small, headed, heavy
Malva sylvestris
Medicago lupulina
Papaver somniferum
Papaver spp.

Table 4.1. Taxon codes used in correspondence analyses of crop content of site-phase presence data.

Abbreviation (as seen on species plots)	**Taxon**
DIC	Emmer
SPL	Spelt
FTW	Free-threshing wheat
SEC	Rye
HOR	Barley
AV	Oat
PIS	Pea
VFAB	Bean
LENS	Lentil
LIN	Flax

Table 4.2. Instances of finds of free-threshing wheat rachis fragments identifiable as either tetraploid or hexaploid type. Finds categorised by site-phase type (urban, rural, or other).

		Instances of presence:		
Period	**Free-threshing wheat**	**Urban site-phase**	**Rural site-phase**	**Other site-phases**
Romano-British	tetraploid	1	0	1
	hexaploid	6	20	3
Saxon	tetraploid	1	15	0
	hexaploid	7	35	1
Medieval	tetraploid	25	31	0
	hexaploid	56	56	0

Table 4.3. Percentages of Romano-British urban site-phases with emmer presence in each temporal sub-period.

	London	**Major towns**	**Minor towns**
ERB	31%, n=13	38%, n=6	39%, n=23
MRB	9%, n=11	22% n=9	34%, n=47
LRB	10%, n=10	17 %, n=12	33%, n=27

Chapter 5

Table 5.1. Samples classified as winnowing by-products categorised by (a) temporal period, (b) climatic zone, (c) urban or rural, (d) urban sites categorised by town type, (e) secular elite site type, and (f) other period-specific site types.

a

Romano-British				**Saxon**			**Medieval**			**TOTAL**
Early	Mid	Late	**TOTAL**	Early-mid	Late	**TOTAL**	High	Late	**TOTAL**	
2	0	6	**8**	1	1	**2**	10	2	**12**	**22**

b

	Romano-British	**Saxon**	**Medieval**
North-east England and eastern Scotland	0	0	0
East central and southern	2	1	1
West central and southern	2	1	11
Wales and south-west	4	0	0
Coastal north-west	0	0	0
North-west	0	0	0

c

	Romano-British				**Saxon**			**Medieval**		
	Early	Mid	Late	**TOTAL**	Early-mid	Late	**TOTAL**	High	Late	**TOTAL**
Urban	0	0	1	**1**	0	0	**0**	1	1	**2**
Rural	2	0	5	**7**	1	1	**2**	9	1	**10**

d

	Romano-British	**Saxon**	**Medieval**
London	0	0	0
Large towns	0	0	1
Small towns	1	0	1

e

	Romano-British	**Saxon**	**Medieval**
Urban			
Secular elite	0	0	0
Secular non-elite	1	0	2
Rural			
Secular elite	0	1	0
Secular non-elite	7	1	9

f

	Romano-British	**Saxon**	**Medieval**
Forts	0	n/a	n/a
Vici	0	n/a	n/a
Former *vici*	0	n/a	n/a
Religious institutions (Christian)	n/a	0	0

Table 5.2. Samples classified as fine sieve products categorised by (a) temporal period, (b) climatic zone, (c) urban or rural, (d) urban sites categorised by town type, (e) secular elite site type, and (f) other period-specific site types.

a

Romano-British				**Saxon**			**Medieval**			**TOTAL**
Early	Mid	Late	**TOTAL**	Early-mid	Late	**TOTAL**	High	Late	**TOTAL**	
39	36	29	**108**	20	36	**56**	52	6	**58**	**222**

b

	Romano-British	**Saxon**	**Medieval**
North-east England and eastern Scotland	3	0	2
East central and southern	54	34	34
West central and southern	38	21	22
Wales and south-west	4	1	0
Coastal north-west	0	0	0
North-west	9	0	0

c

	Romano-British				**Saxon**			**Medieval**		
	Early	Mid	Late	**TOTAL**	Early-mid	Late	**TOTAL**	High	Late	**TOTAL**
Urban	28	13	7	**48**	4	12	**16**	26	5	**31**
Rural	9	21	19	**52**	16	24	**40**	26	1	**27**

d

	Romano-British	**Saxon**	**Medieval**
London	6	6	5
Large towns	7	5	25
Small towns	35	5	1

e

	Romano-British	**Saxon**	**Medieval**
Urban			
Secular elite	0	0	9
Secular non-elite	48	16	20
Rural			
Secular elite	45	38	6
Secular non-elite	7	0	21

f

	Romano-British	**Saxon**	**Medieval**
Forts	5	n/a	n/a
Vici	16	n/a	n/a
Former *vici*	7	n/a	n/a
Religious institutions (Christian)	n/a	1	2

Table 5.3. Samples classified as fine sieve by-products categorised by (a) temporal period, (b) climatic zone, (c) urban or rural, (d) urban sites categorised by town type, (e) secular elite site type, and (f) other period-specific site types.

a

Romano-British				**Saxon**			**Medieval**			**TOTAL**
Early	Mid	Late	**TOTAL**	Early-mid	Late	**TOTAL**	High	Late	**TOTAL**	
200	200	226	**687**	198	201	**399**	416	172	**603**	**1689**

b

	Romano-British	**Saxon**	**Medieval**
North-east England and eastern Scotland	61	2	64
East central and southern	385	260	365
West central and southern	212	119	159
Wales and south-west	17	16	12
Coastal north-west	2	2	0
North-west	10	0	3

c

	Romano-British				**Saxon**			**Medieval**		
	Early	Mid	Late	**TOTAL**	Early-mid	Late	**TOTAL**	High	Late	**TOTAL**
Urban	46	50	42	**139**	35	92	**127**	140	42	**187**
Rural	98	119	145	**410**	160	107	**267**	276	130	**416**

d

	Romano-British	**Saxon**	**Medieval**
London	7	57	7
Large towns	15	26	78
Small towns	117	44	102

e

	Romano-British	**Saxon**	**Medieval**
Urban			
Secular elite	0	0	18
Secular non-elite	139	127	139
Rural			
Secular elite	73	11	126
Secular non-elite	337	250	259

f

	Romano-British	**Saxon**	**Medieval**
Forts	14	n/a	n/a
Vici	2	n/a	n/a
Former *vici*	21	n/a	n/a
Religious institutions (Christian)	n/a	8	37

Table 5.4. Taxon and plant part codes used in correspondence analyses of cereal content of fine sieve by-product samples (N.B. the chaff of glume wheats is represented by glume bases, and the chaff of free-threshing cereals by rachis internodes).

Abbreviation (as seen on species plots)	**Taxon and plant part**
DICG	Emmer grain
DICC	Emmer chaff
SPLG	Spelt grain
SPLC	Spelt chaff
FTWG	Free-threshing wheat grain
FTWC	Free-threshing wheat chaff
SECG	Rye grain
SECC	Rye chaff
HORG	Barley grain
HORC	Barley chaff
AVG	Oat grain

Figures

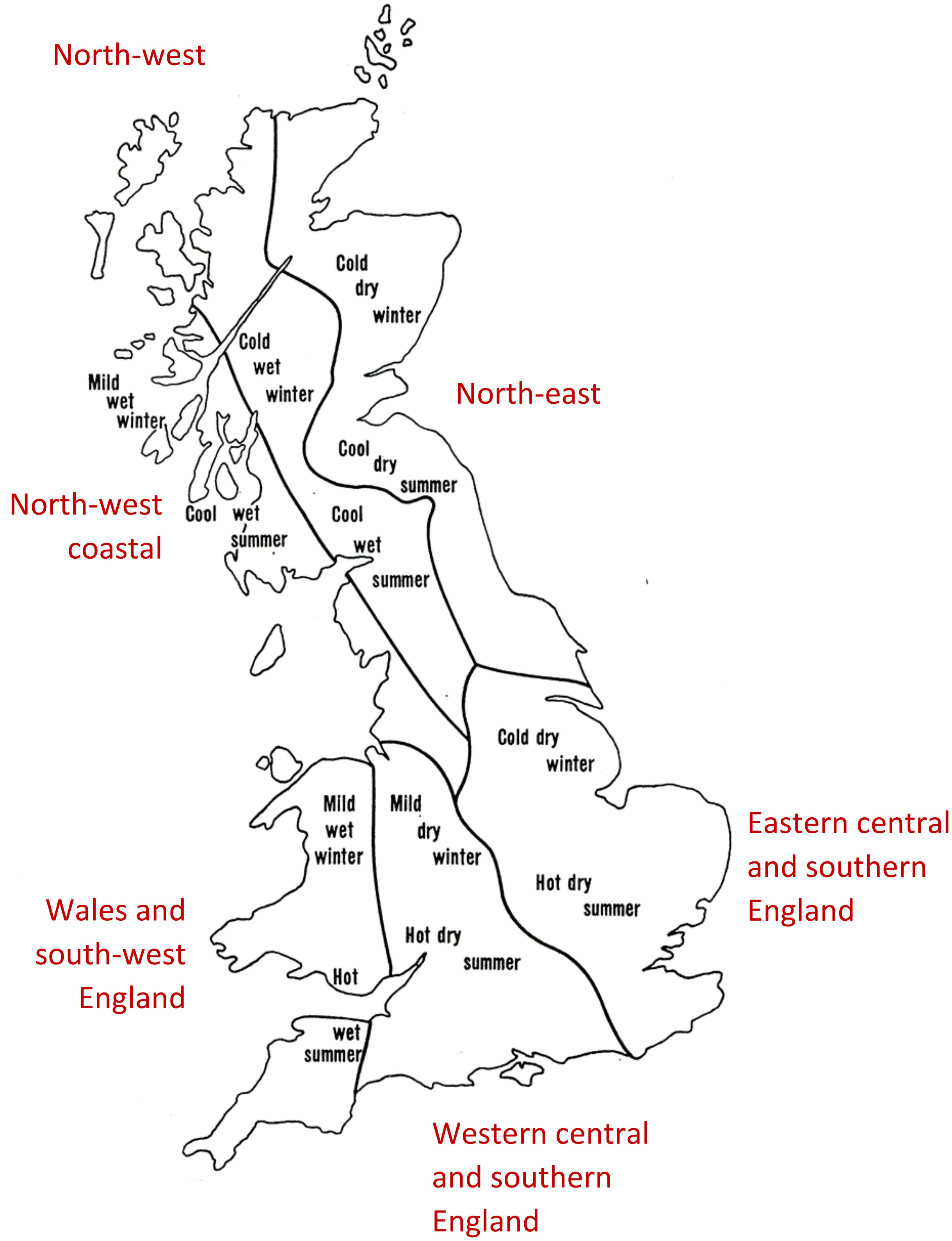


Figure 3.1. Climatic zones of Britain (adapted from Shirlaw, 1966, p.21)

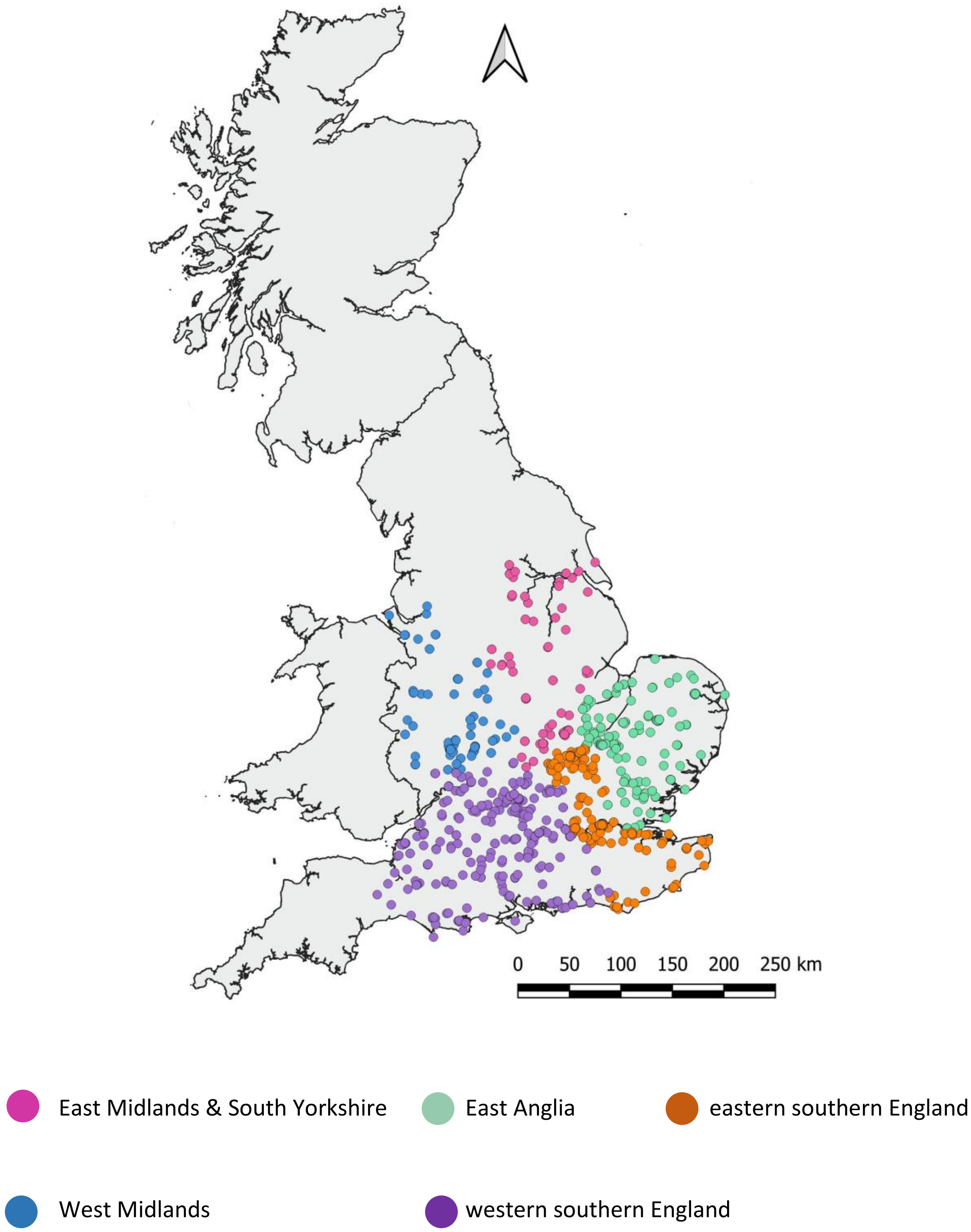


Figure 3.2. Subdivisions of central and southern climatic zones.

Chapter 4

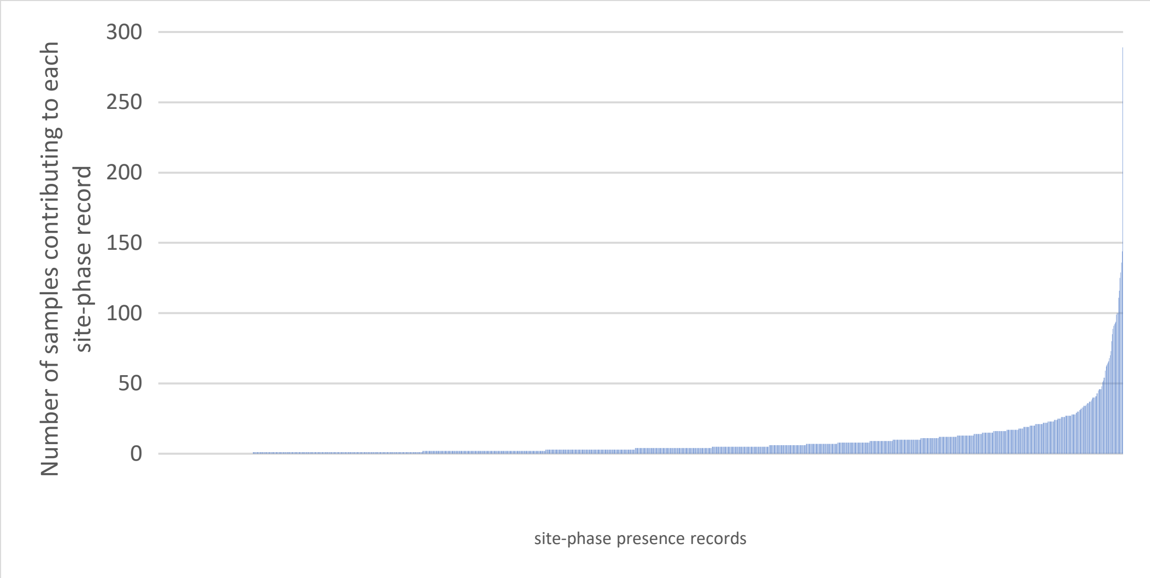


Figure 4.1. Histogram showing the number of samples contributing to the crop data for each site-phase record, in order of increasing number of samples.

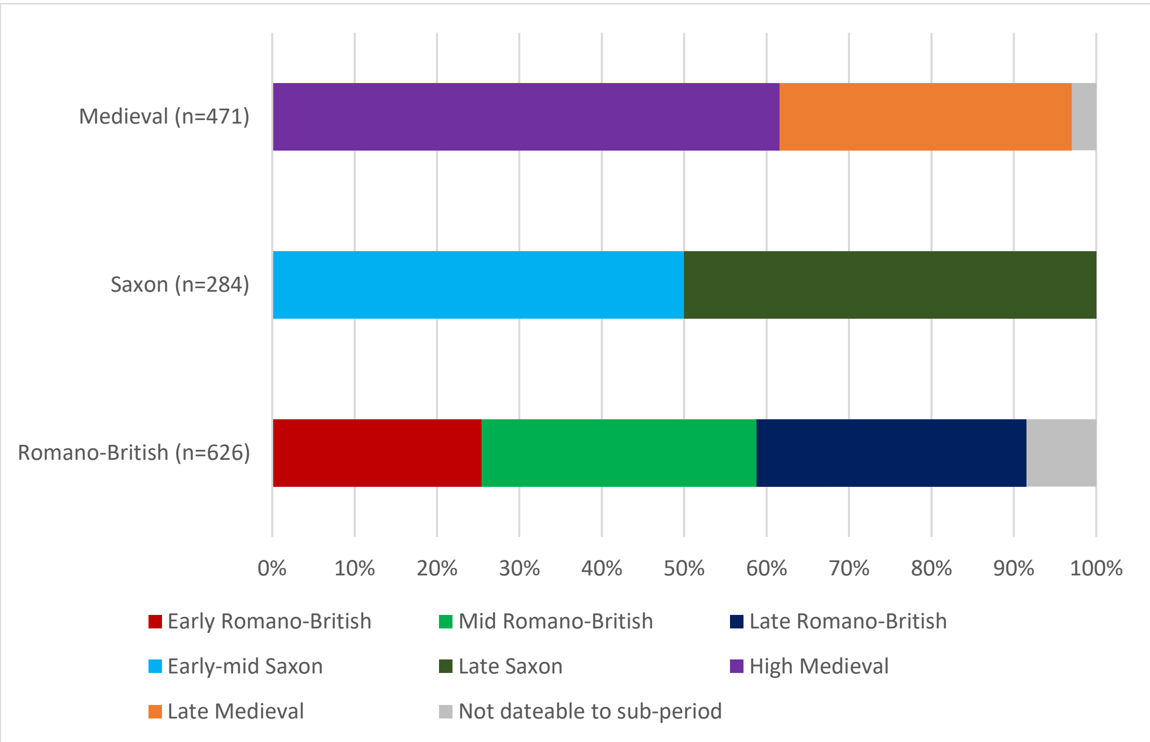


Figure 4.2. Bar chart showing the classification of site-phase crop records according to temporal period and sub-period.

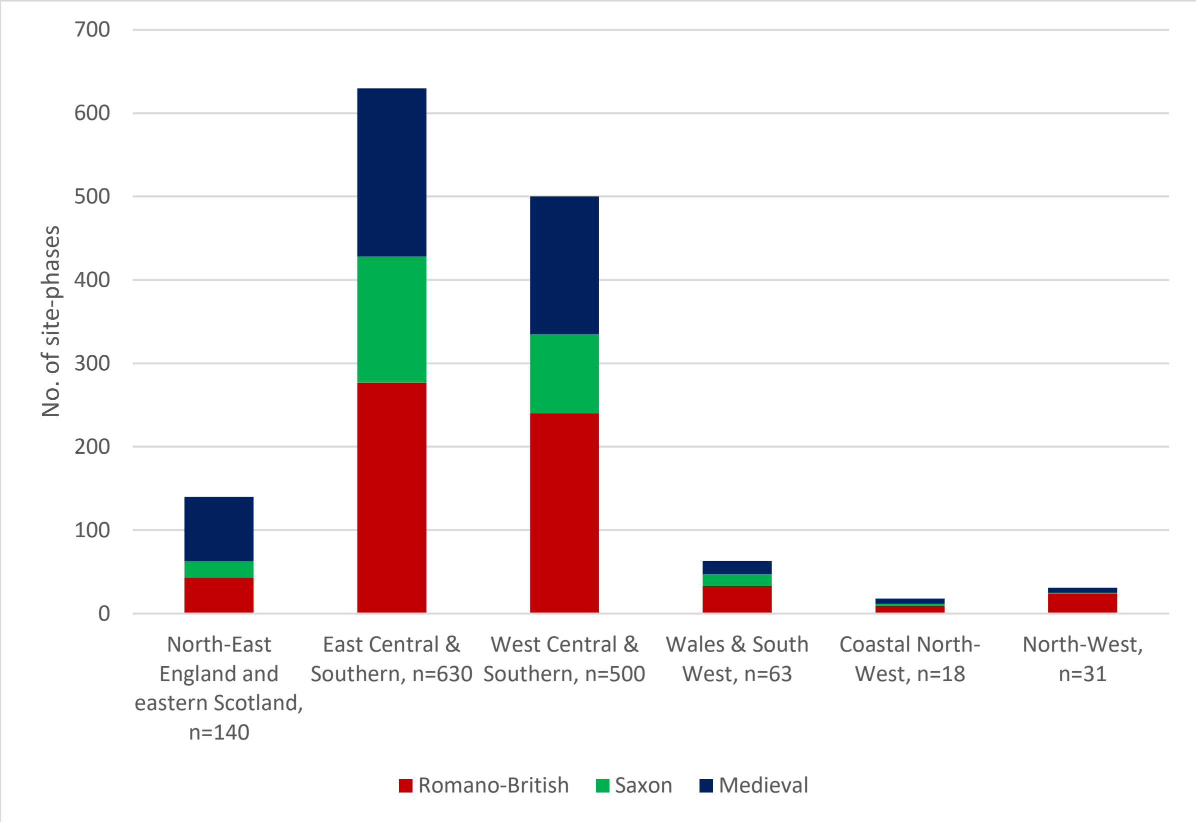
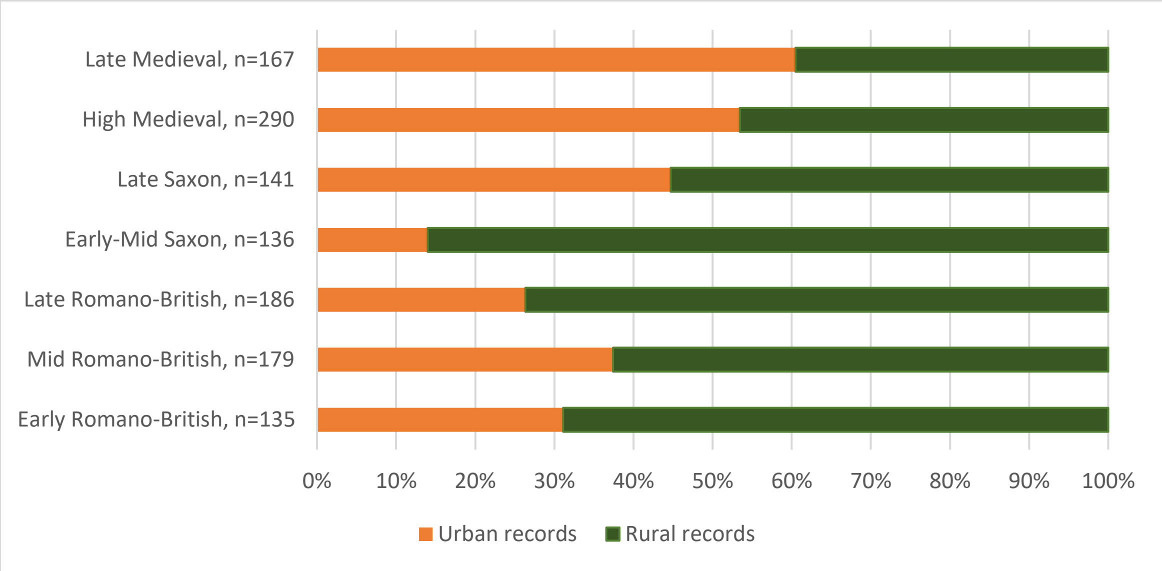


Figure 4.3. Bar chart showing the classification of site-phase crop records according to broad climatic zones (following Shirlaw, 1966, pp. 20–21).

a



b

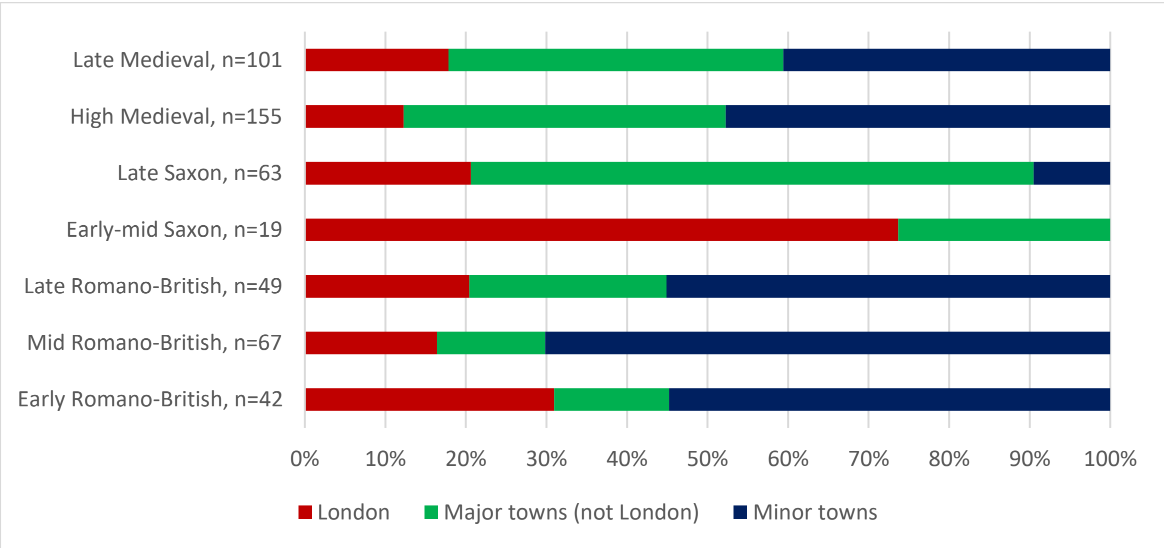


Figure 4.4. Bar chart showing the classification of site-phase crop records according to site type (a) urban or rural location, (b) records from urban sites categorised by town size (see Section 3.3.4.3 for a description of the major and minor town categories).

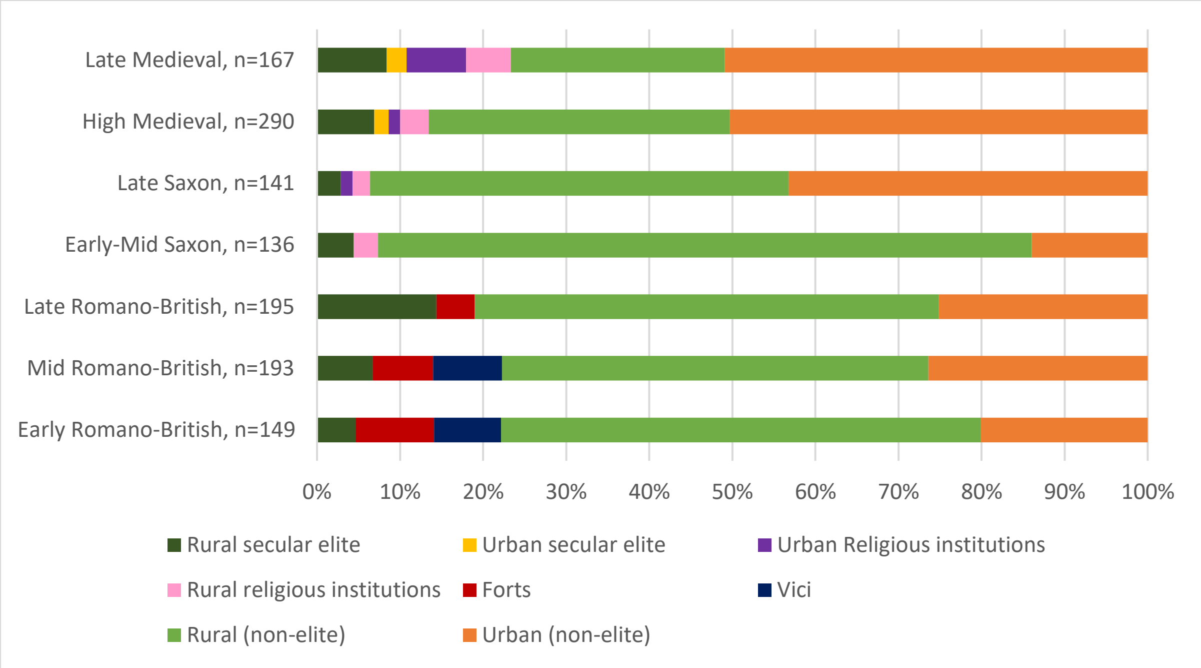


Figure 4.5. Bar chart showing the classification of site-phase crop records according to socio-economic variables (see Section 3.3.4.3 for descriptions of each category).

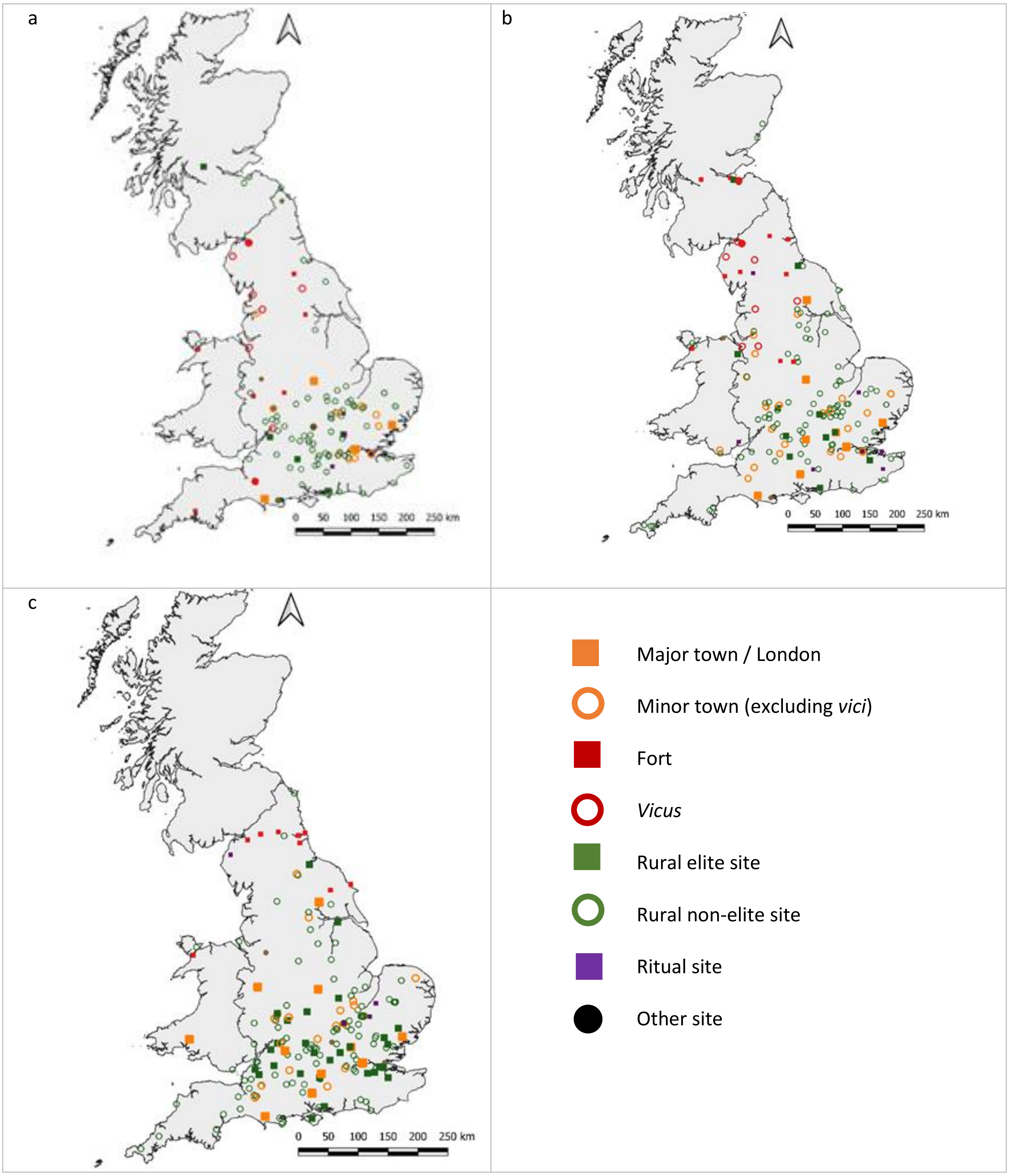


Figure 4.6. Maps of (a) early, (b) mid, and (c) late Romano-British site-phase crop records, coded by site type.

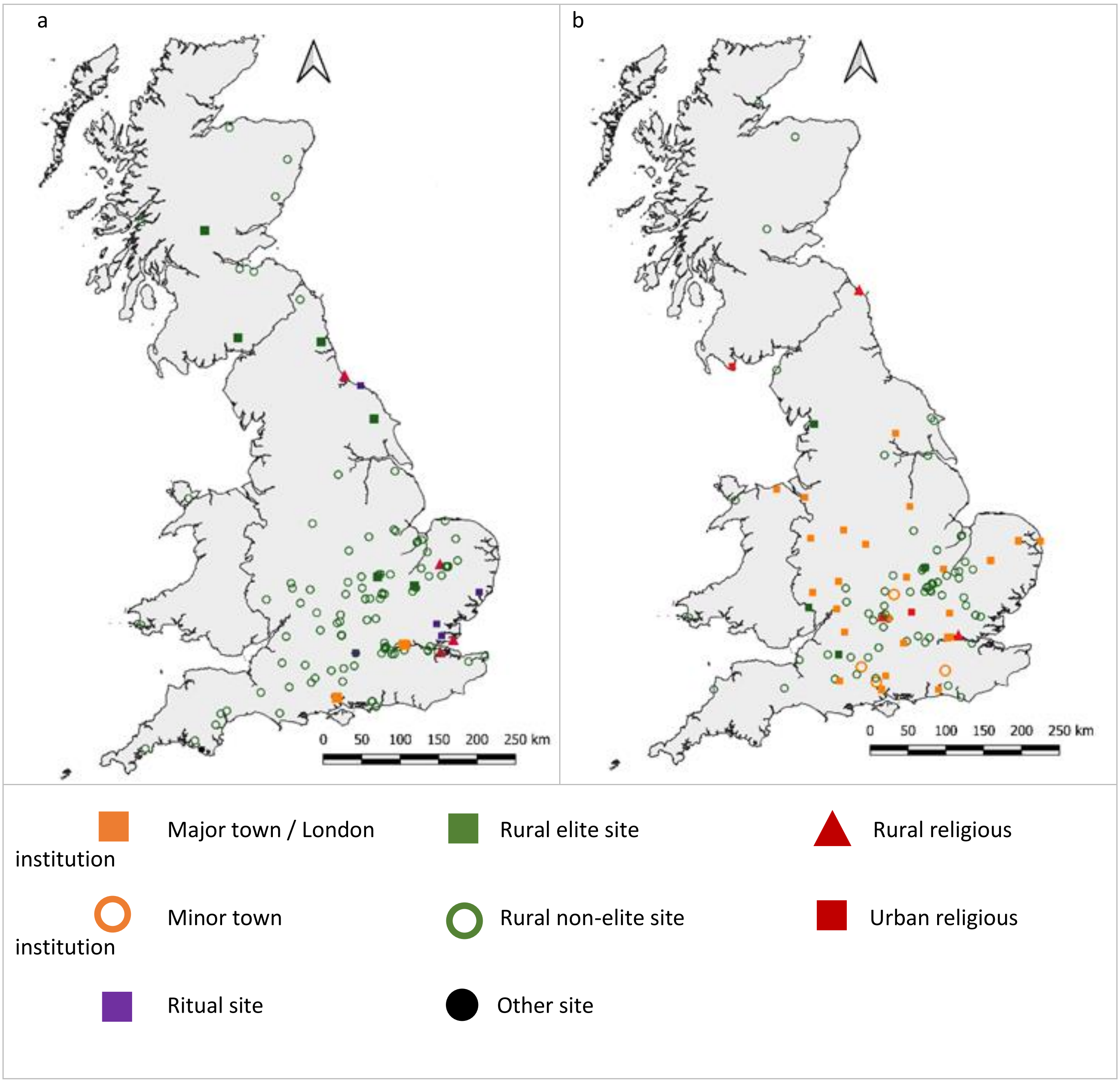


Figure 4.7. Maps of (a) early-mid, and (b) late Saxon site-phase crop records, coded by site type.

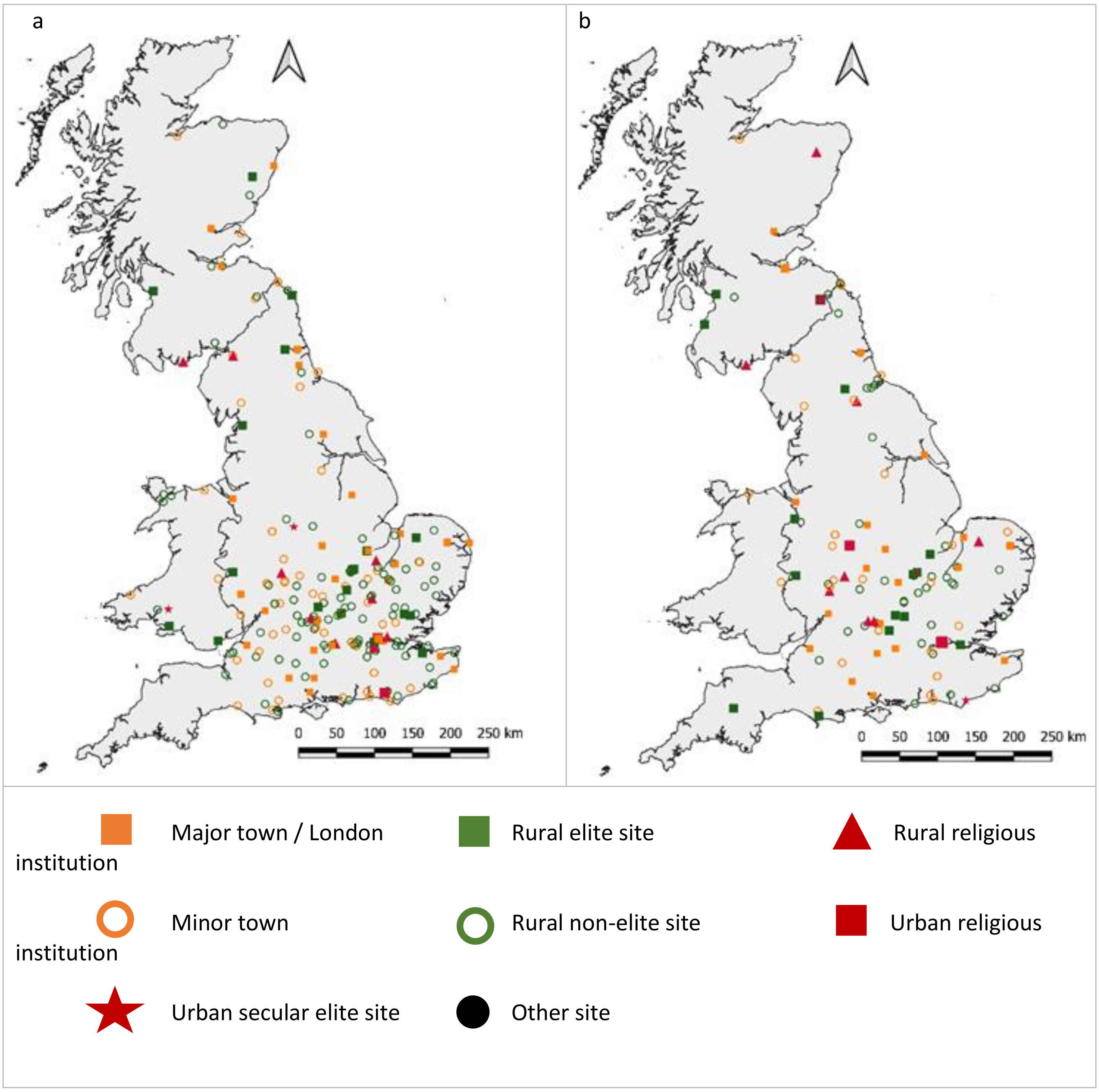


Figure 4.8. Maps of (a) High, and (b) late Medieval site-phase crop records, coded by site type.

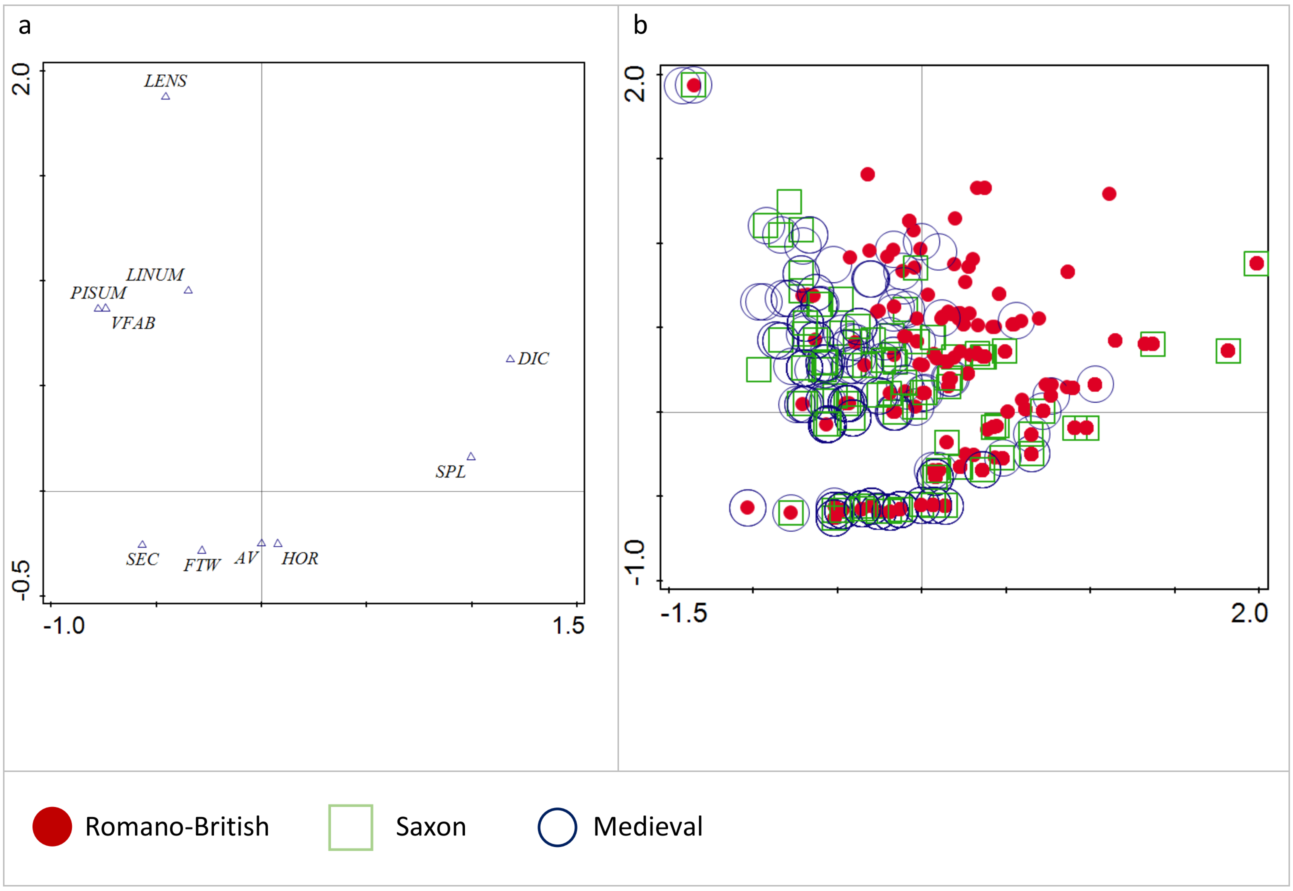


Figure 4.9. Correspondence analysis plots of the whole crop presence dataset (axes 1x2), (a) species plot, (b) site-phase plot coded by broad temporal period. Taxa codes are given in Table 4.1.

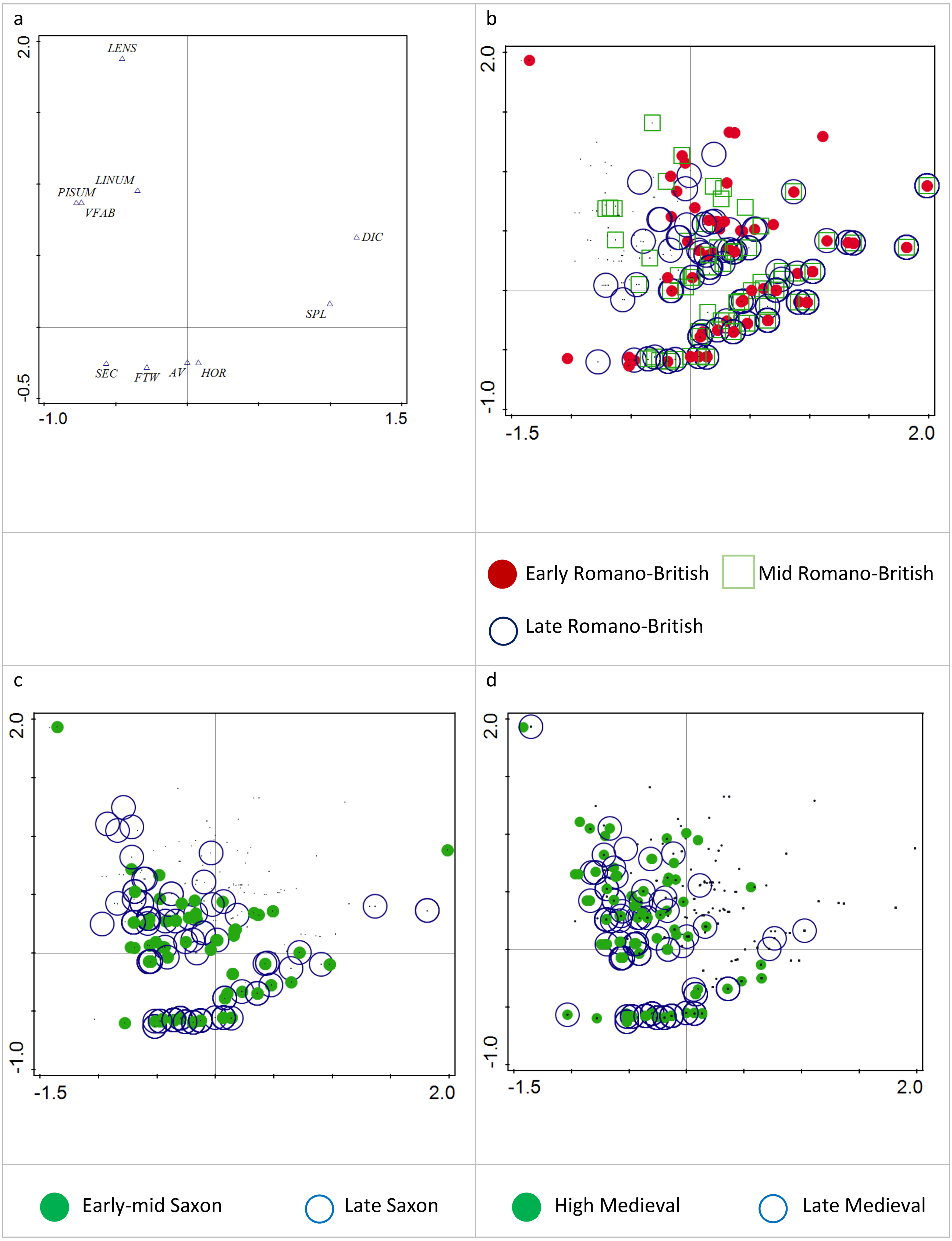


Figure 4.10. Correspondence analysis plots of the whole crop presence dataset (axes 1x2), (a) species plot, (b) site-phase plot with Romano-British records period highlighted, (c) site-phase plot with Saxon records highlighted, (d) site-phase plot with Medieval records highlighted. Site-phase records coded by temporal sub-period; taxa codes are given in Table 4.1.

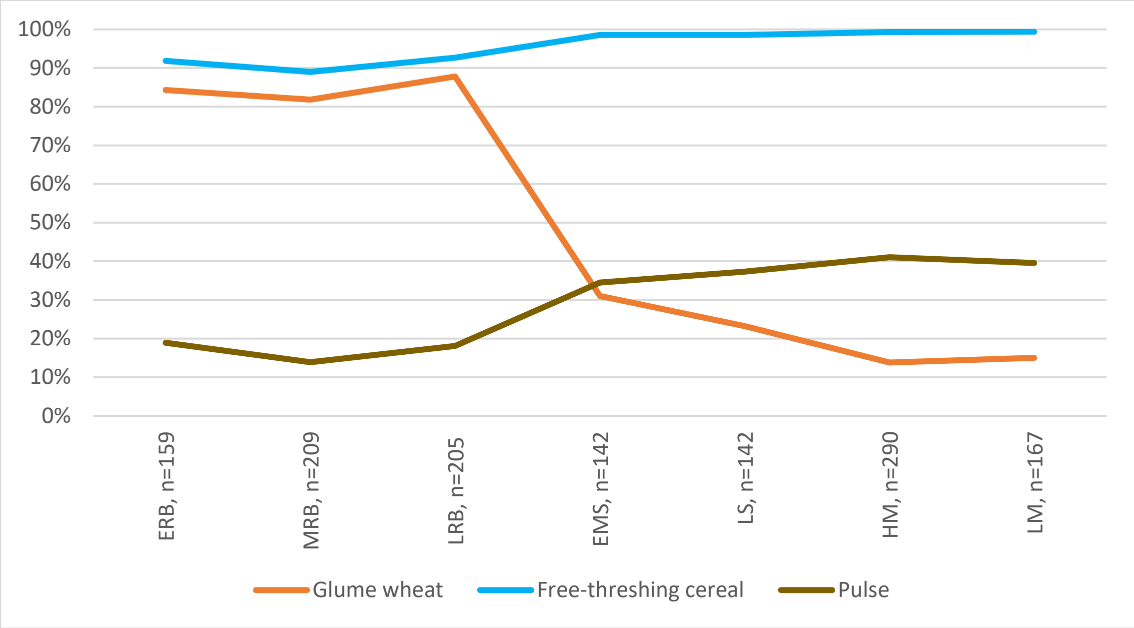
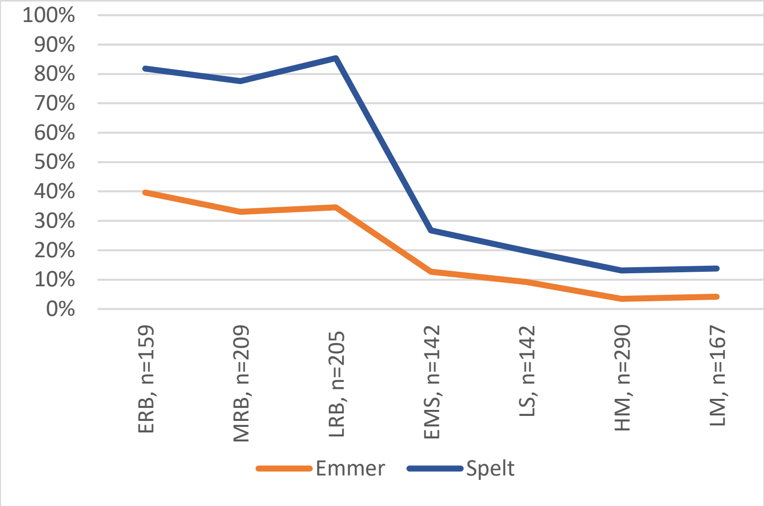
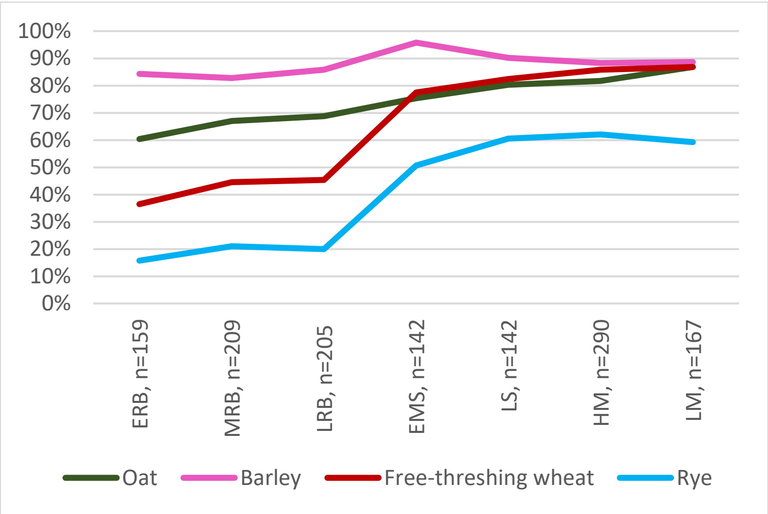


Figure 4.11. Line graph showing the percentage of site-phase presence records in each sub-period for each broad category of crop.

a



b



c

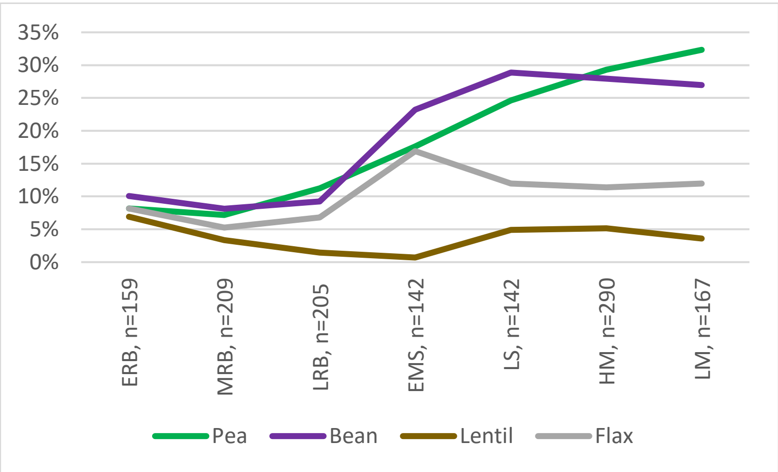
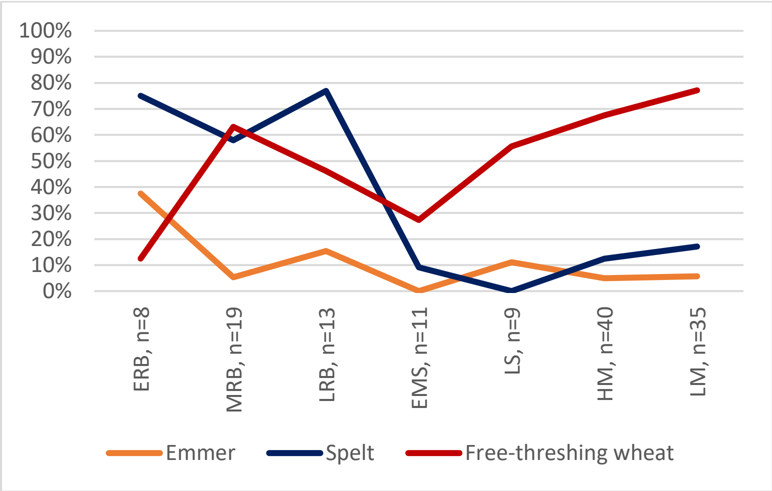
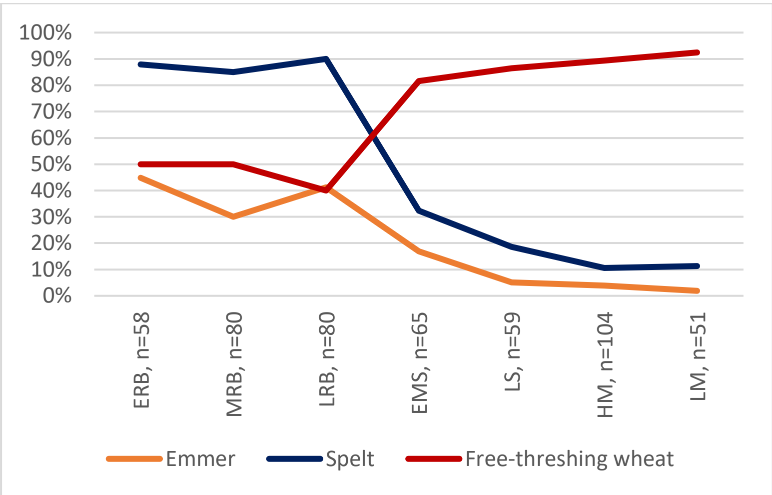


Figure 4.12: Line graphs showing the percentage of site-phase presence records in each sub-period: (a) glume wheats, (b) free threshing cereals, (c) pulses and flax.

a



b



c

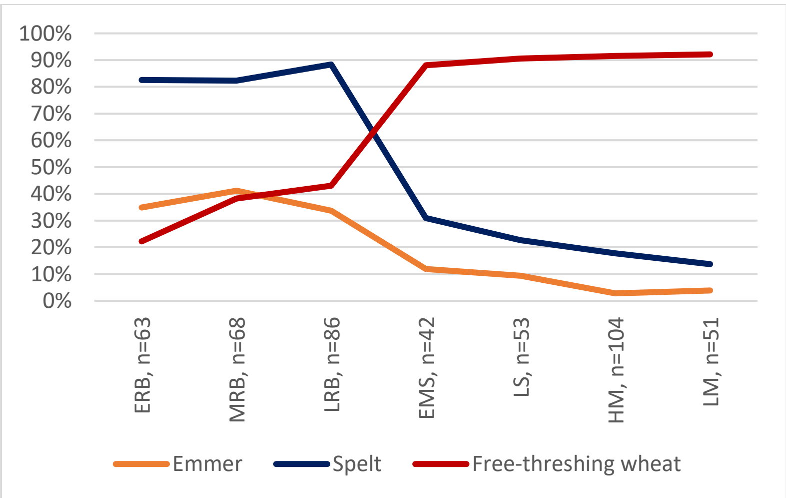
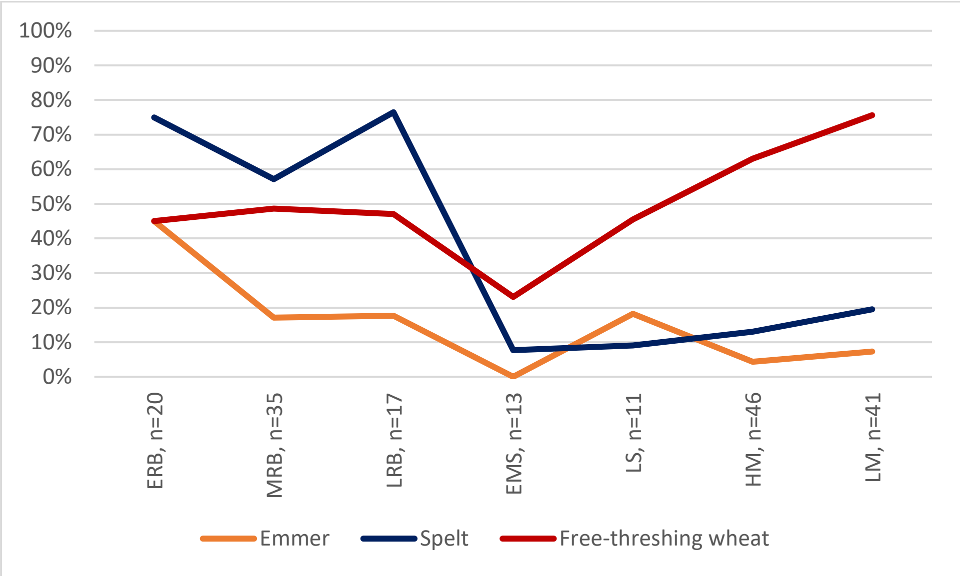


Figure 4.13. Line graphs showing the percentage of site-phase presence records for wheat taxa in each sub-period. Climatic zones based on Shirlaw (1966, pp. 20–21): (a) north-east (n=135), (b) eastern central and south (n=499), (c) western central and south (n=470).

a



b

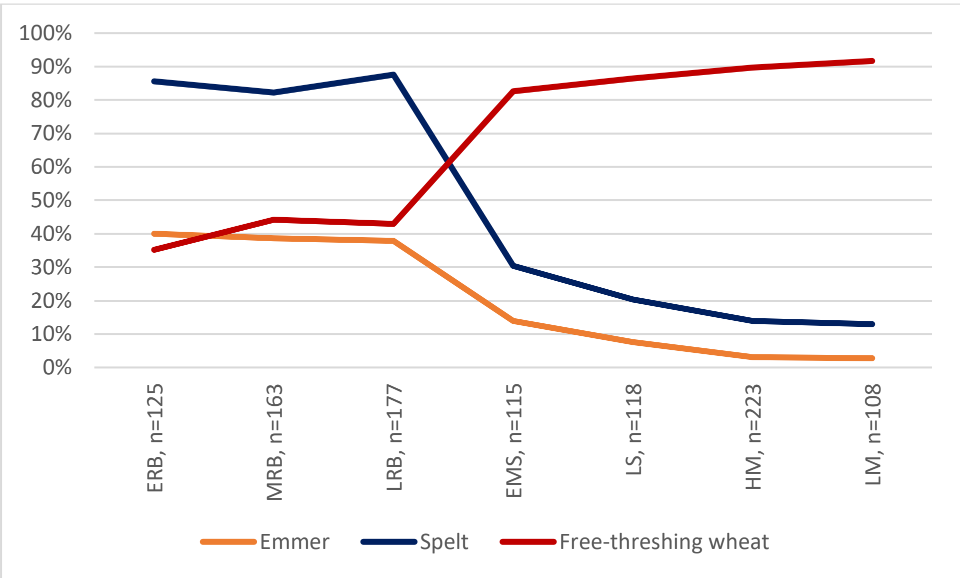
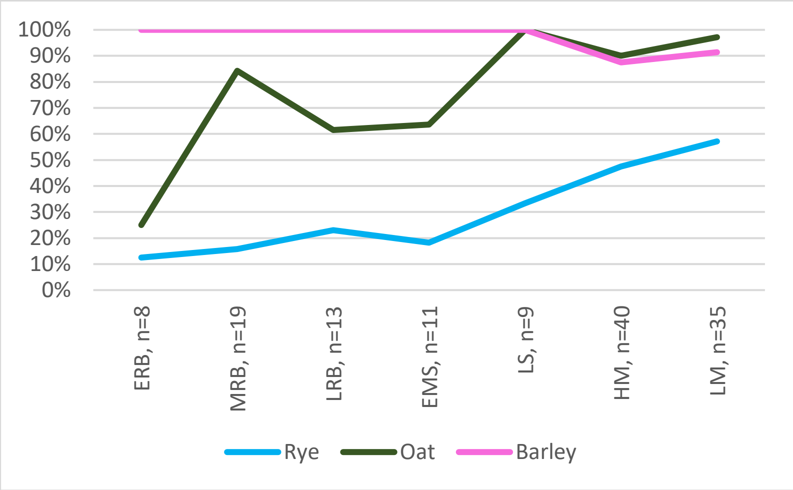
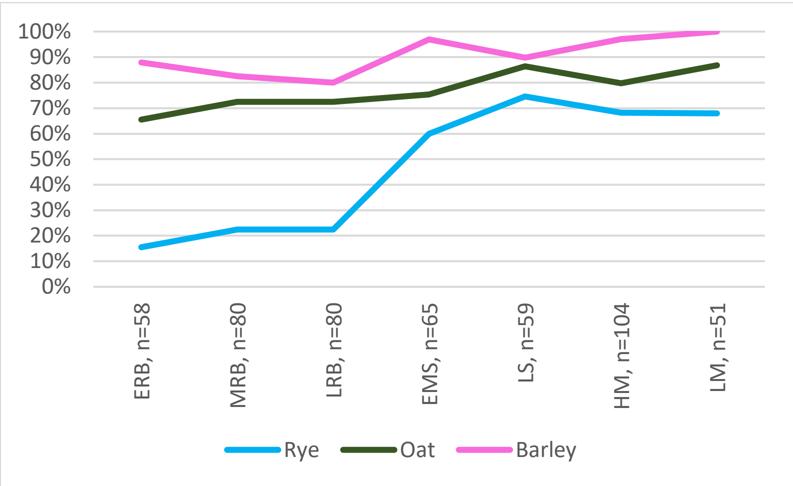


Figure 4.14. Line graphs showing the percentage of site-phase presence records for wheat taxa in each sub-period in the (a) north (n=183), (b) south (n=969).

a



b



c

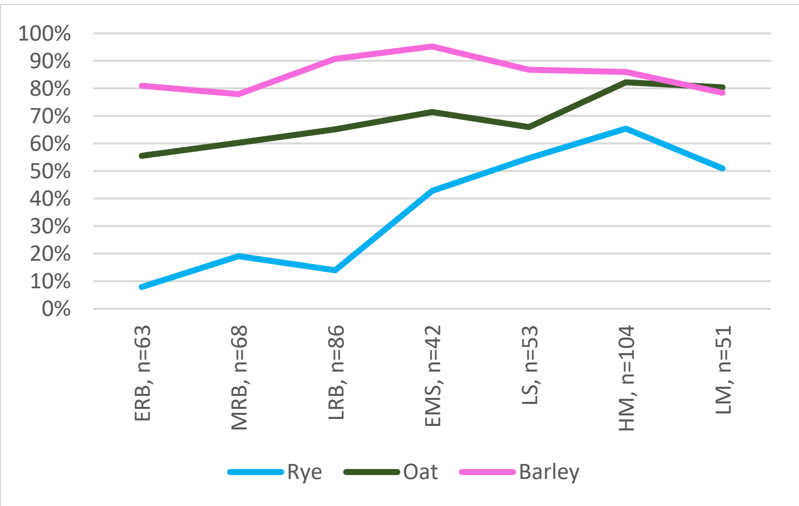
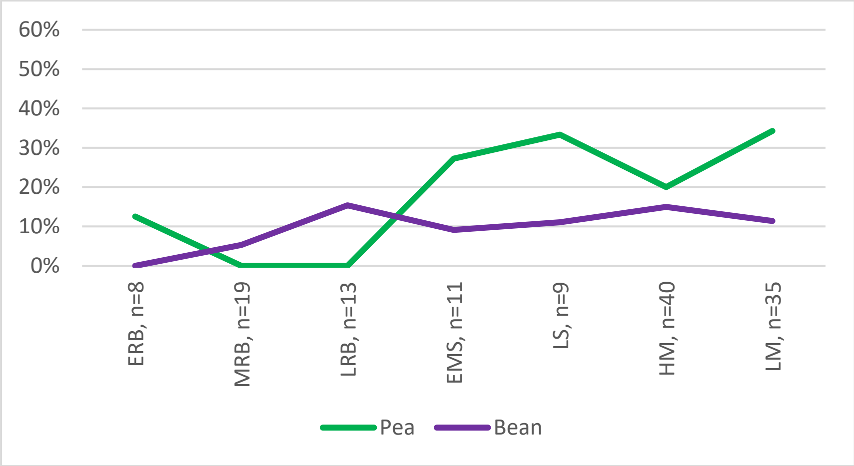
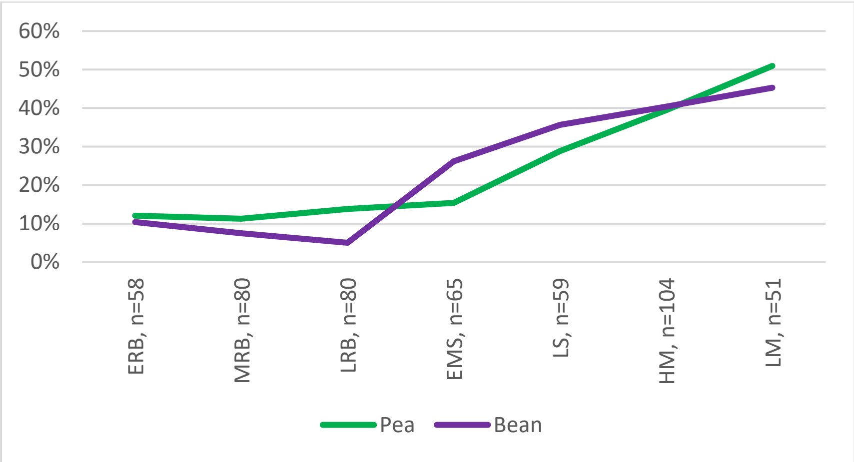


Figure 4.15. Line graphs showing the percentage of site-phase presence records for non-wheat cereal taxa in each sub-period. Climatic zones based on Shirlaw (1966, pp. 20–21): (a) north-east (n=135), (b) eastern central and south (n=499), (c) western central and south (n=470).

a



b



c

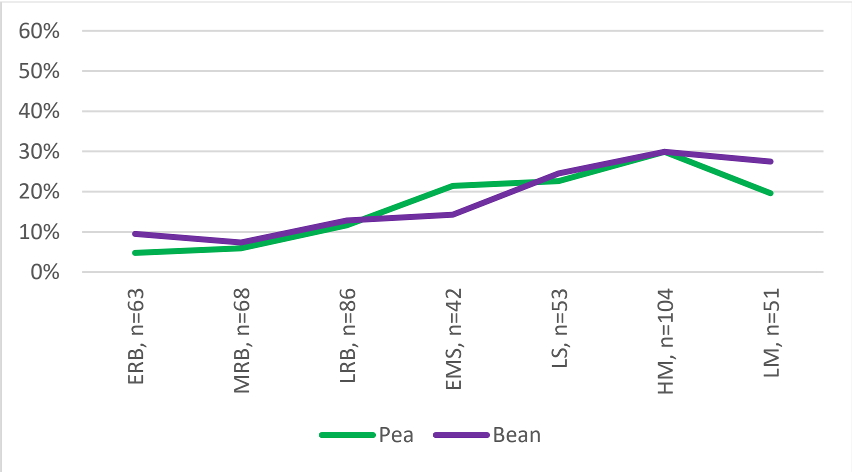
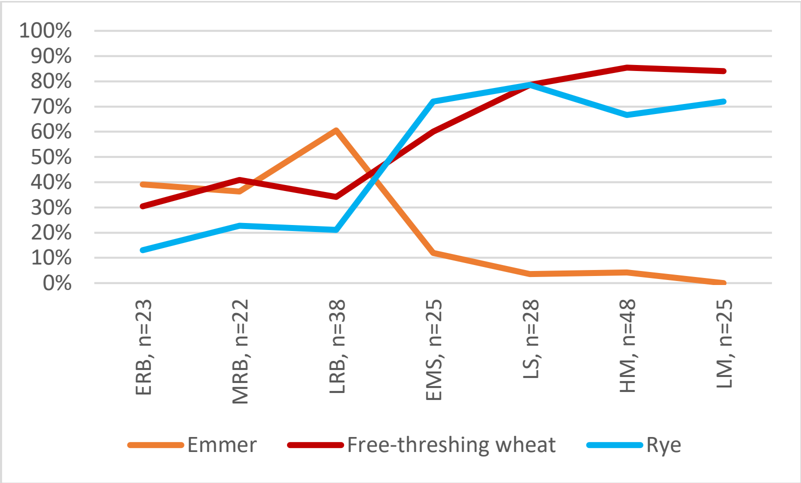
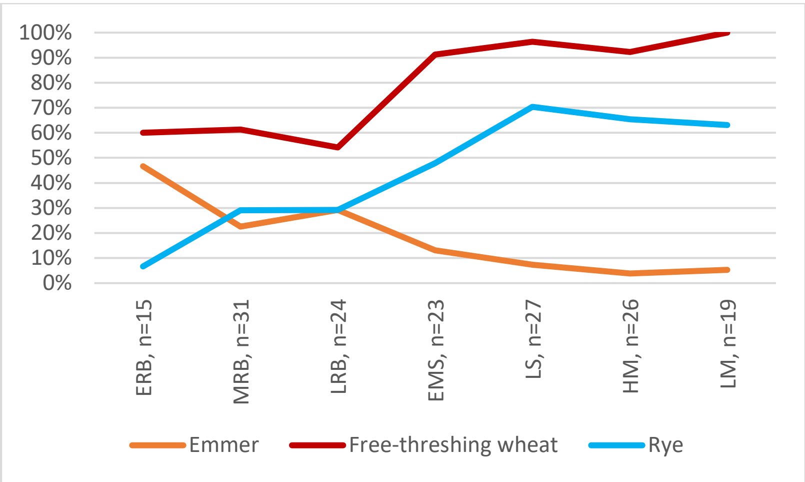


Figure 4.16. Line graphs showing the percentage of site-phase presence records in each sub-period for pea and bean. Climatic zones based on Shirlaw (1966, pp. 20–21): (a) north-east (n=135), (b) eastern central and south (n=499), (c) western central and south (n=470).

a



b



c

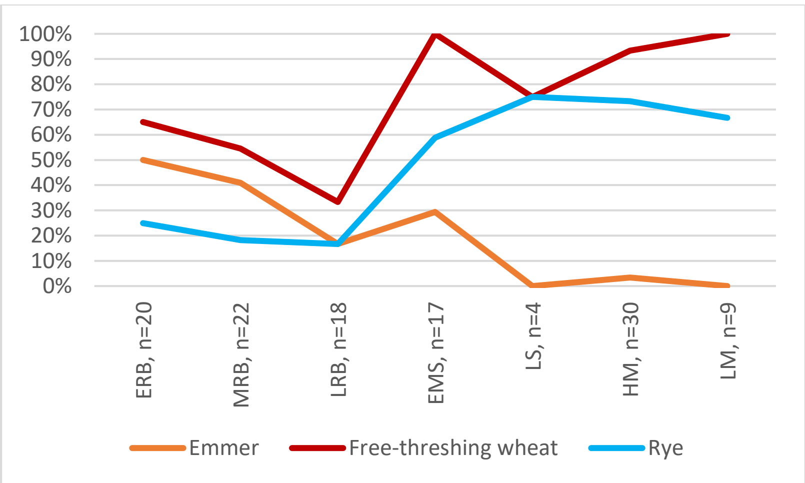
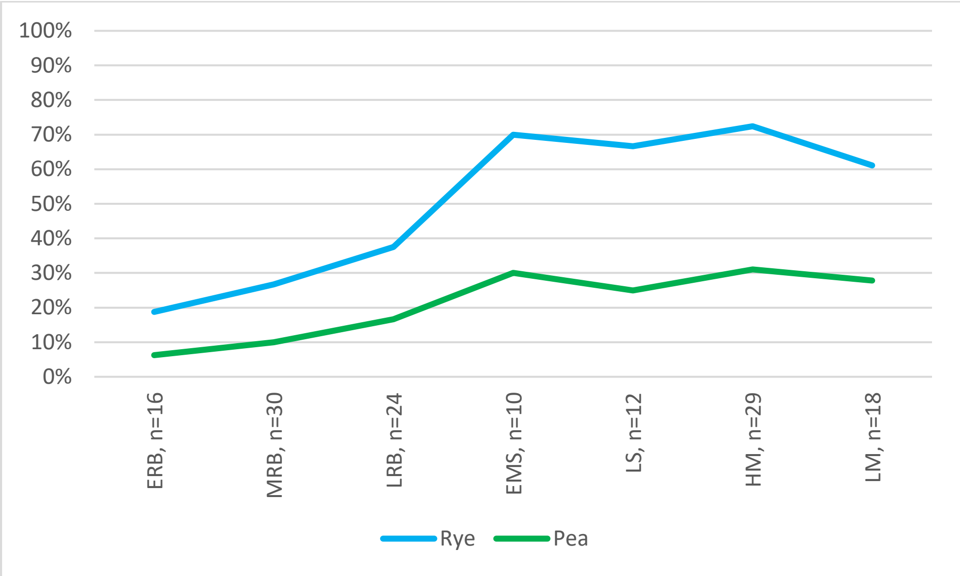


Figure 4.17. Line graphs showing the percentage of site-phase presence records for taxa which exhibit different temporal trends between areas within the eastern central and southern climatic zone (1966, pp. 20–21): (a) East Anglia (n=209), (b) East Midlands (n=165), (c) south-east England (n=120).

a



b

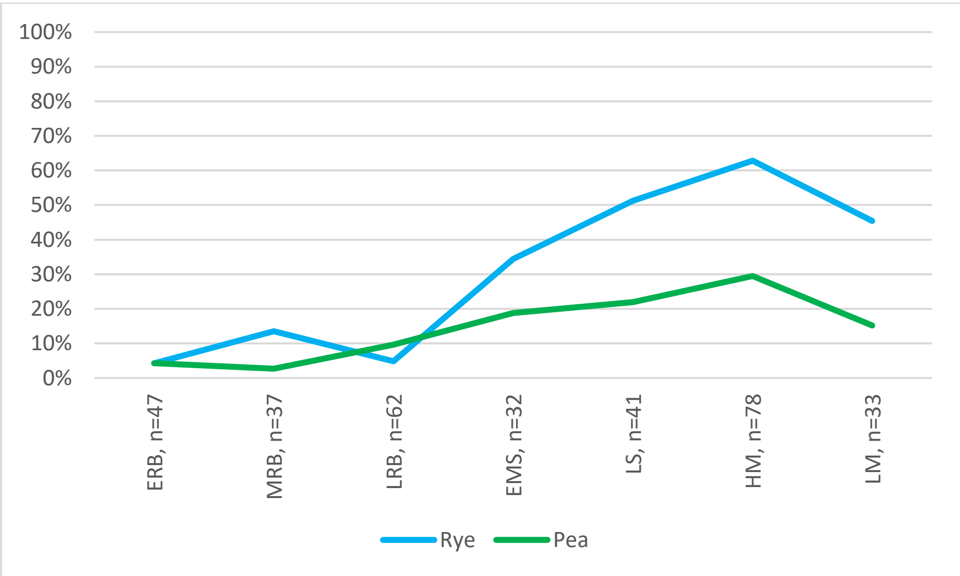


Figure 4.18. Line graphs showing the percentage of site-phase presence records for taxa which exhibit different temporal trends between areas within the western central and southern climatic zone (1966, pp. 20–21): (a) West Midlands (n=139), (b) western southern England (n=330).

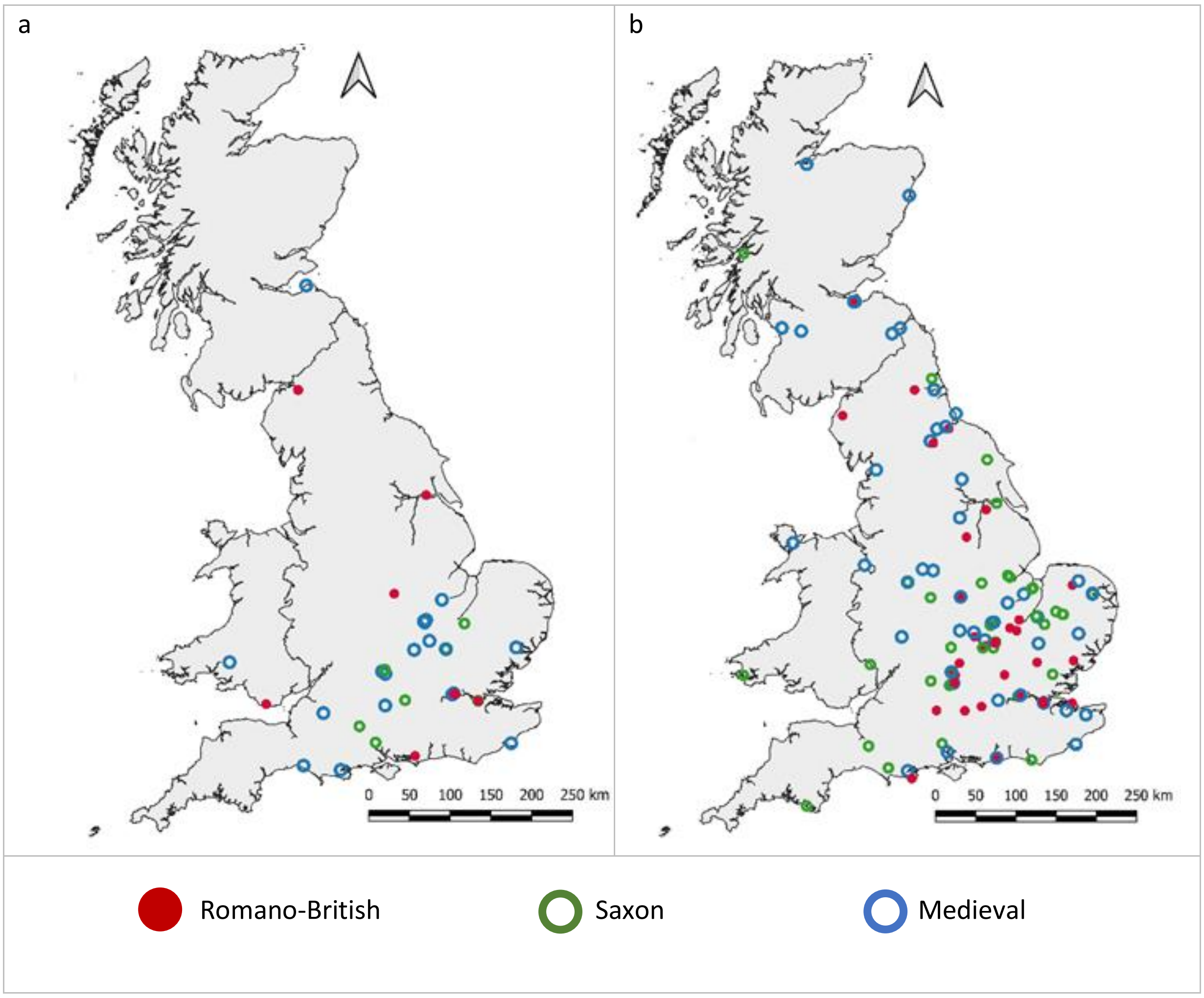


Figure 4.19. Maps of (a) lentil and (b) flax site-phase presence records, coded by broad temporal period.

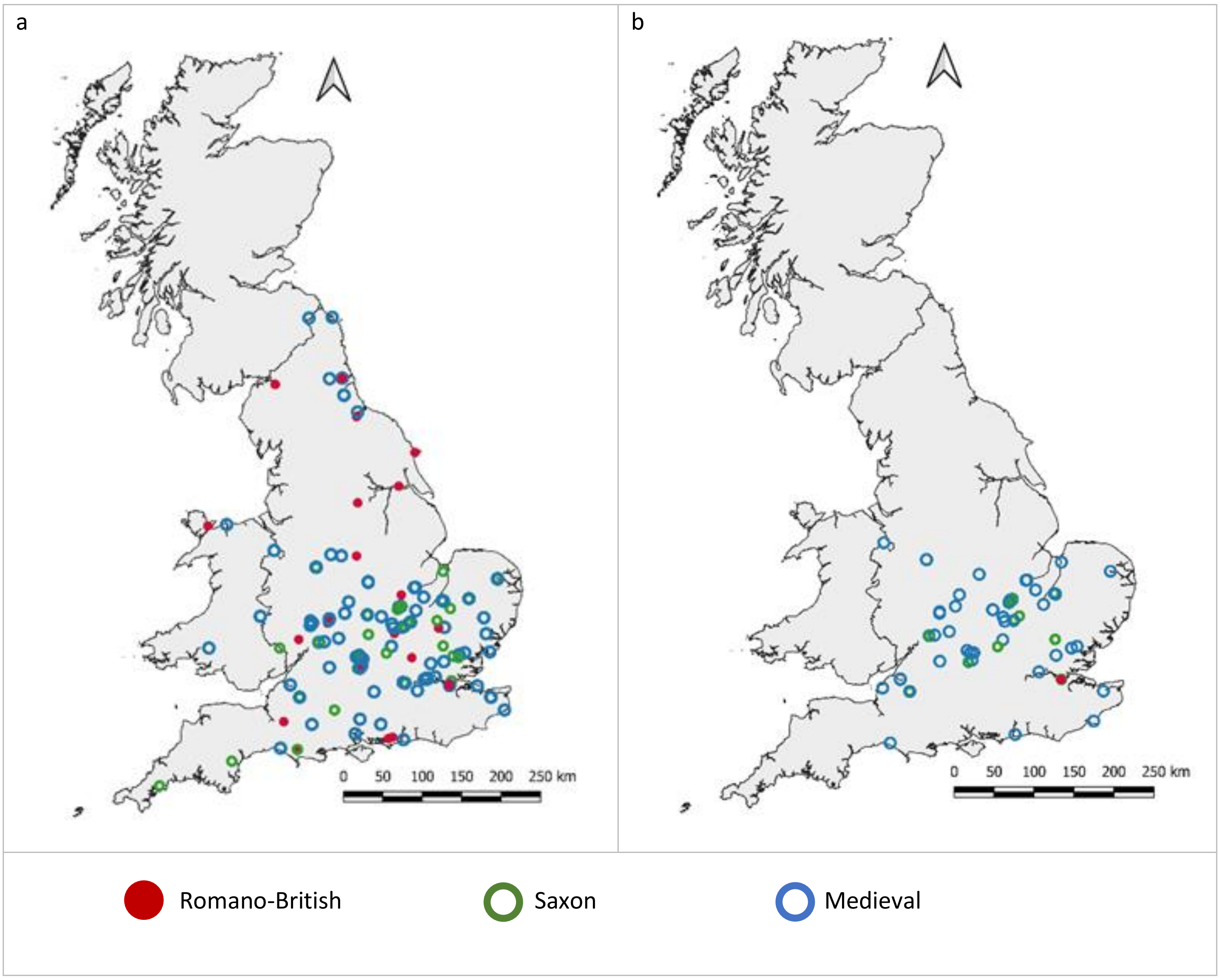


Figure 4.20. Maps of (a) hexaploid, and (b) tetraploid, free-threshing wheat rachis fragment site-phase presence records, coded by broad temporal period.

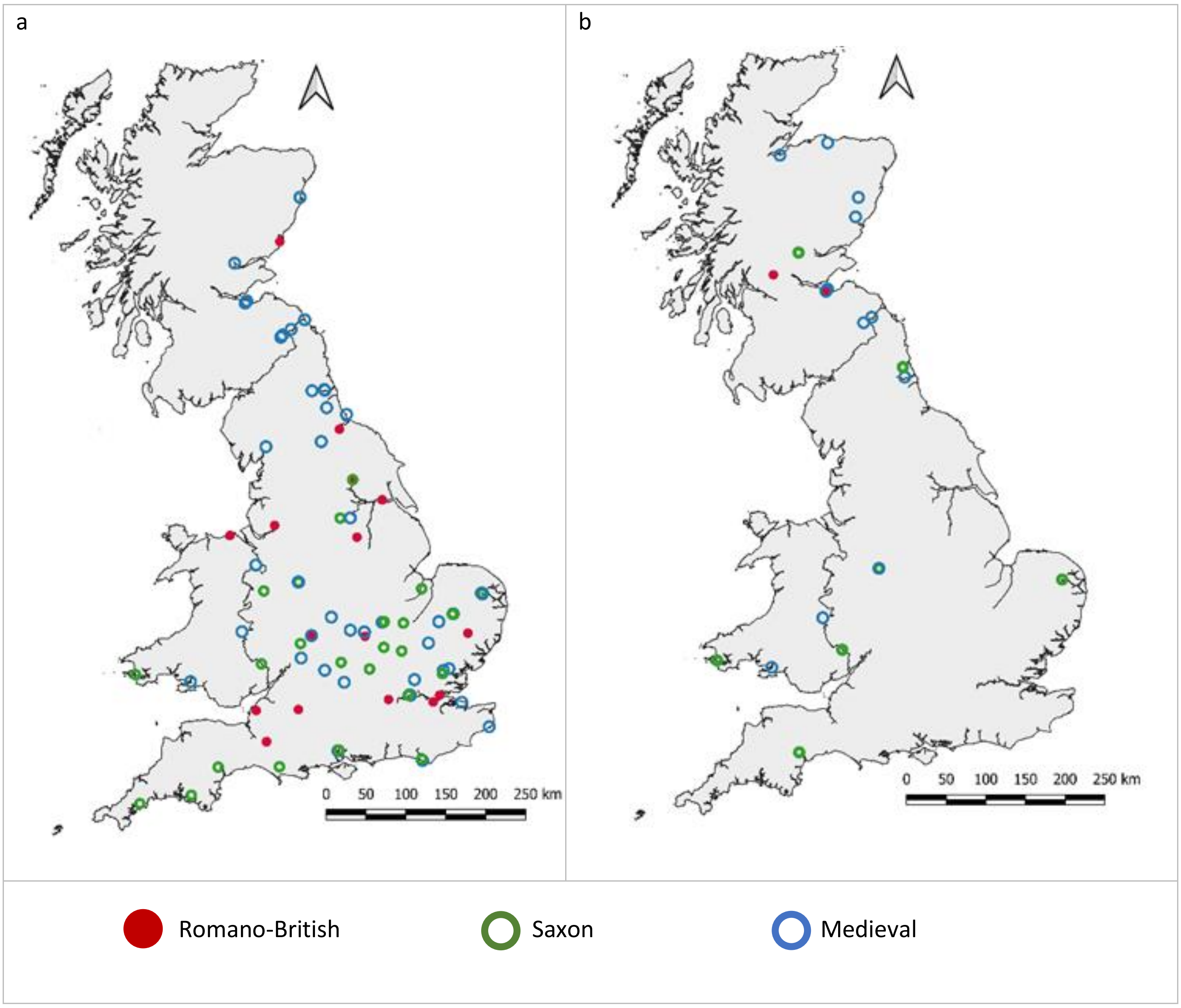


Figure 4.21. Maps of cultivated oat floret base site-phase records, coded by broad temporal period, (a) Common oat, (b) Bristle oat

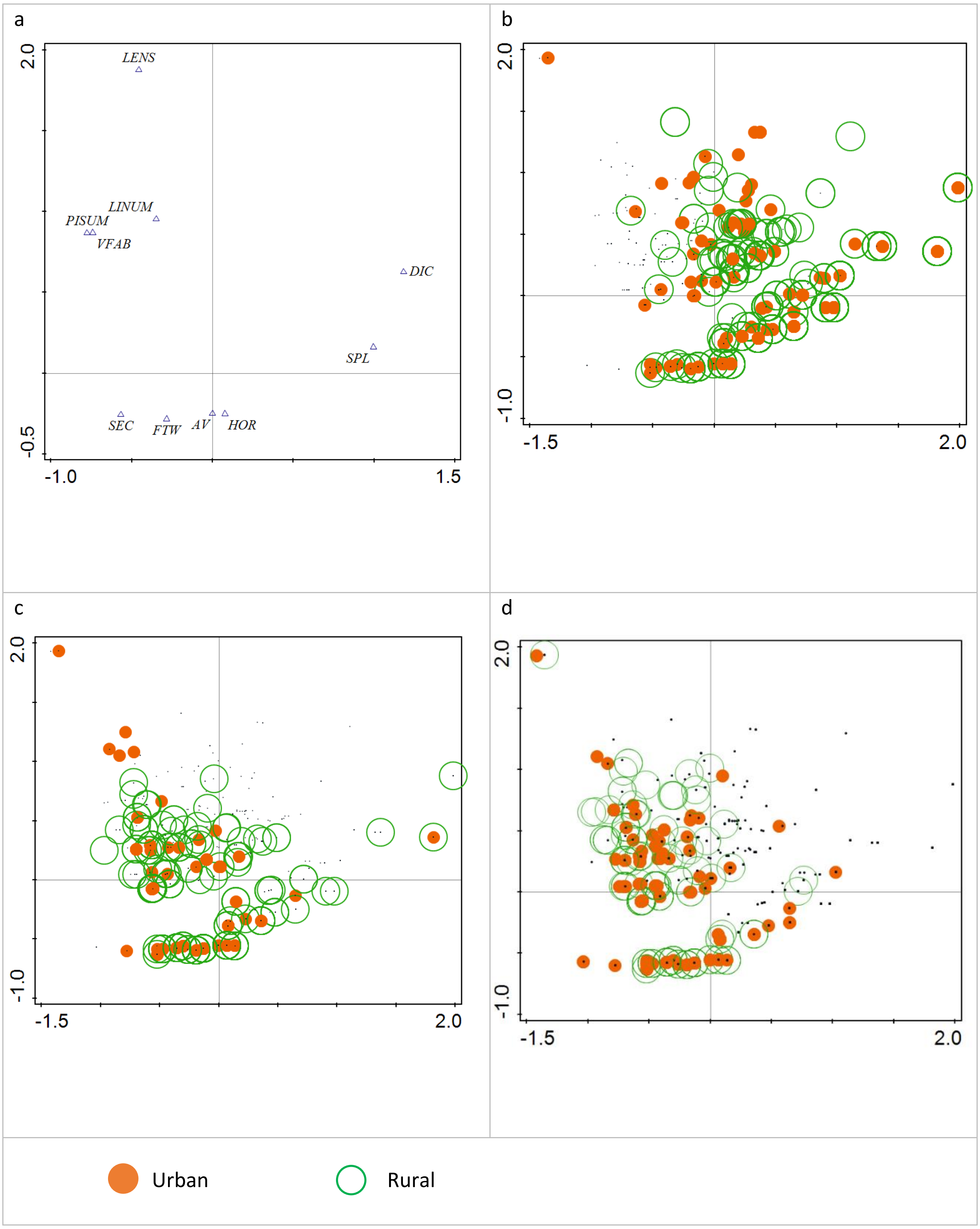
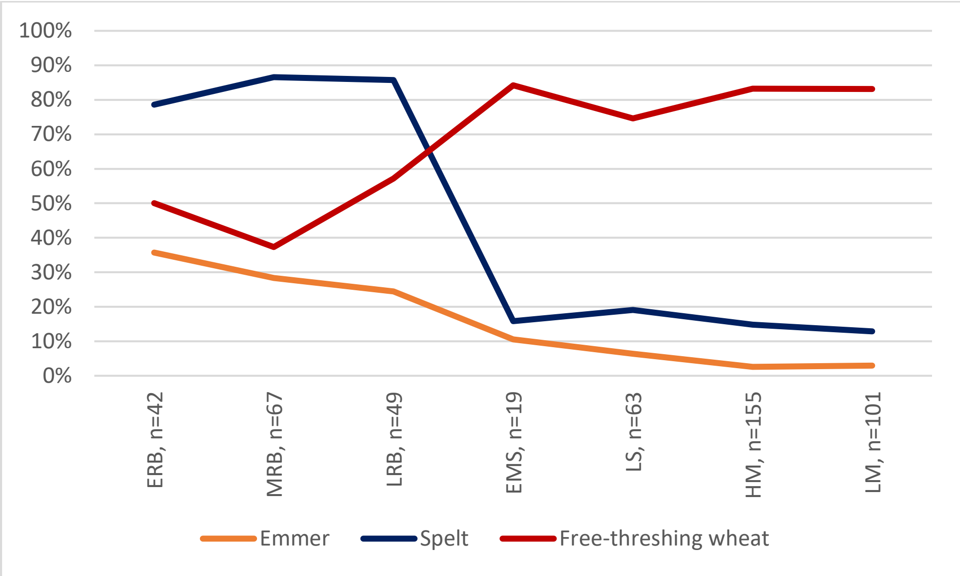


Figure 4.22. Correspondence analysis plots of the whole crop presence dataset (axes 1x2), (a) species plot, (b) site-phase plot with Romano-British records highlighted, (c) site-phase plot with Saxon records highlighted, (d) site-phase plot with Medieval records highlighted. Site-phase records coded as rural or urban; taxa codes are given in Table 4.1.

a



b

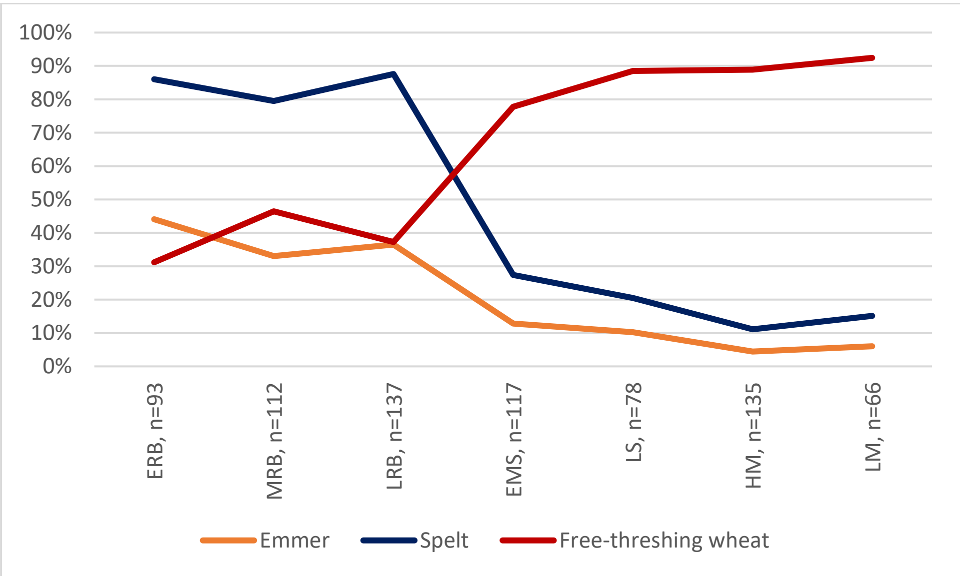
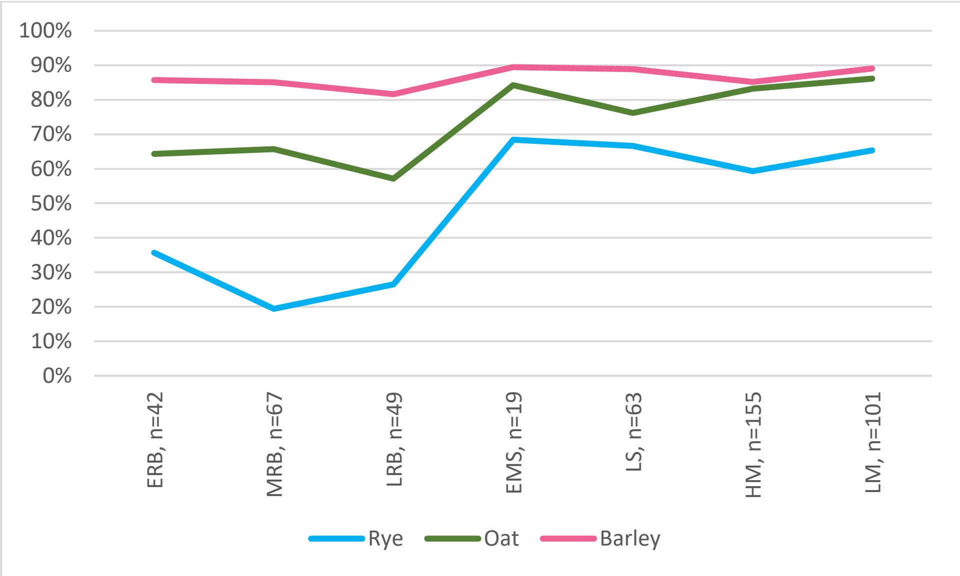


Figure 4.23 Line graphs showing the percentage of site-phase presence records for wheat taxa in each sub-period from (a) urban sites (n=496) and (b) rural sites (n=758).

a



b

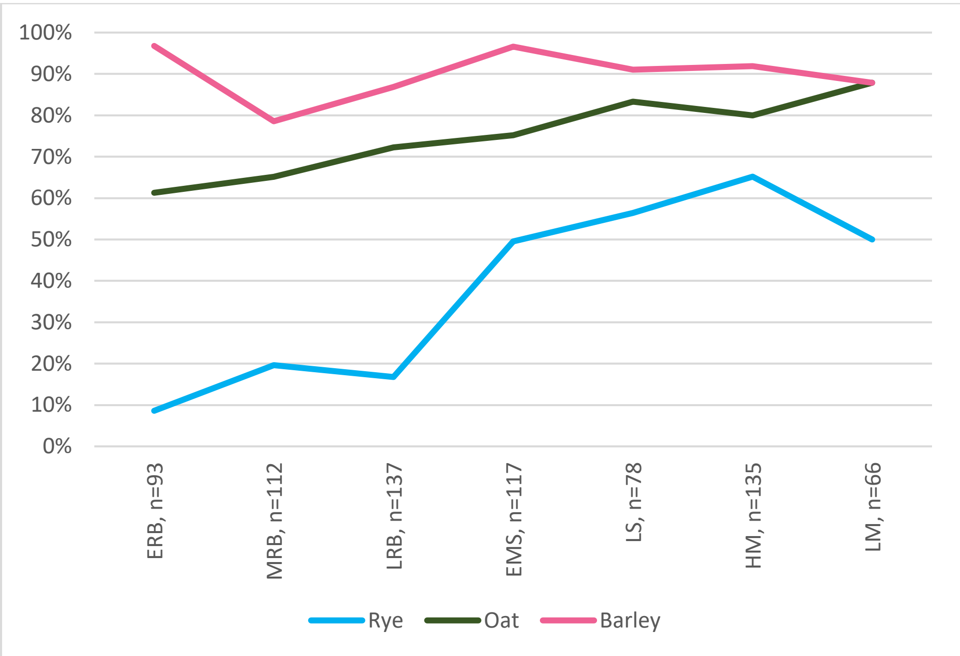
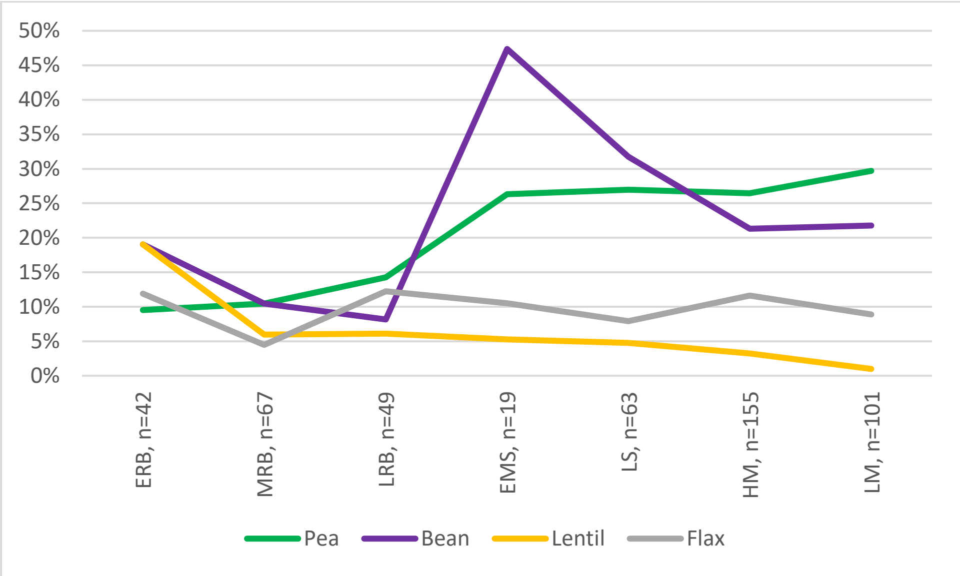


Figure 4.24. Line graphs showing the percentage of site-phase presence records for non-wheat cereal taxa in each sub-period from (a) urban sites (n=496) and (b) rural sites (n=758).

a



b

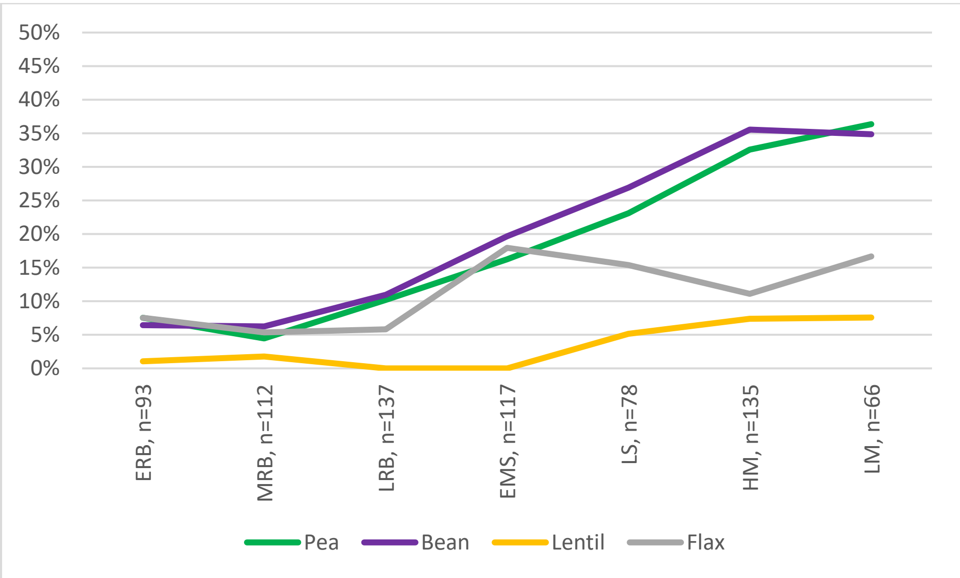


Figure 4.25. Line graphs showing the percentage of site-phase presence records for pulses and flax in each sub- period from (a) urban sites (n=496) and (b) rural sites (n=758).

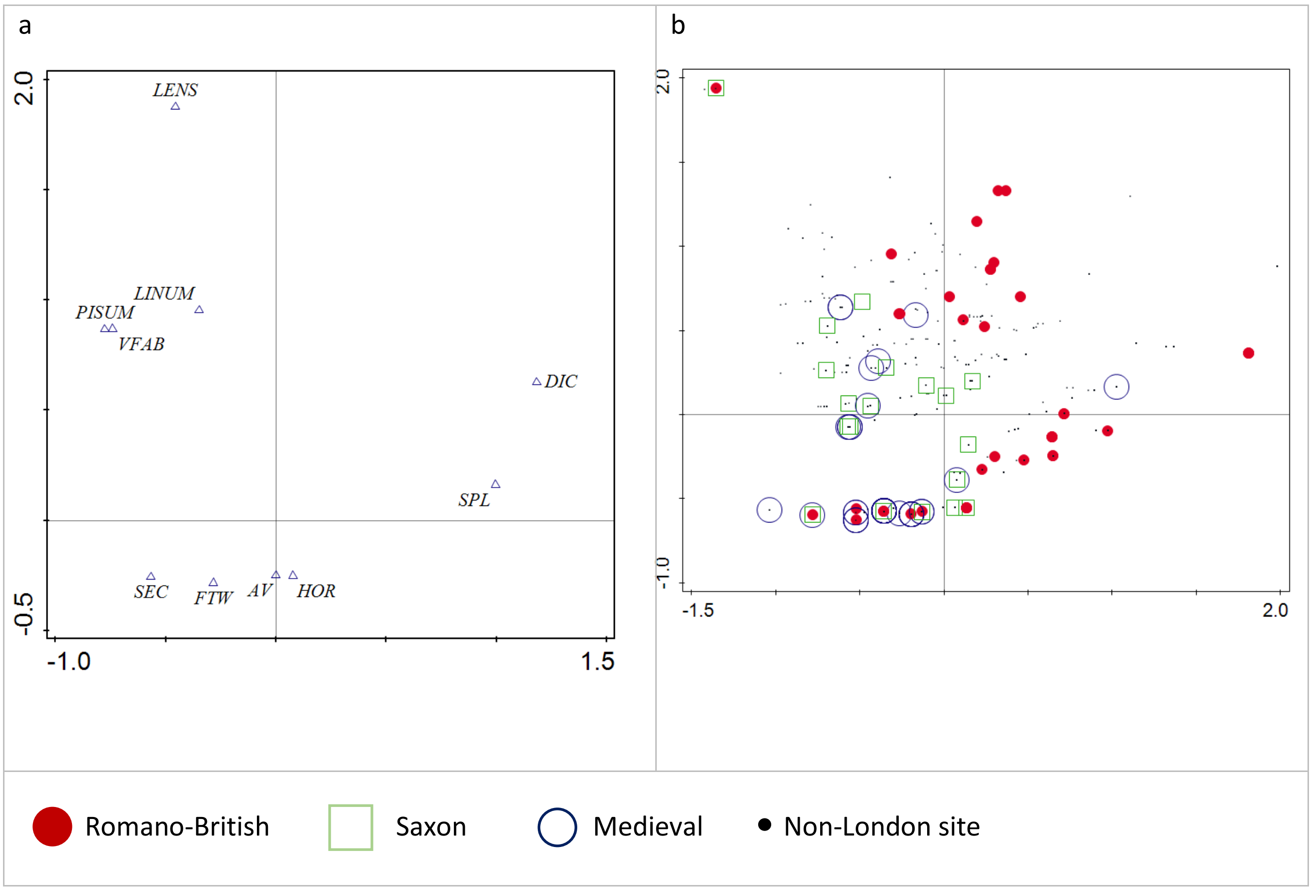
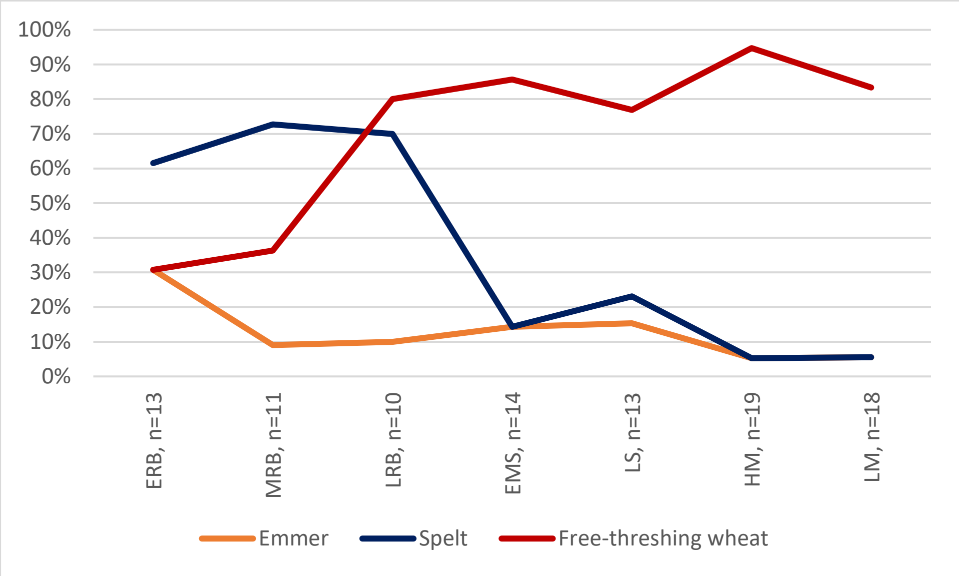


Figure 4.26. Correspondence analysis plots of the whole crop presence dataset (Axes 1x2), (a) species plot, (b) site-phase plot with London records highlighted and coded by broad temporal period. Taxa codes are given in Table 4.1.

a



b

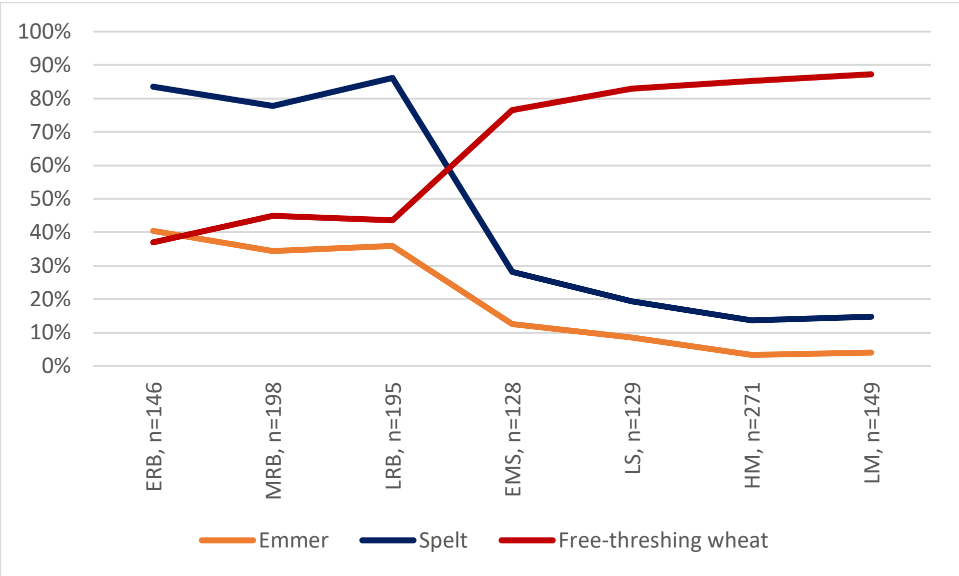
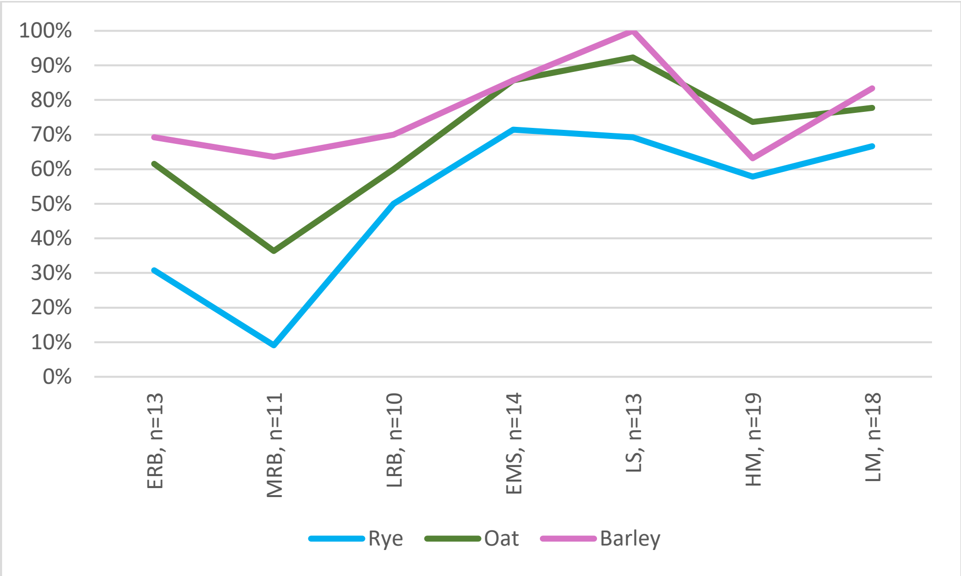


Figure 4.27. Line graphs showing the percentage of site-phase presence records for wheat taxa in each sub-period: (a) London (n=198), and (b) other sites (n=1216).

a



b

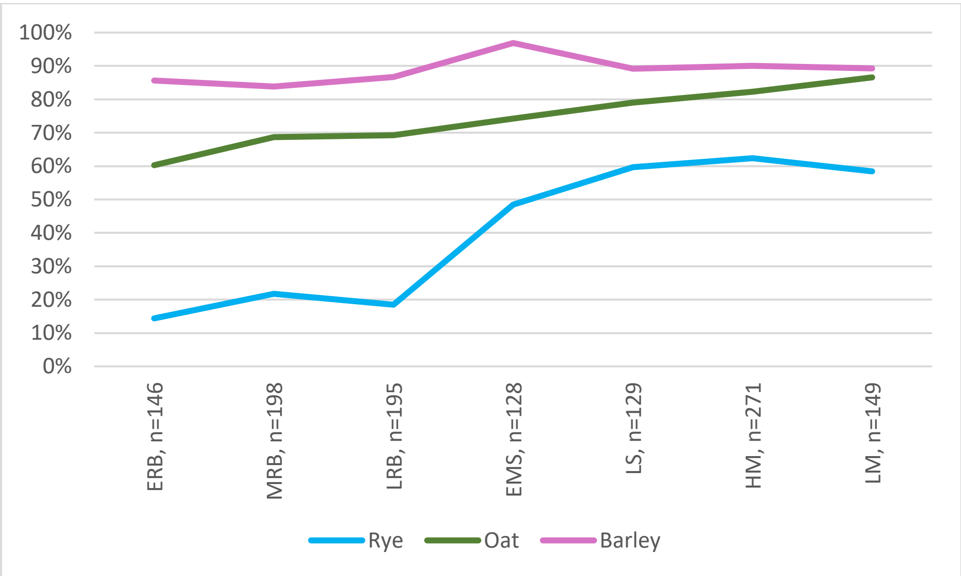
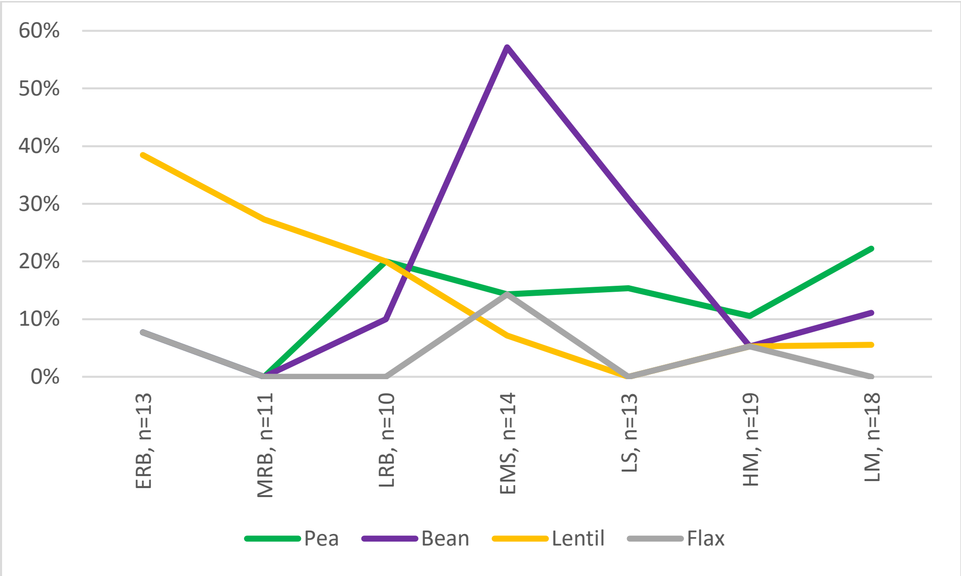


Figure 4.28. Line graphs showing the percentage of site-phase presence records for non-wheat taxa in each sub-period, (a) London (n=198), and (b) other sites (n=1216).

a



b

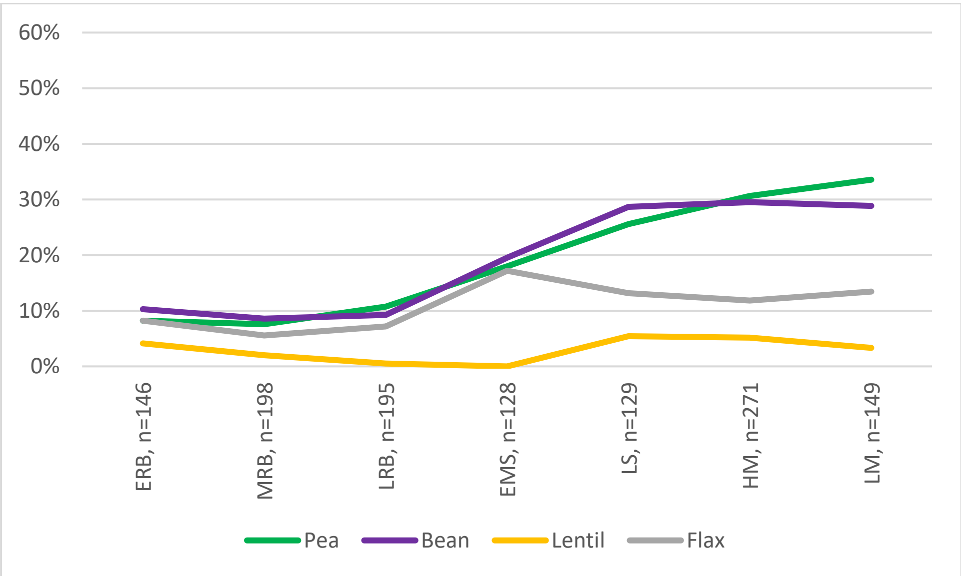
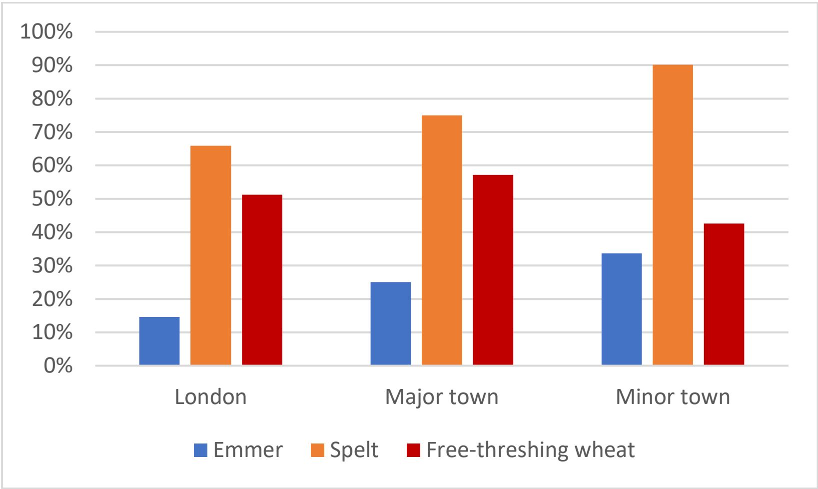
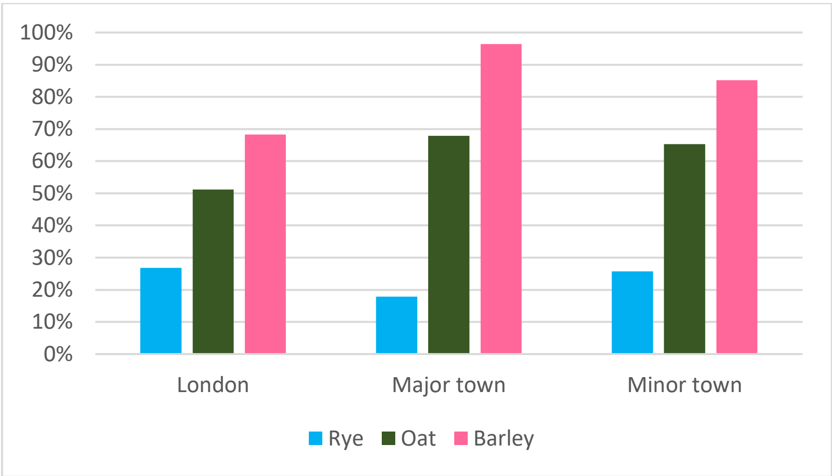


Figure 4.29. Line graphs showing the percentage of site-phase presence records for pulses and flax in each sub-period, (a) London (n=198), and (b) other sites (n=1216).

a



b



c

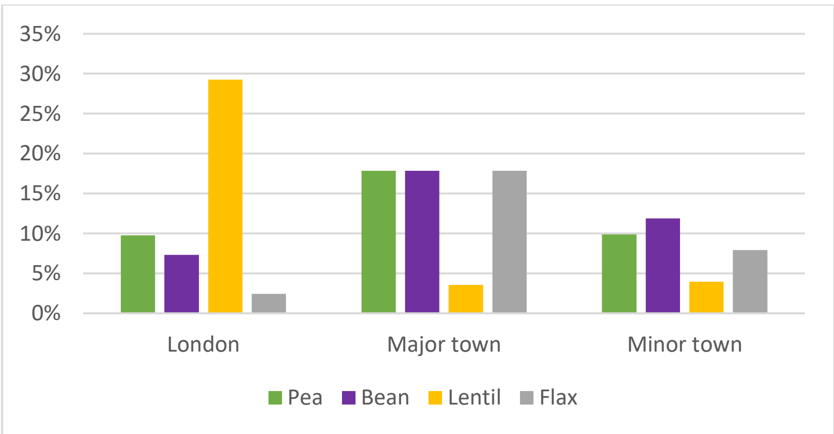
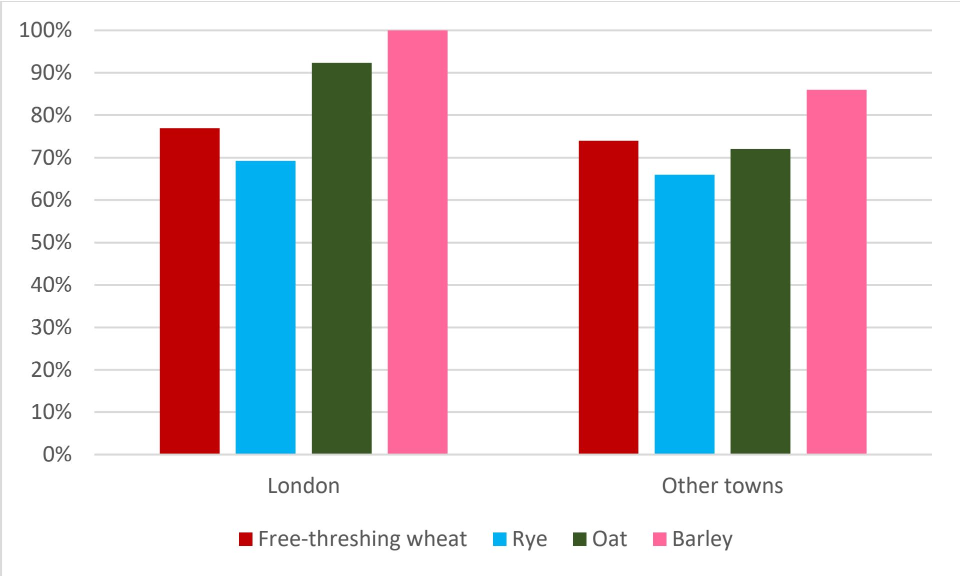


Figure 4.30. Bar charts showing the percentage of Romano-British site-phase presence records from London (n=41), other major towns (n=28), and minor towns (n=101): (a) wheat taxa, (b) non-wheat cereal taxa, (c) pulses and flax.

a



b

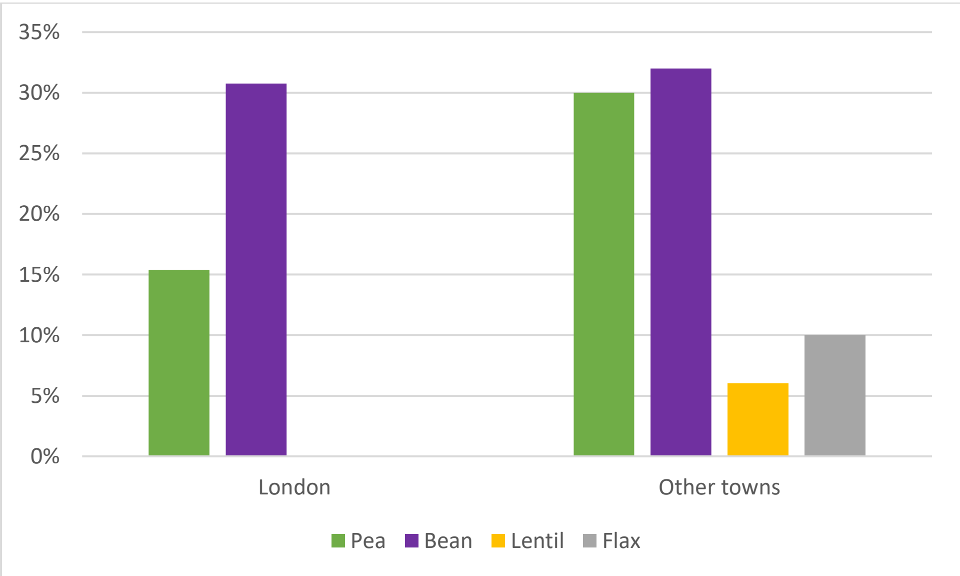
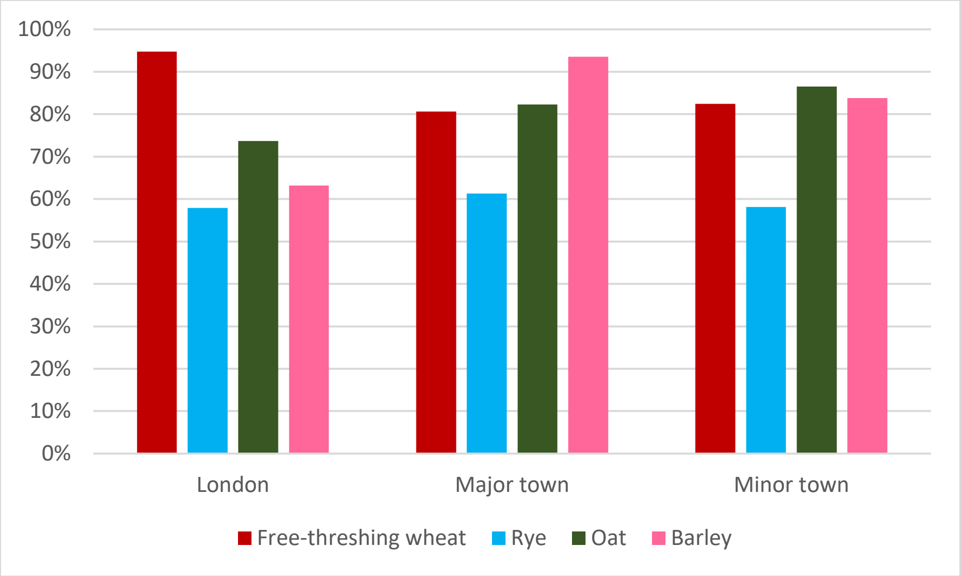


Figure 4.31. Bar charts showing the percentage of Late Saxon site-phase presence records from London (n=13), and other towns(n=50), (a) free-threshing cereal taxa and (b) pulses and flax.

a



b

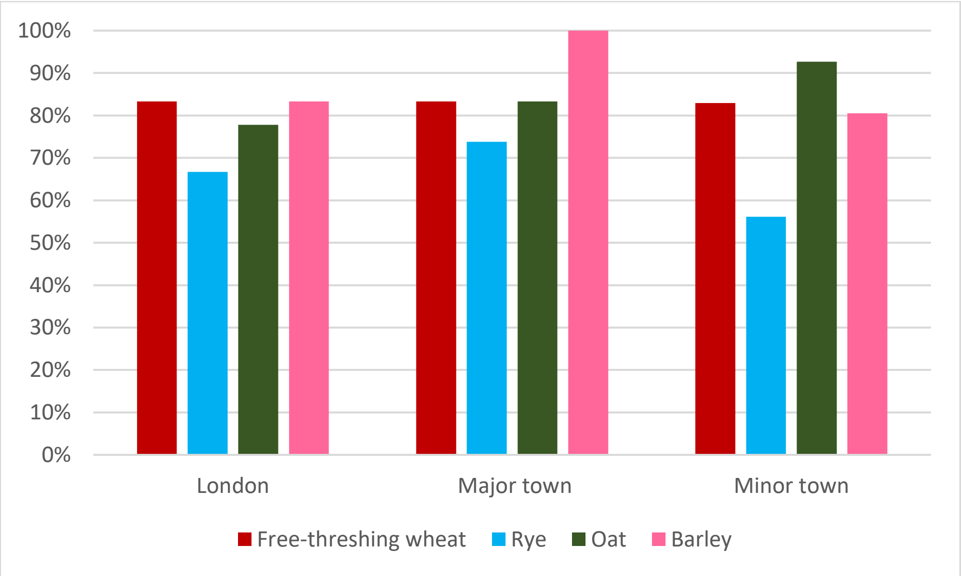
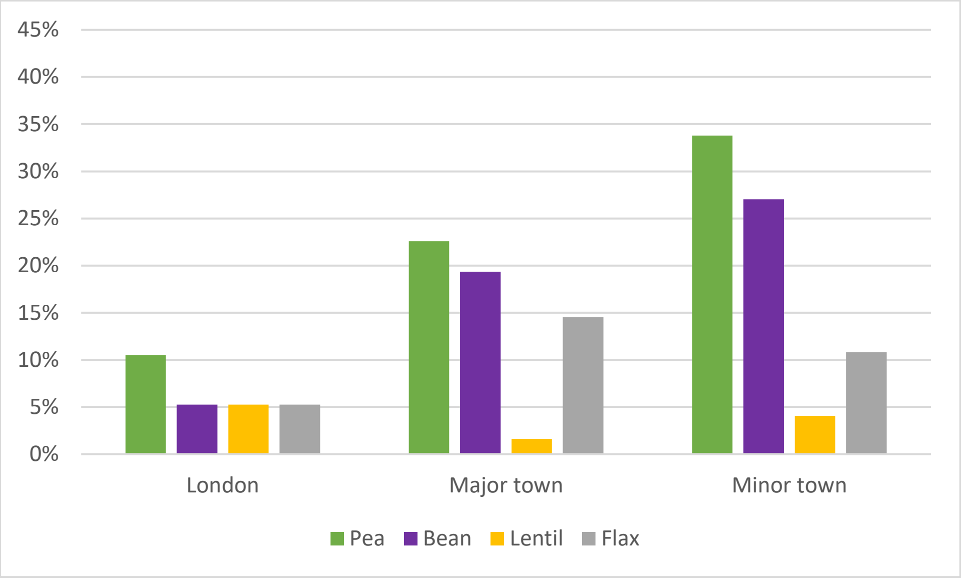


Figure 4.32. Bar charts showing the percentage of Medieval site-phase free-threshing cereal presence records from London (High Medieval n=19, Late Medieval n=18), other major towns (High Medieval n=62, Late Medieval n=42), and minor towns (High Medieval n=74, Late Medieval n=41): (a) High Medieval and (b) Late Medieval.

a



b

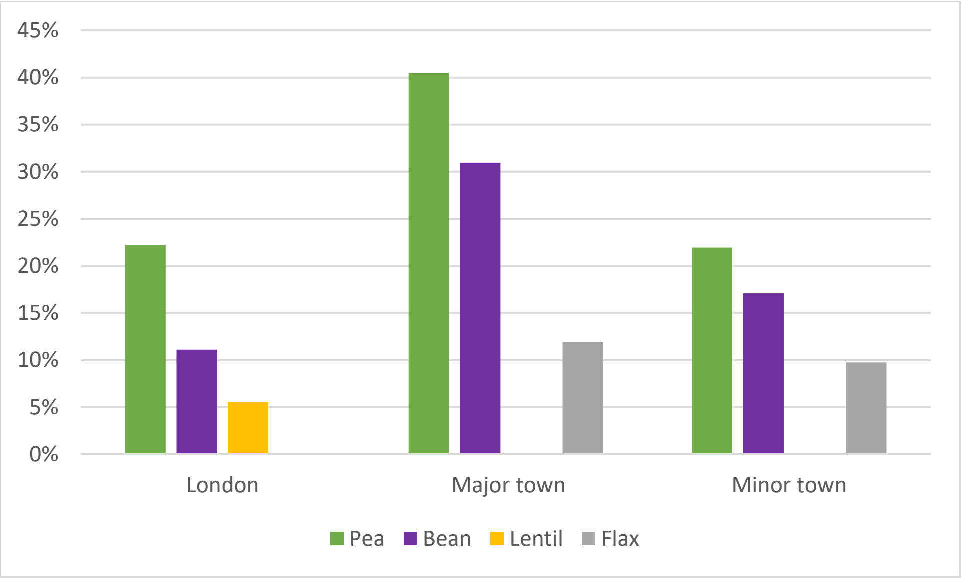


Figure 4.33. Bar charts showing the percentage of site-phase presence records for pulses and flax in London, other major towns, and minor towns: (a) High Medieval, and (b) Late Medieval. See caption to Figure 4.32 for numbers of records.

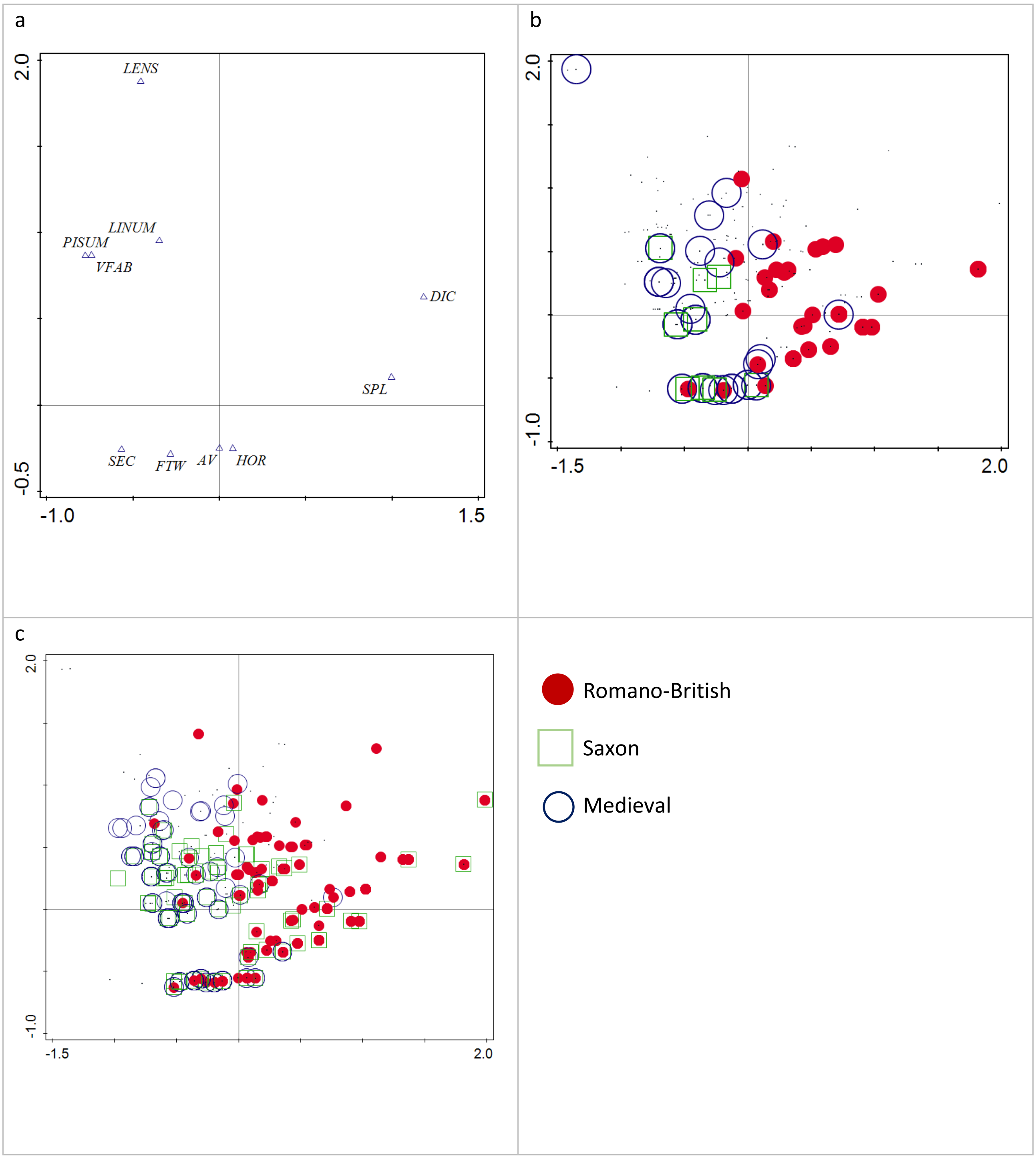


Figure 4.34. Correspondence analysis plots of the whole crop presence dataset (Axes 1x2), (a) species plot, (b) site-phase plot with rural secular elite records highlighted, (c) site-phase plot with rural secular non-elite records highlighted. Site-phase records coded by broad temporal period; taxa codes are given in Table 4.1.

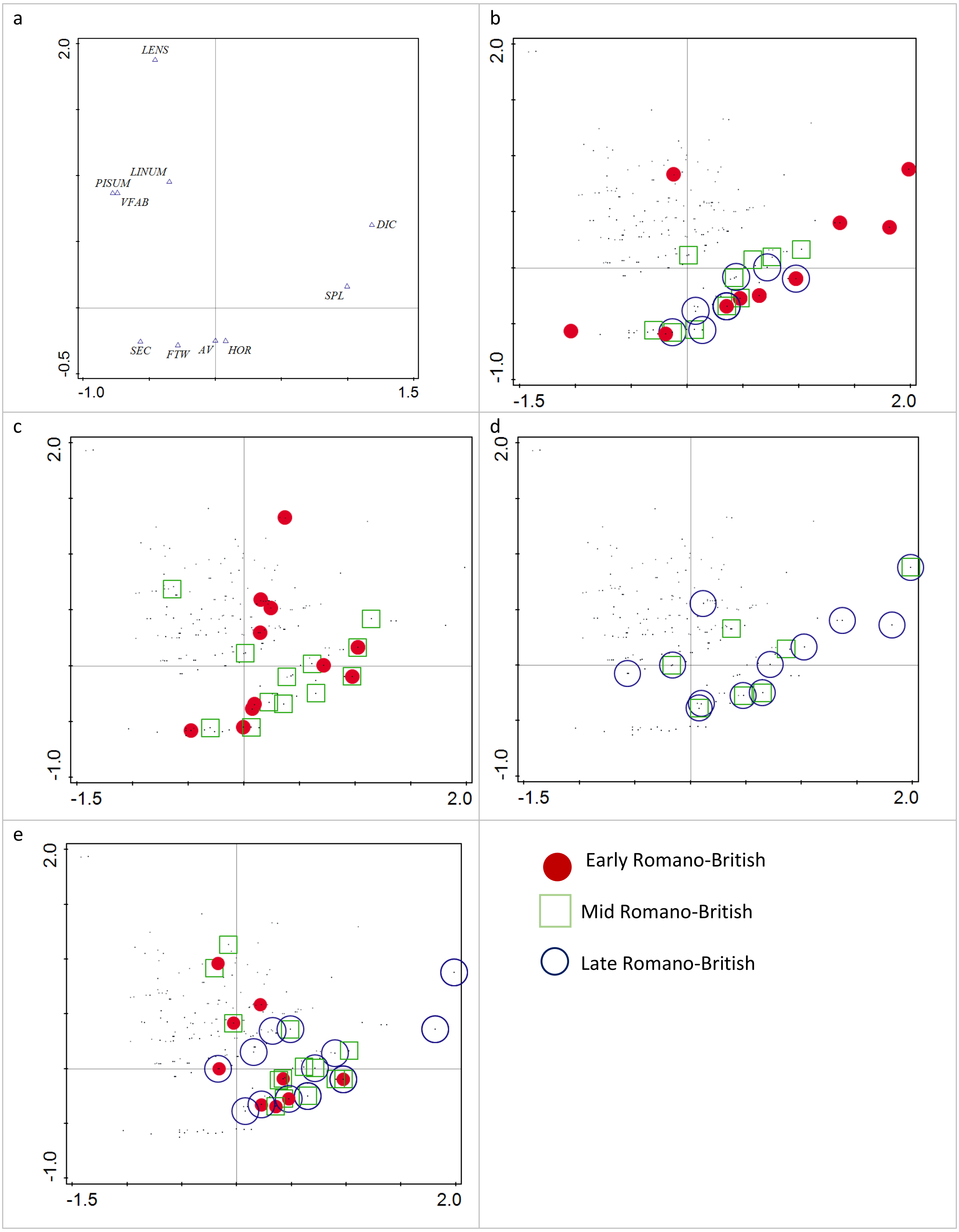
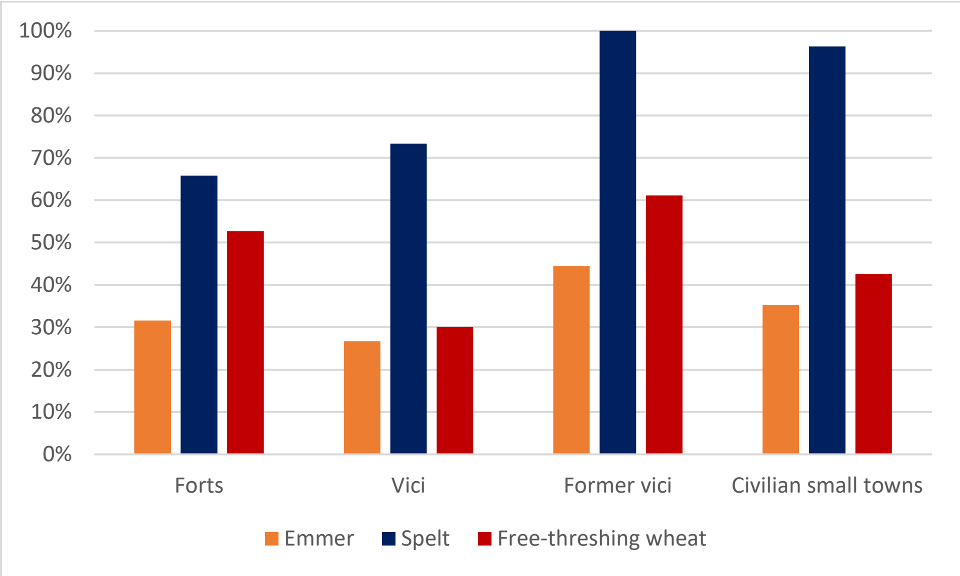


Figure 4.35. Correspondence analysis plots of the whole crop presence dataset (Axes 1x2), (a) species plot, (b) site-phase plot with Romano-British records from forts highlighted, (c) site-phase plot with Romano-British records from vici highlighted, (d) site-phase plot with Romano-British records from former vici highlighted, (e) site-phase plot with records from Romano-British small civilian towns (with no military influence) highlighted. Site-phase records coded by temporal sub-period; taxa codes are given in Table 4.1.

a



b

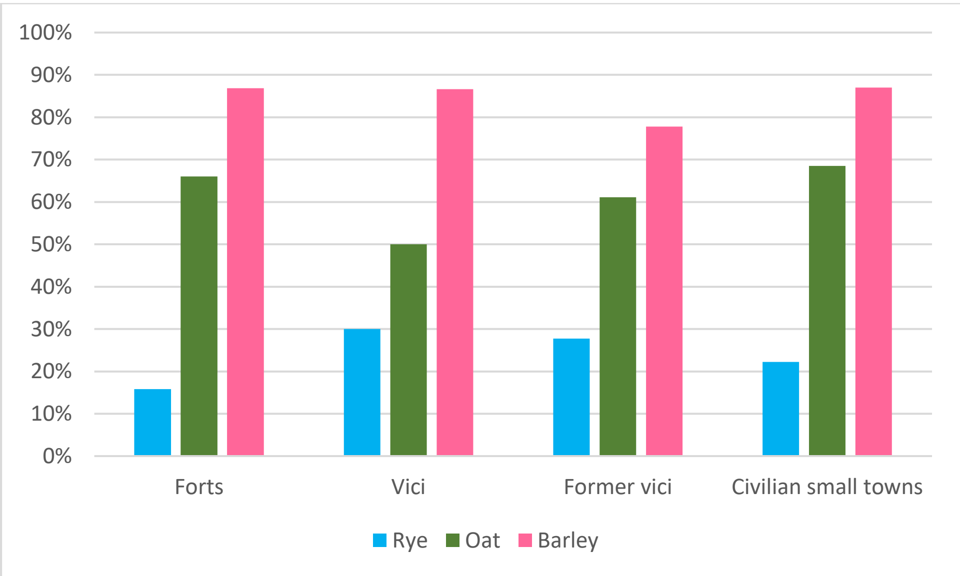


Figure 4.36. Bar charts showing the percentage of site-phase records from military-influenced sites (forts, n=38; vici, n=30; and former vici, n=18) and small civilian towns with no military influence (n=54) in the Romano-British period, (a) wheats (b) non-wheat cereal taxa.

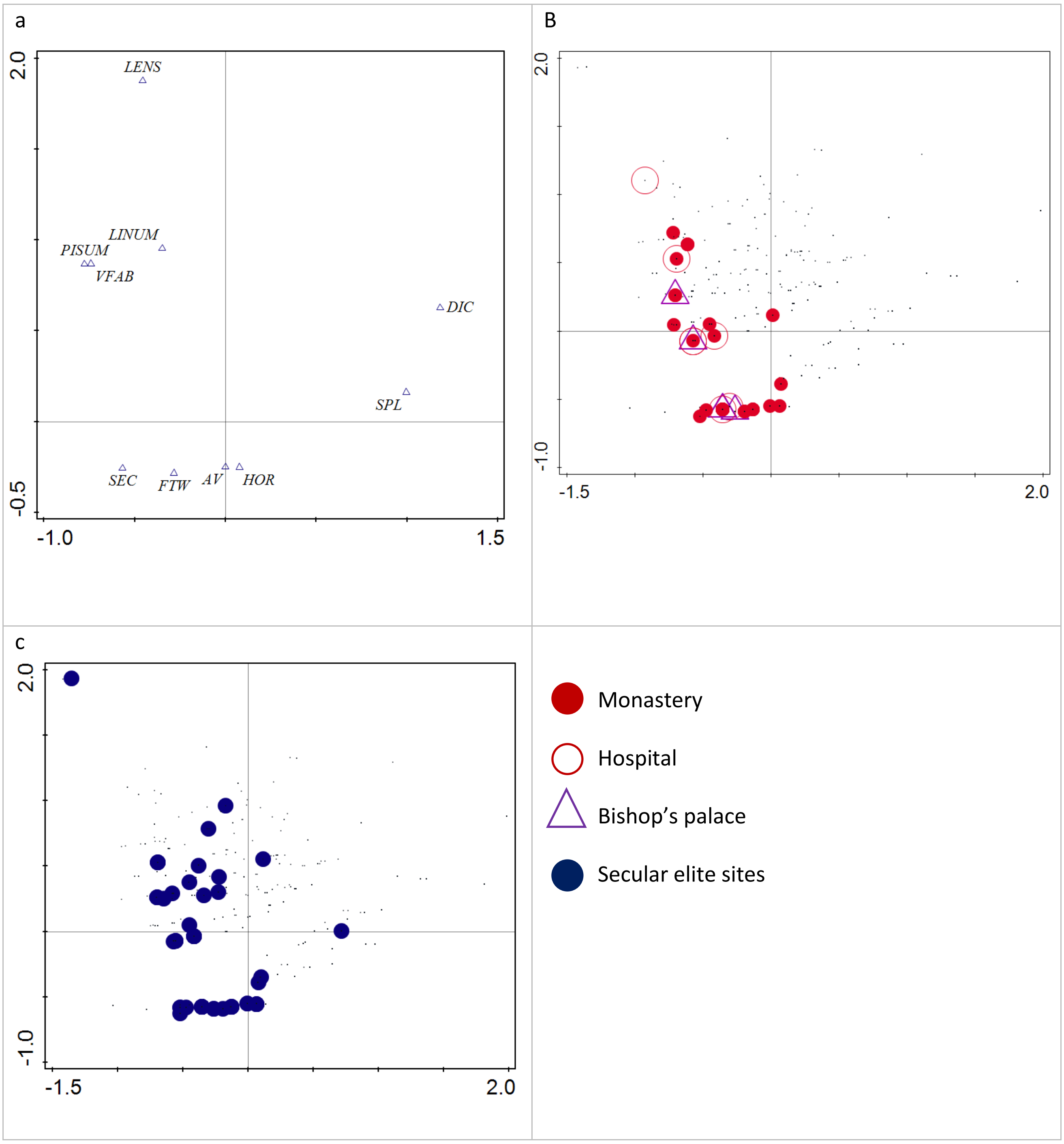
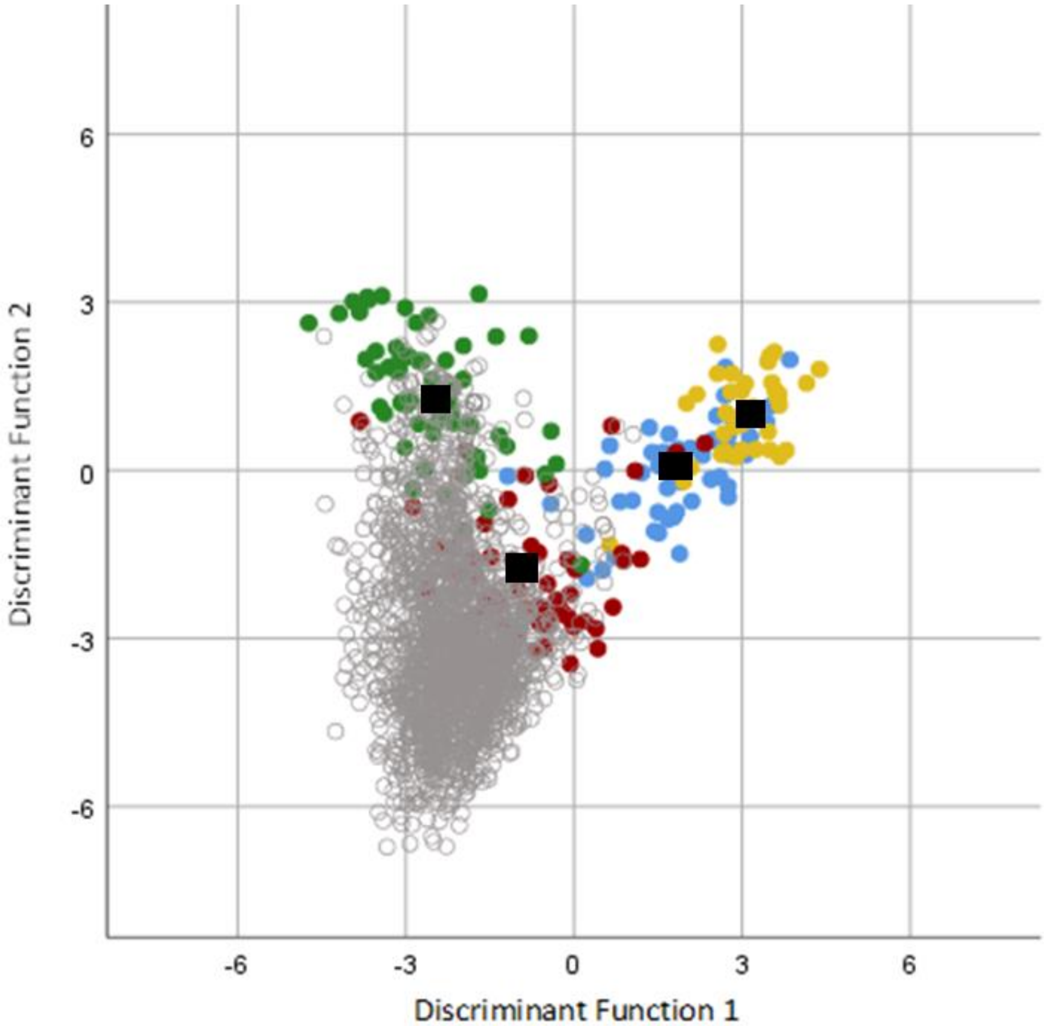


Figure 4.37. Correspondence analysis plots of the whole crop presence dataset (Axes 1x2), (a) species plot, (b) site-phase plot with Saxon and Medieval religious institutions highlighted, and records coded by type of site, (c) site-phase plot with Saxon and Medieval secular elite sites highlighted. Taxa codes are given in Table 4.1.

Chapter 5



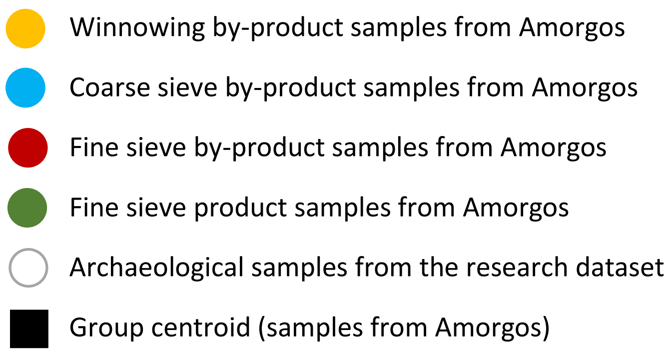


Figure 5.1. Discriminant analysis plot comparing the weed seed characteristics of samples in the study dataset with that of samples of known crop processing stage collected from Amorgos, Greece (Jones, 1983, 1984, 1987). The classification of weed seeds from the study dataset is given in Table 3.8.

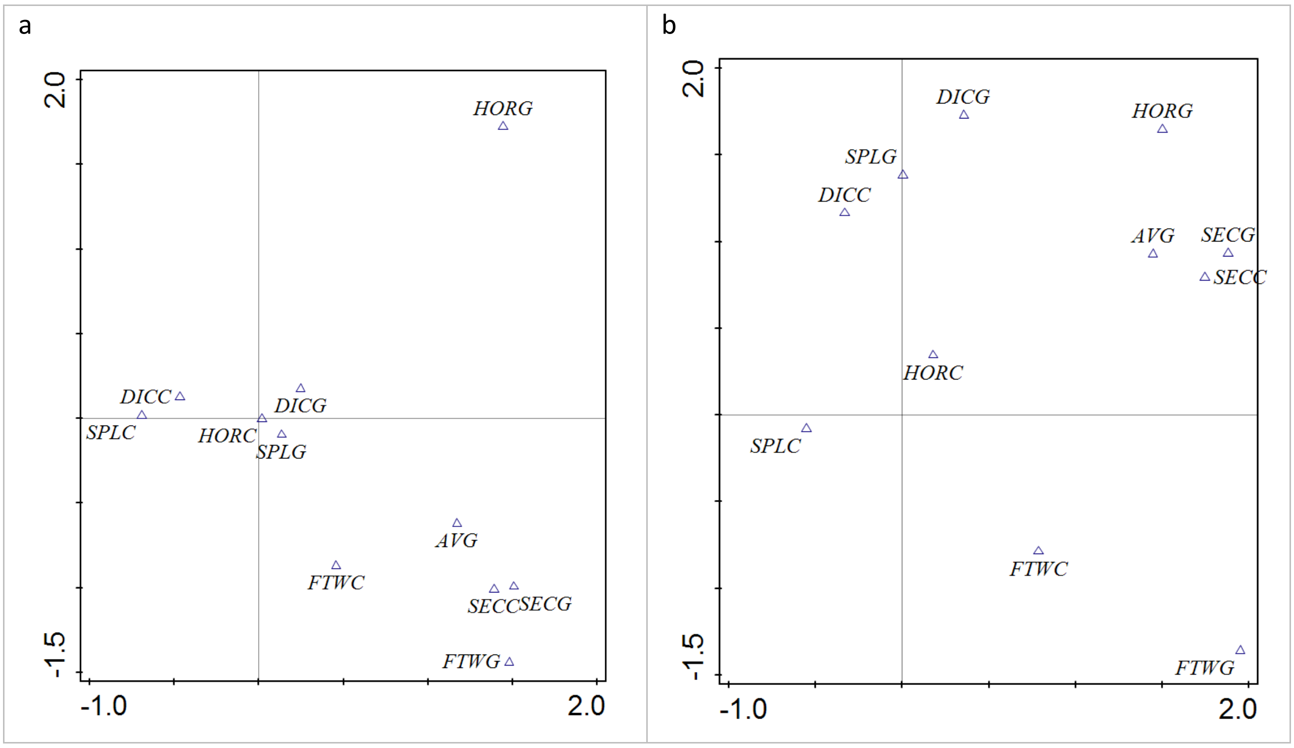


Figure 5.2. Correspondence analysis species plots (Axes 1x2) of cereal grains and chaff in samples from the whole study period, (a) all samples, (b) fine sieve by-product samples. Taxa codes are given in Table 5.4.

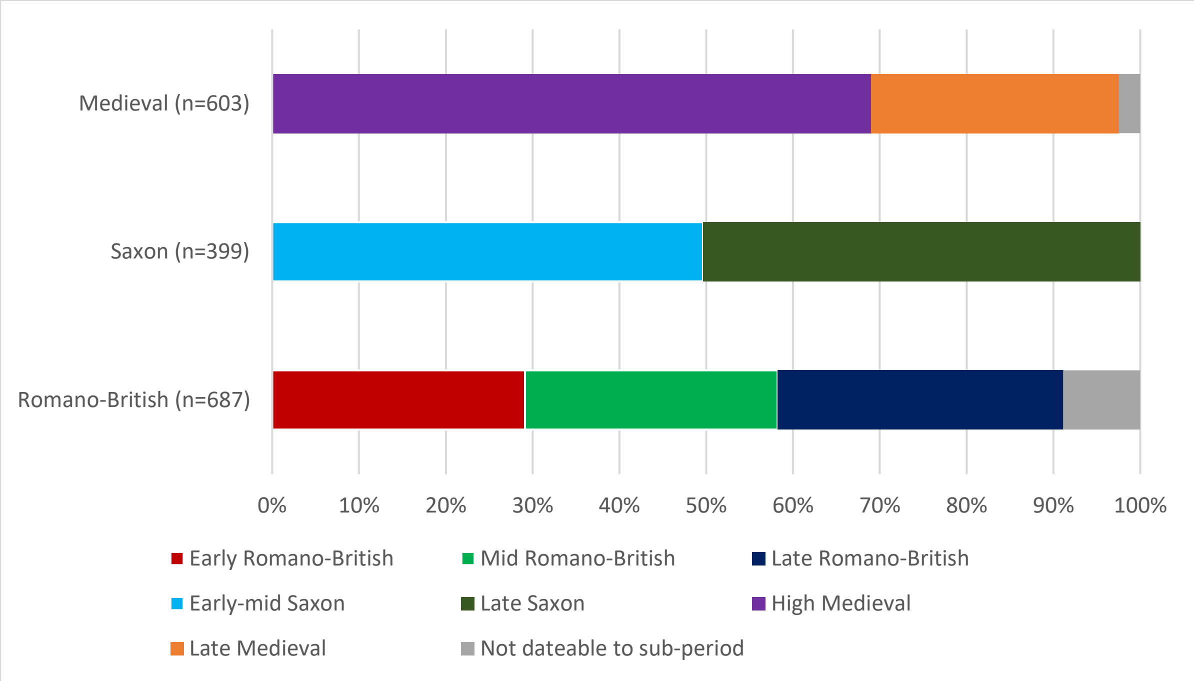


Figure 5.3. Bar chart showing the classification of fine sieve by-product samples according to temporal period and sub-period.

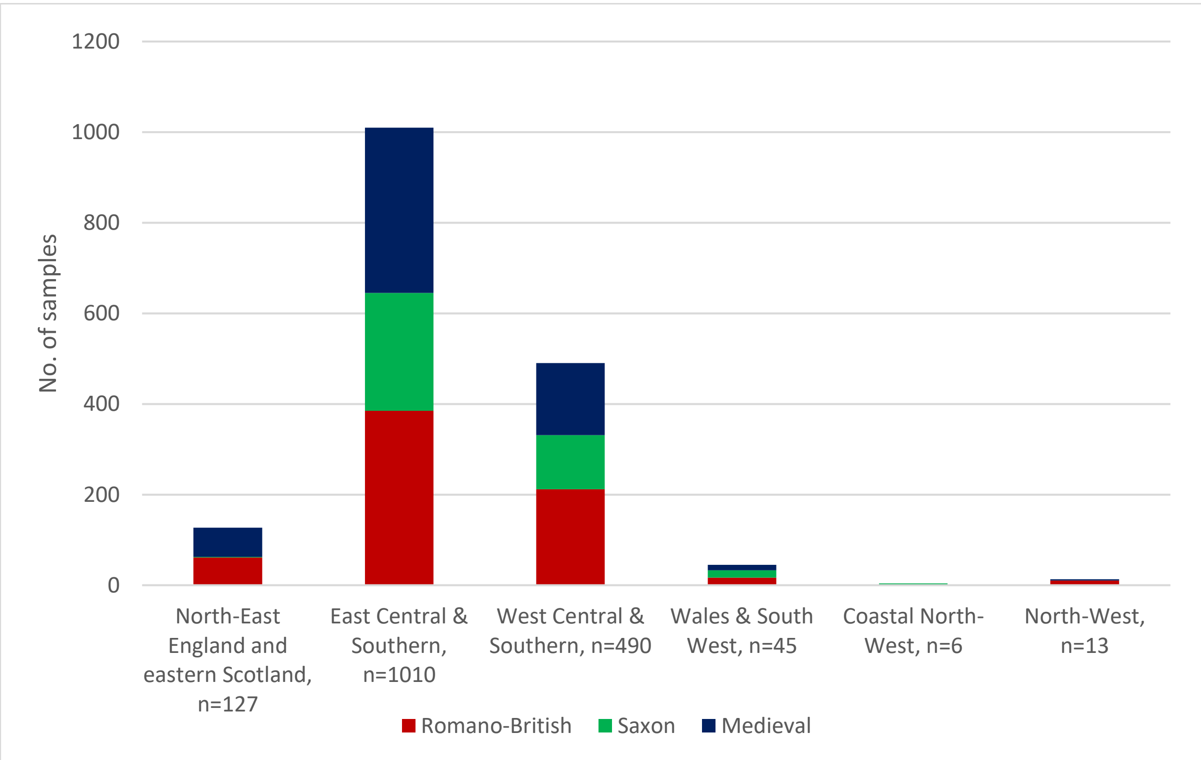
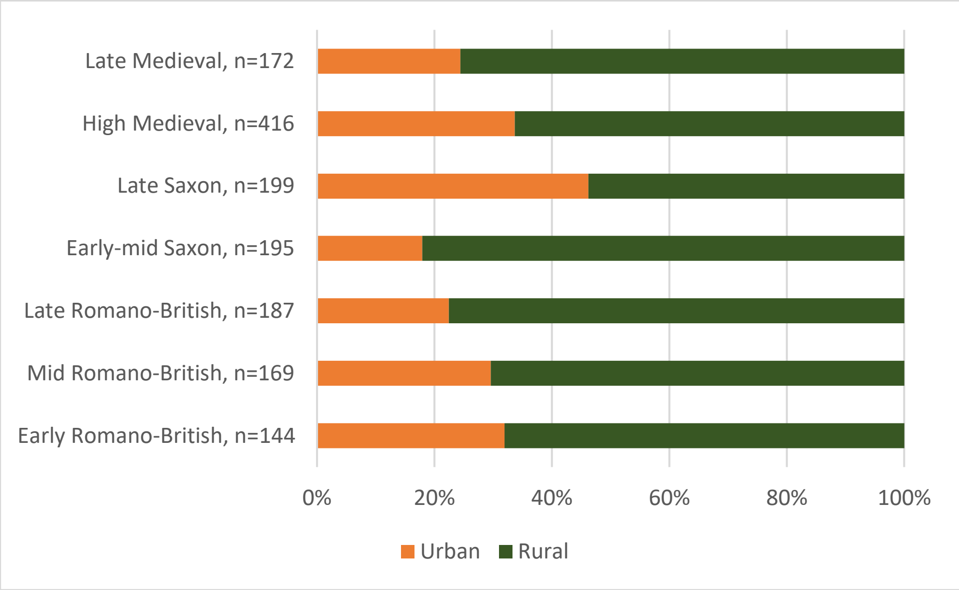


Figure 5.4. Bar chart showing the classification of fine sieve by-product samples according to broad climatic regions (following Shirlaw, 1966, pp. 20–21).

a



b

Figure 5.5. Bar chart showing the classification of fine sieve by-product samples according to site type (a) urban or rural location, (b) samples from urban sites categorised by town size (see Section 3.3.4.3).

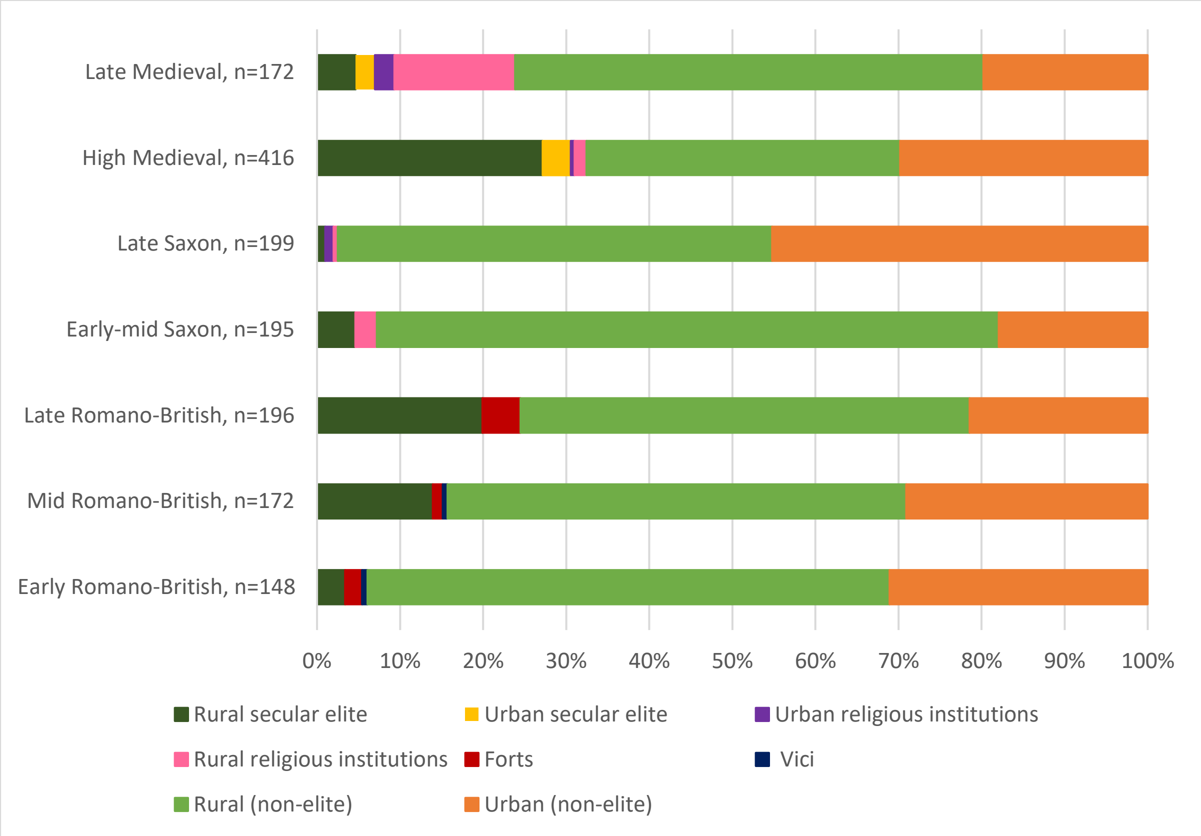


Figure 5.6. Bar chart showing the classification of fine sieve by-product samples according to socio-economic variables (see Section 3.3.4.3 for descriptions of each category).

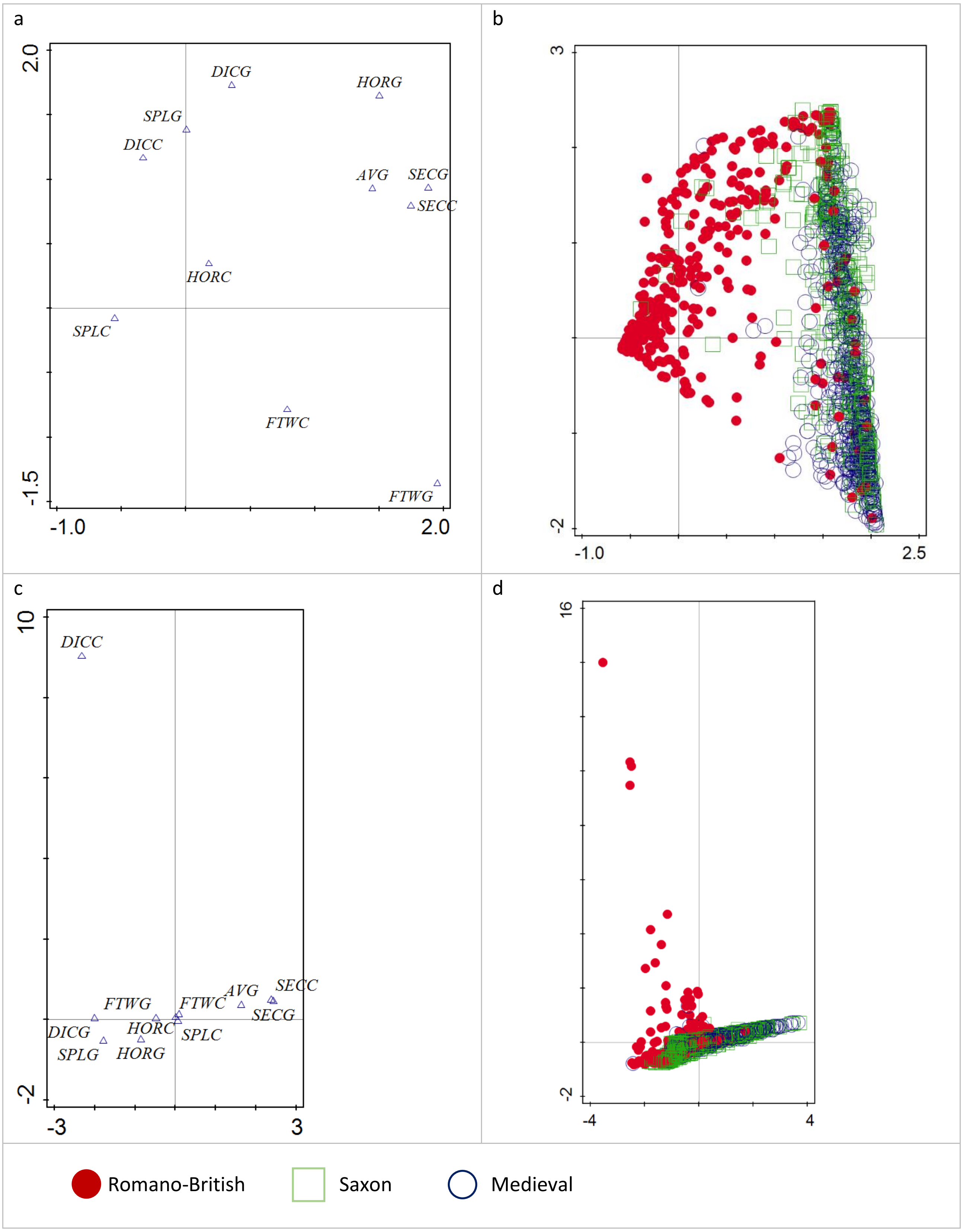


Figure 5.7. Correspondence analysis plots of cereal content (grains and chaff) of all fine sieve by-product samples (a) species plot (Axes 1x2), (b) sample plot coded by broad temporal period (Axes 1x2), (c) species plot (Axes 3x4), (d) sample plot coded by broad temporal period (Axes 3x4). Taxa codes are given in Table 5.4.

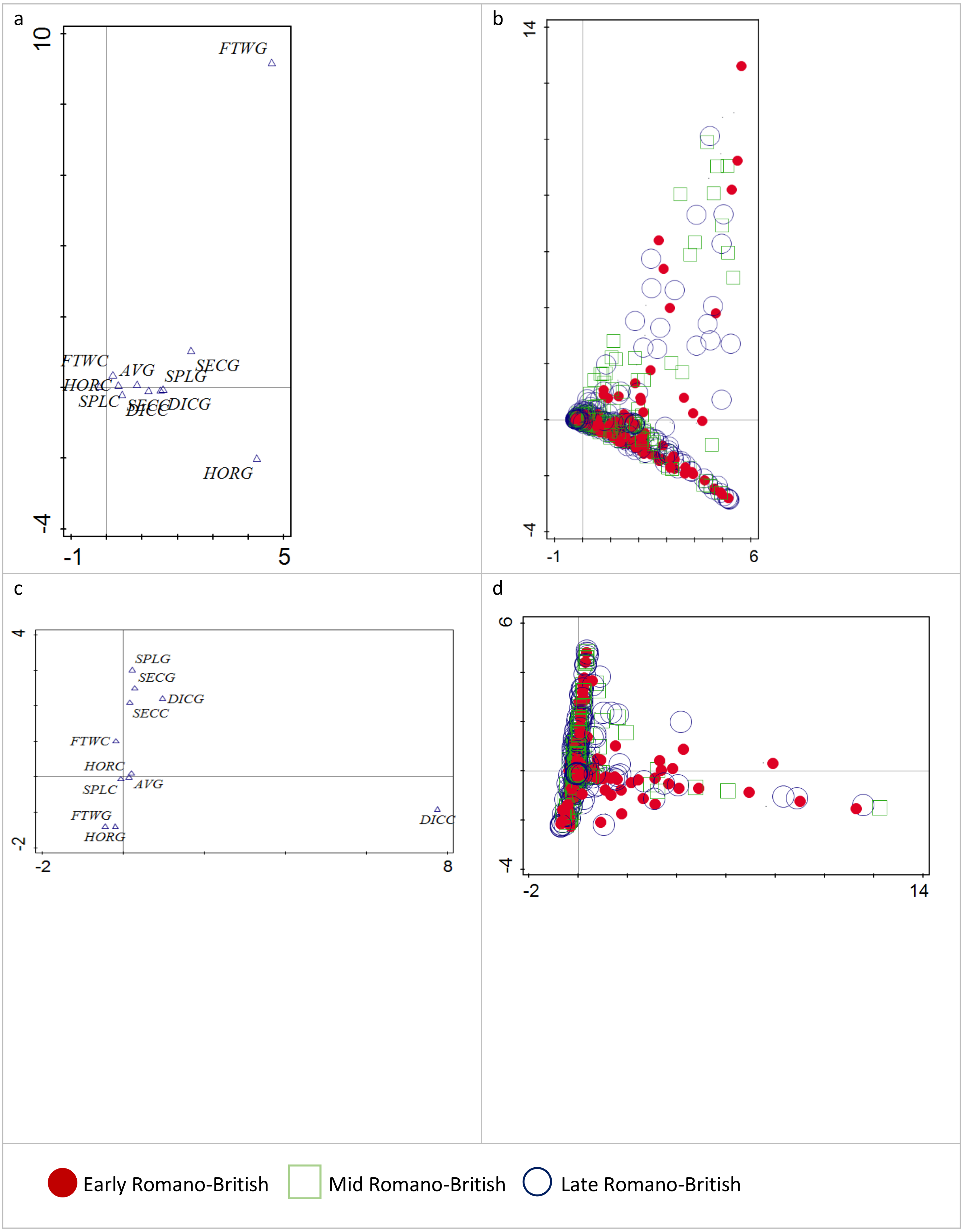


Figure 5.8. Correspondence analysis plots of cereal content (grains and chaff) of Romano-British fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot coded by temporal sub-period (Axes 1x2), (c) species plot (Axes 3x4), (d) sample plot coded by temporal sub-period (Axes 3x4). Taxa codes are given in Table 5.4.

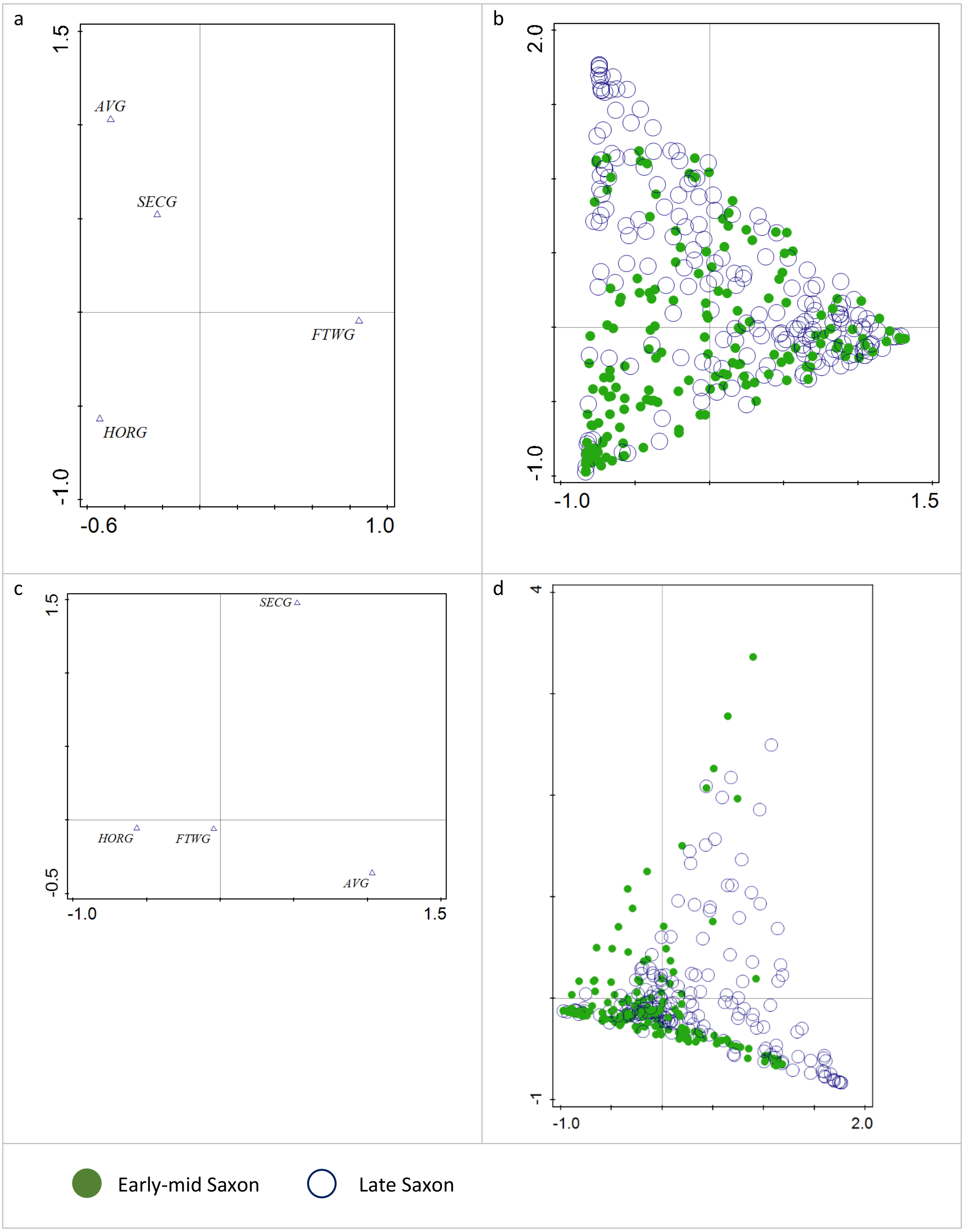


Figure 5.9. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples (a) species plot (Axes 1x2), (b) sample plot coded by temporal sub-period (Axes 1x2), (c) species plot (Axes 2x3), (d) sample plot coded by temporal sub-period (Axes 2x3). Taxa codes are given in Table 5.4.

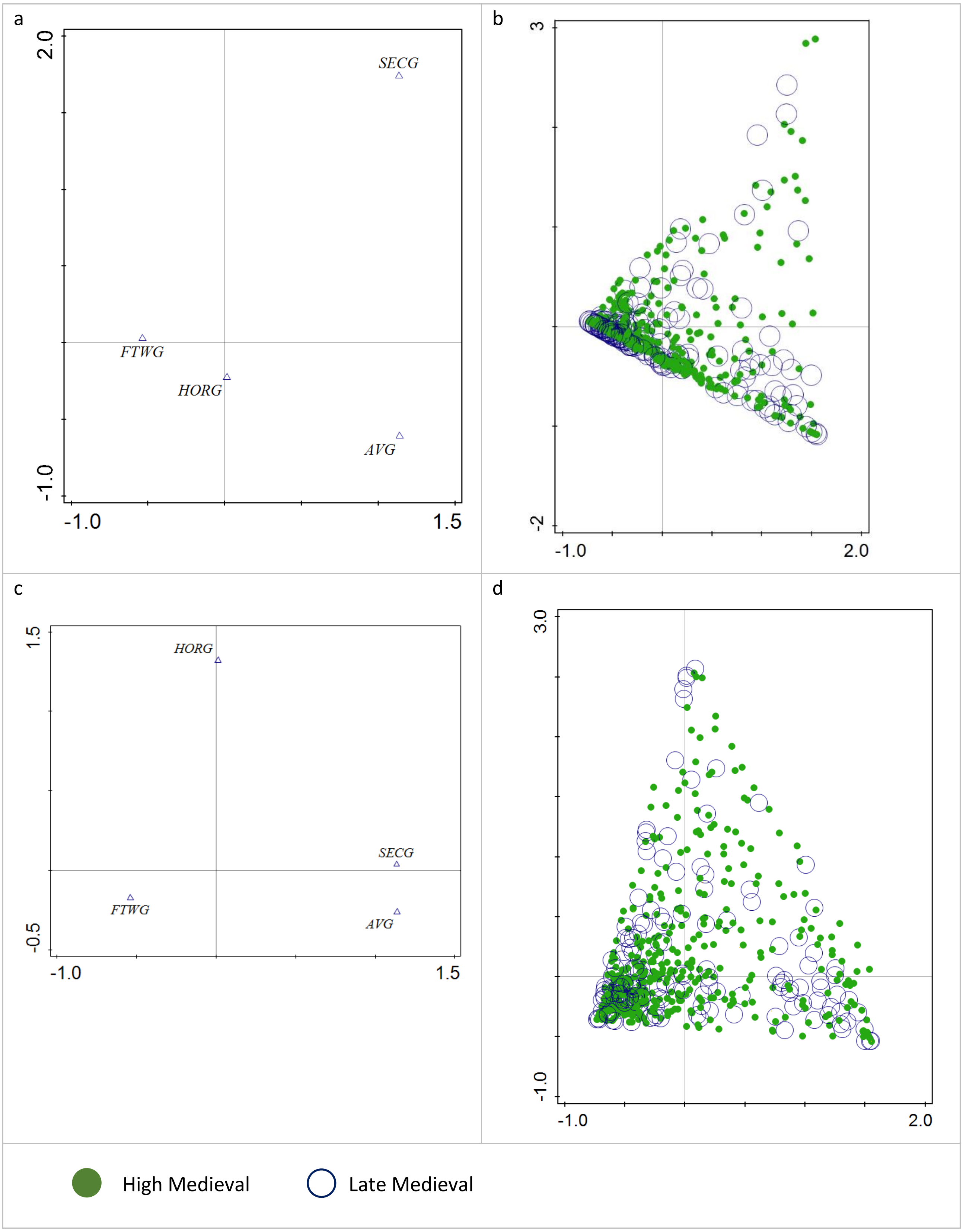


Figure 5.10. Correspondence analysis plots of free-threshing cereal grain content of Medieval fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot coded by temporal sub-period (Axes 1x2), (c) species plot (Axes 1x3), (d) sample plot coded by temporal sub-period (Axes 1x3). Taxa codes are given in Table 5.4.

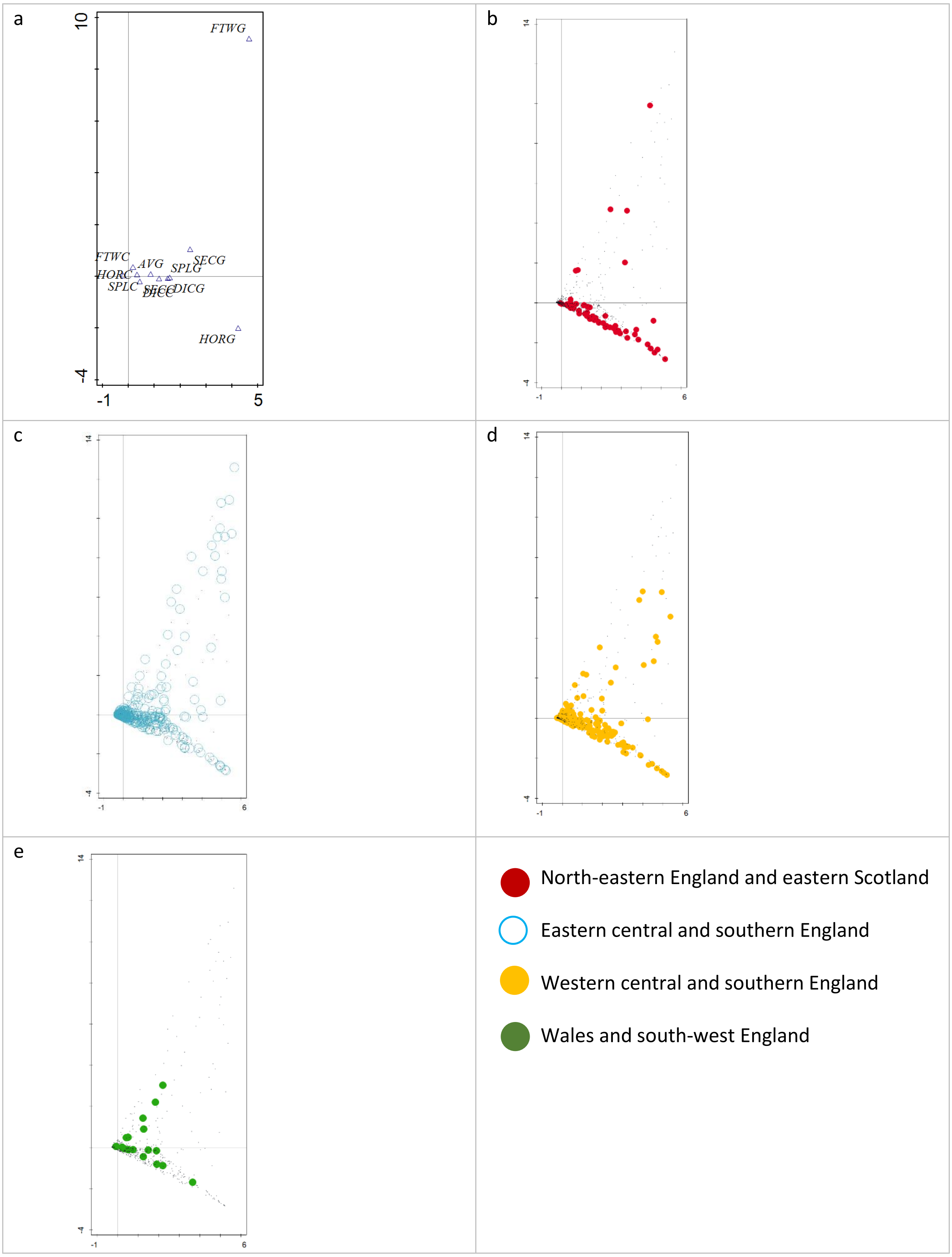


Figure 5.11. Correspondence analysis plots of the cereal content (grains and chaff) of Romano-British fine sieve by-product samples (Axes 1x2): (a) species plot, (b-e) sample plots with samples from individual climatic zones highlighted. Taxa codes are given in Table 5.4.

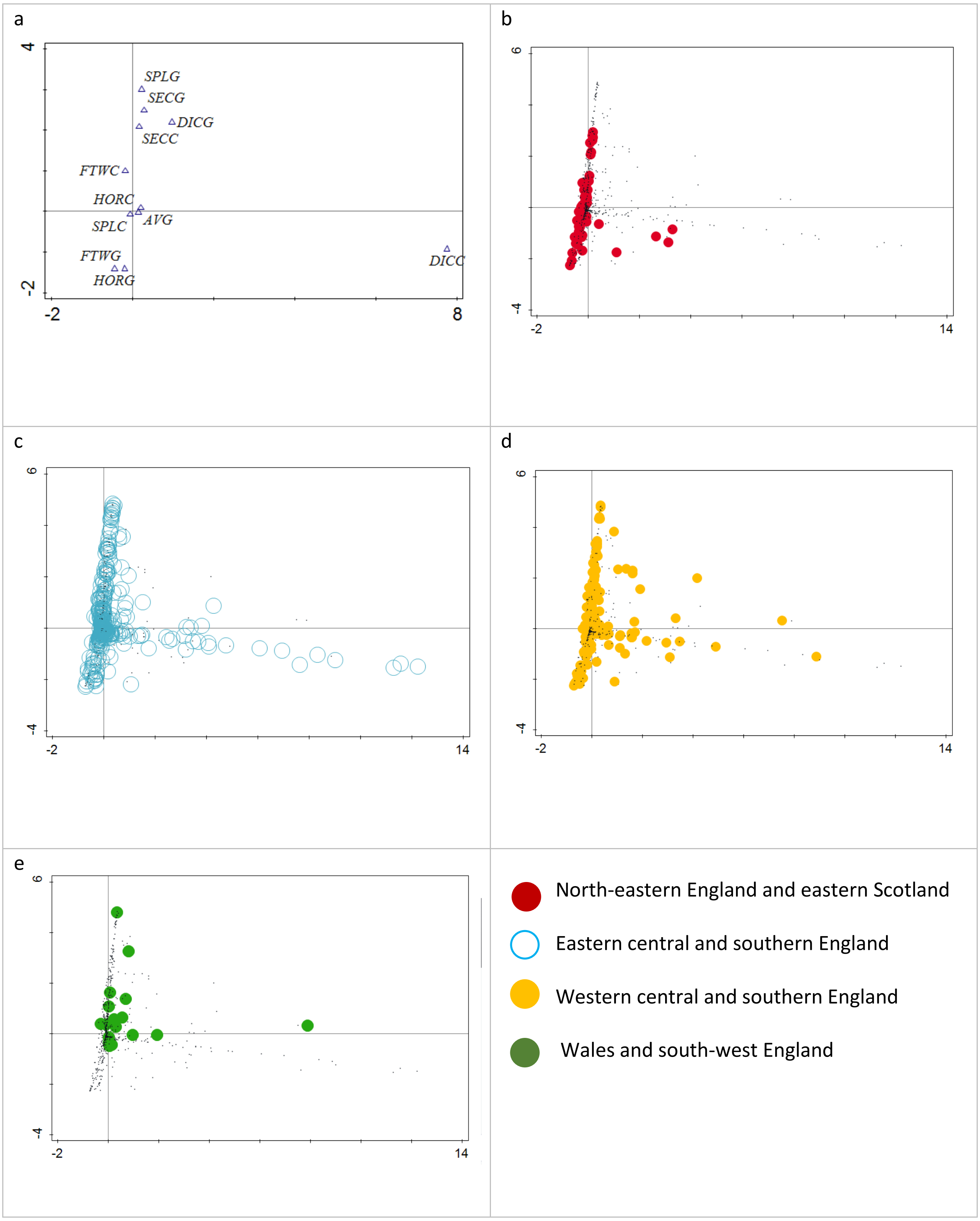


Figure 5.12. Correspondence analysis plots of the cereal content (grains and chaff) of Romano-British fine sieve by-product samples (Axes 3x4): (a) species plot, (b-e) sample plots with samples from individual climatic zones highlighted. Taxa codes are given in Table 5.4.

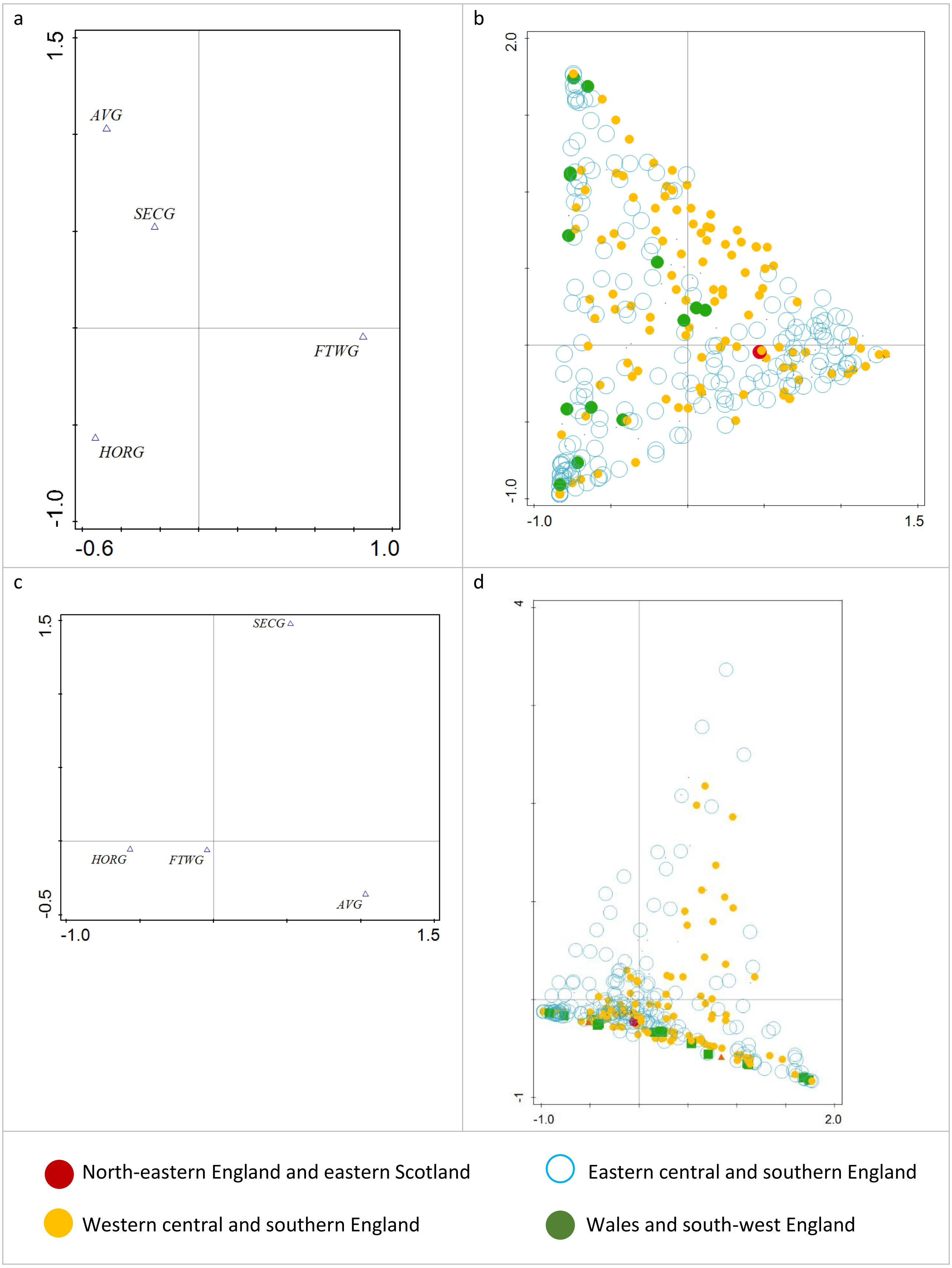


Figure 5.13. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples (a) species plot (Axes 1x2), (b) sample plot coded by climatic zone (Axes 1x2), (c) species plot (Axes 2x3), (d) sample plot coded by climatic zone (Axes 2x3). Taxa codes are given in Table 5.4.

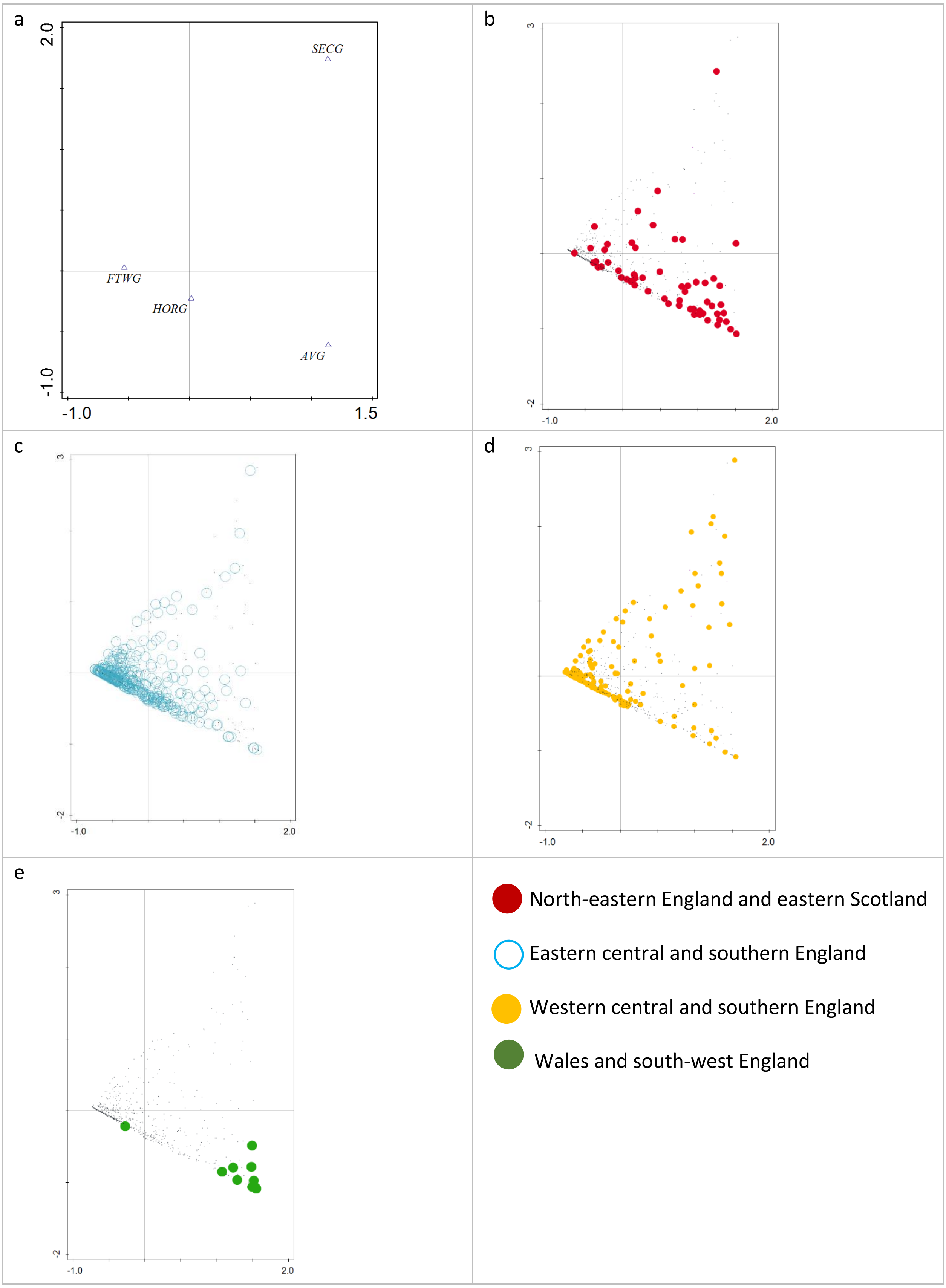


Figure 5.14. Correspondence analysis plots of the free-threshing cereal grain content of Medieval fine sieve by-product samples (Axes 1x2): (a) species plot, (b-e) sample plots with samples from individual climatic zones highlighted. Taxa codes are given in Table 5.4.

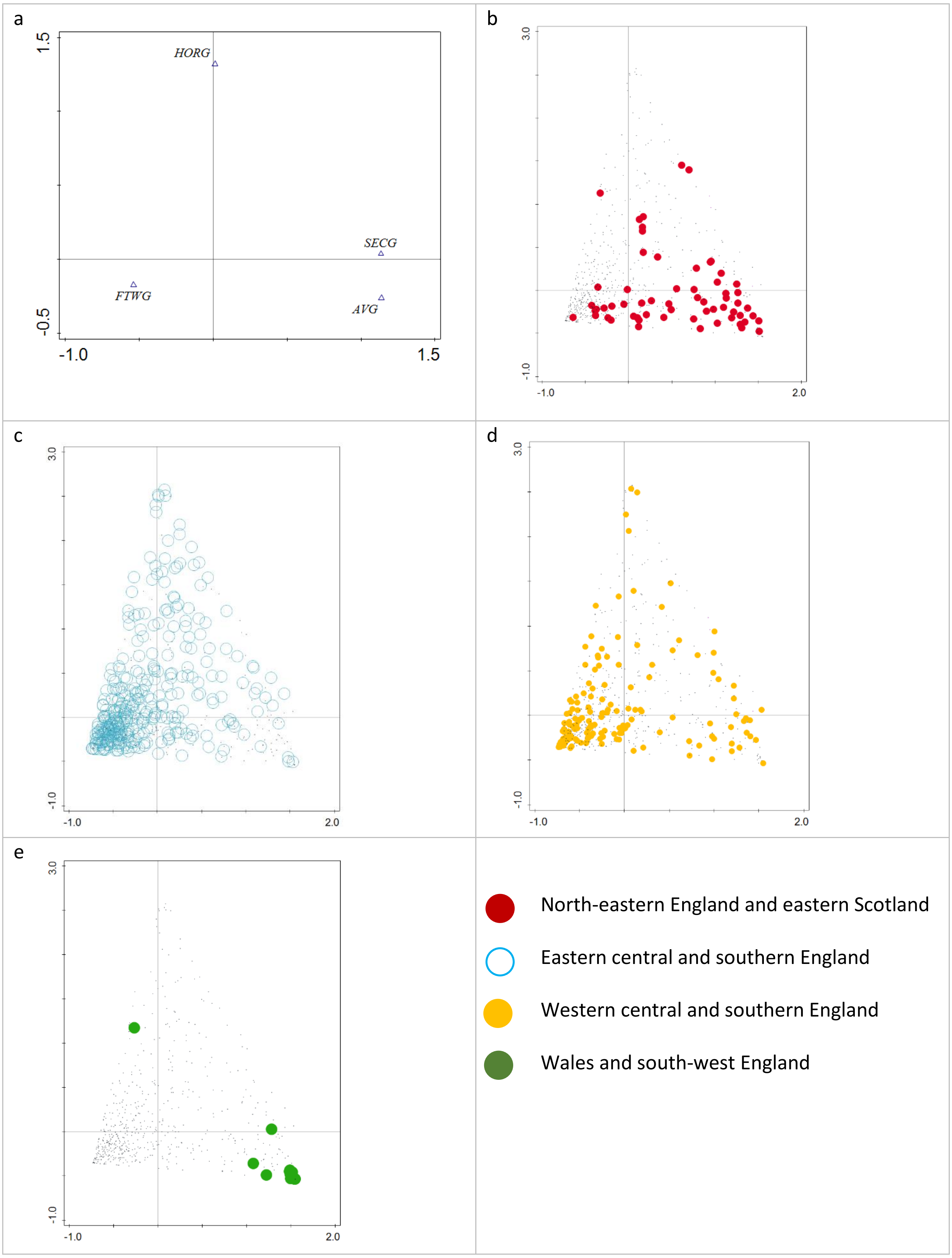


Figure 5.15. Correspondence analysis plots of the free-threshing cereal grain content of Medieval fine sieve by-product samples (Axes 1x3): (a) species plot, (b-e) sample plots with samples from individual climatic zones highlighted. Taxa codes are given in Table 5.4.

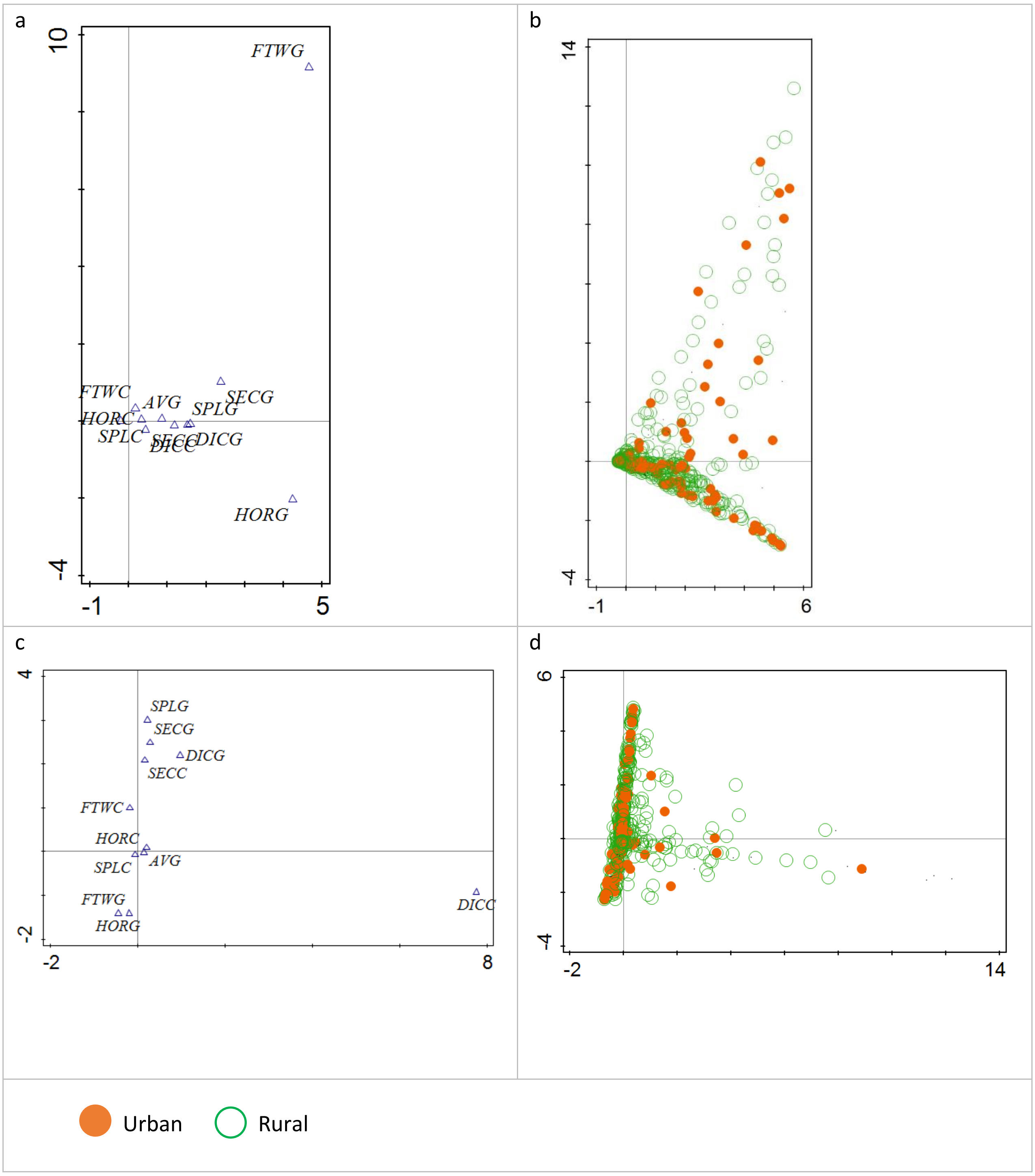


Figure 5.16. Correspondence analysis plots of cereal content (grains and chaff) of Romano-British fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples coded as urban or rural (Axes 1x2), (c) species plot (Axes 3x4), (d) sample plot with samples coded as urban or rural (Axes 3x4). Taxa codes are given in Table 5.4.

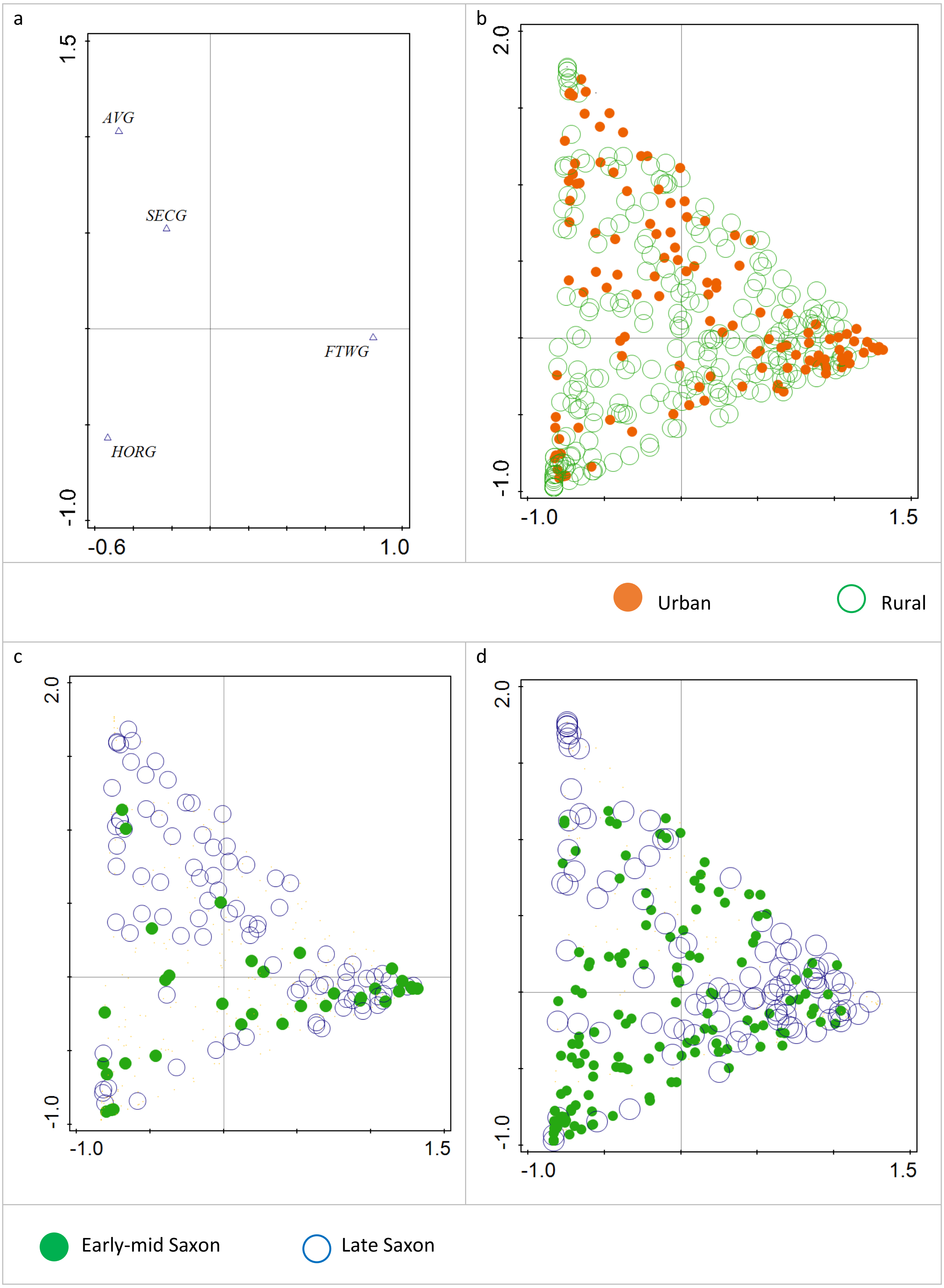


Figure 5.17. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples (Axes 1x2): (a) species plot, (b) sample plot with samples coded as urban or rural, (c) sample plot with urban samples highlighted and coded by temporal sub-period, (d) sample plot with rural samples highlighted and coded by temporal sub-period. Taxa codes are given in Table 5.4.

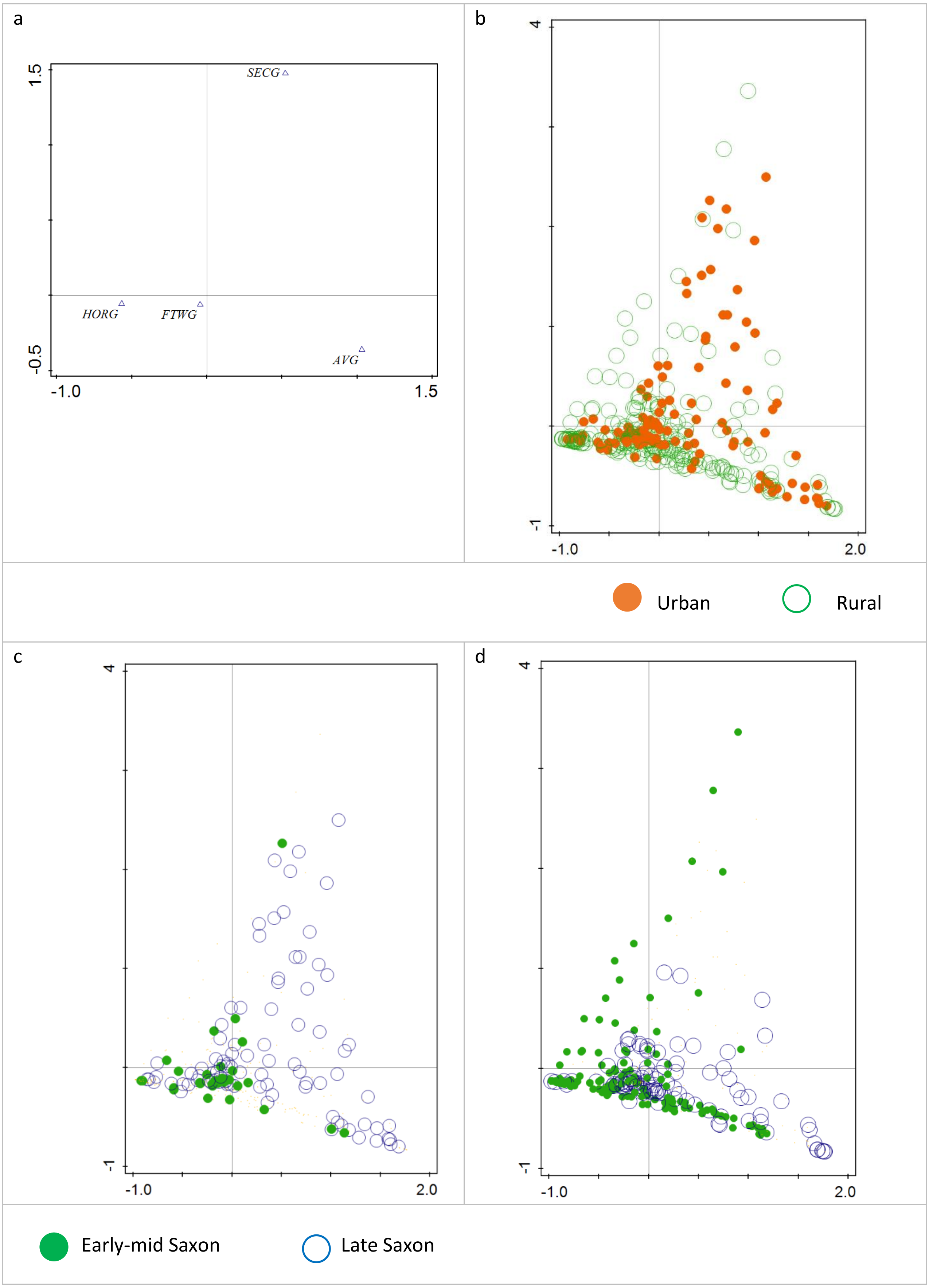


Figure 5.18. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples (Axes 2x3): (a) species plot, (b) sample plot with samples coded as urban or rural (c) sample plot with urban samples highlighted and coded by temporal sub-period, (d) sample plot with rural samples highlighted and coded by temporal sub-period. Taxa codes are given in Table 5.4.

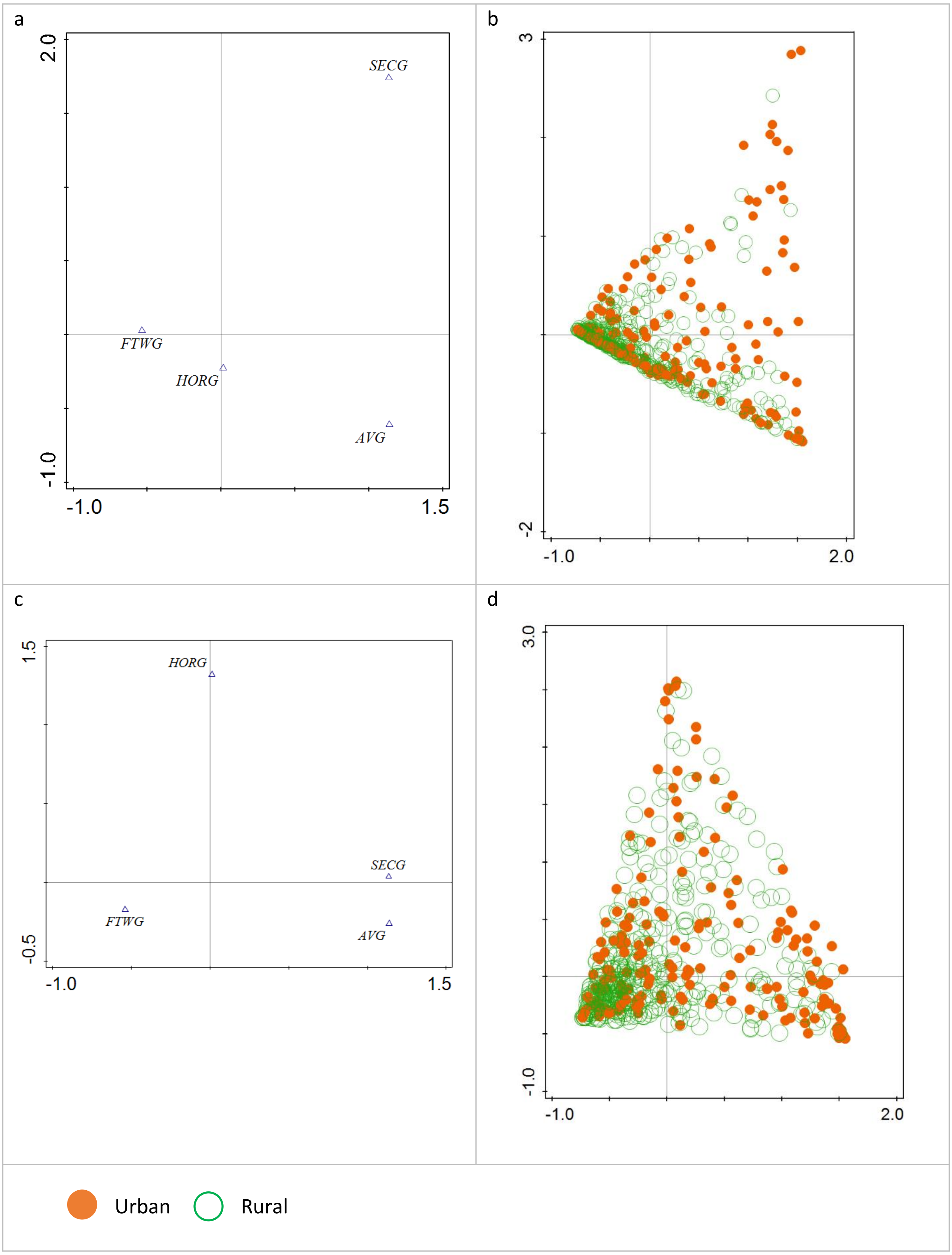


Figure 5.19. Correspondence analysis plots of free-threshing cereal grain content of Medieval fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples coded as urban or rural (Axes 1x2), (c) species plot (Axes 1x3), (d) sample plot with samples coded as urban or rural (Axes 1x3). Taxa codes are given in Table 5.4.

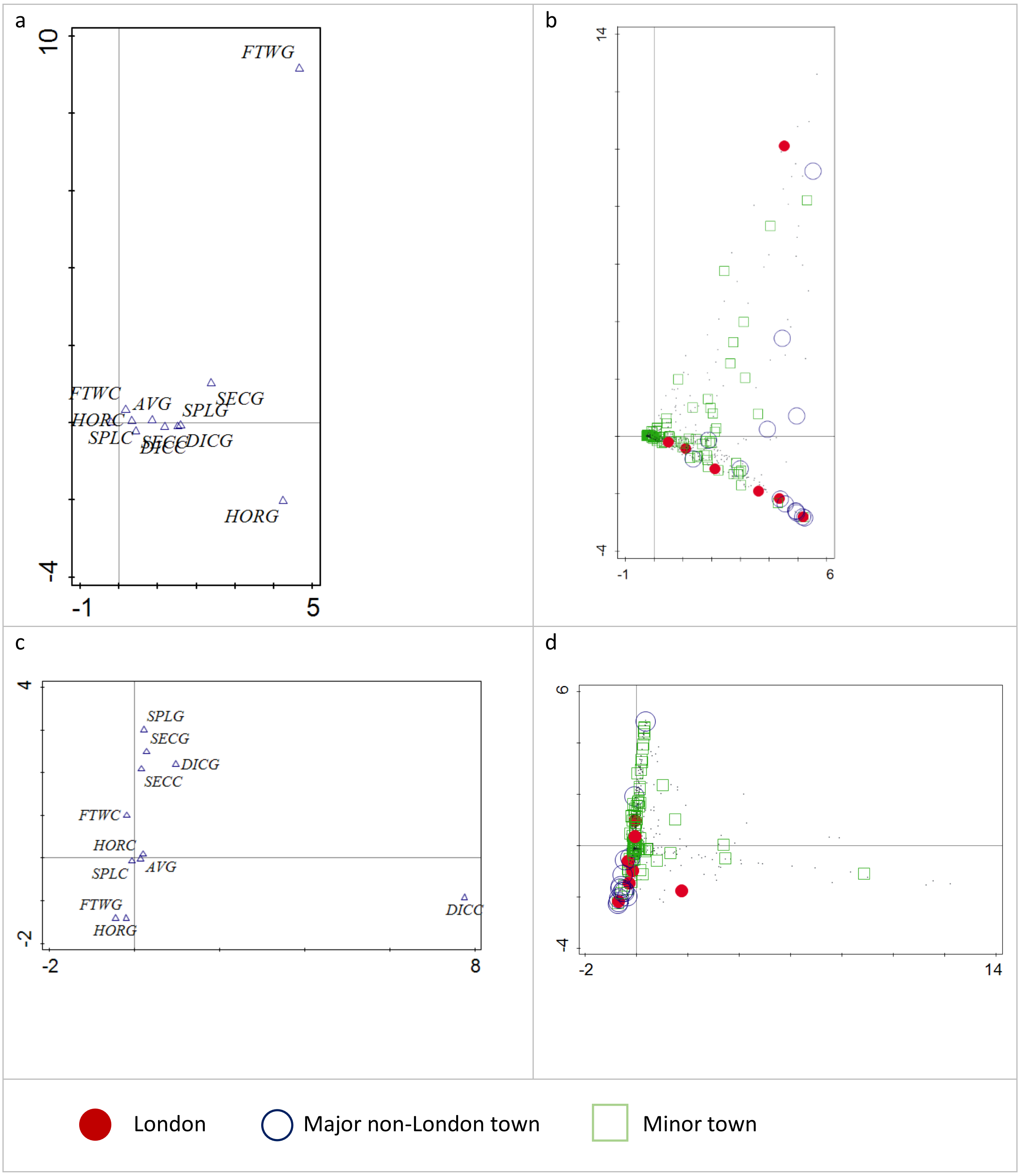


Figure 5.20. Correspondence analysis plots of cereal content (grains and chaff) of Romano-British fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with urban samples highlighted and coded by town size (Axes 1x2), (c) species plot (Axes 3x4), (d) sample plot with urban samples highlighted and coded by town size (Axes 3x4). Taxa codes are given in Table 5.4.

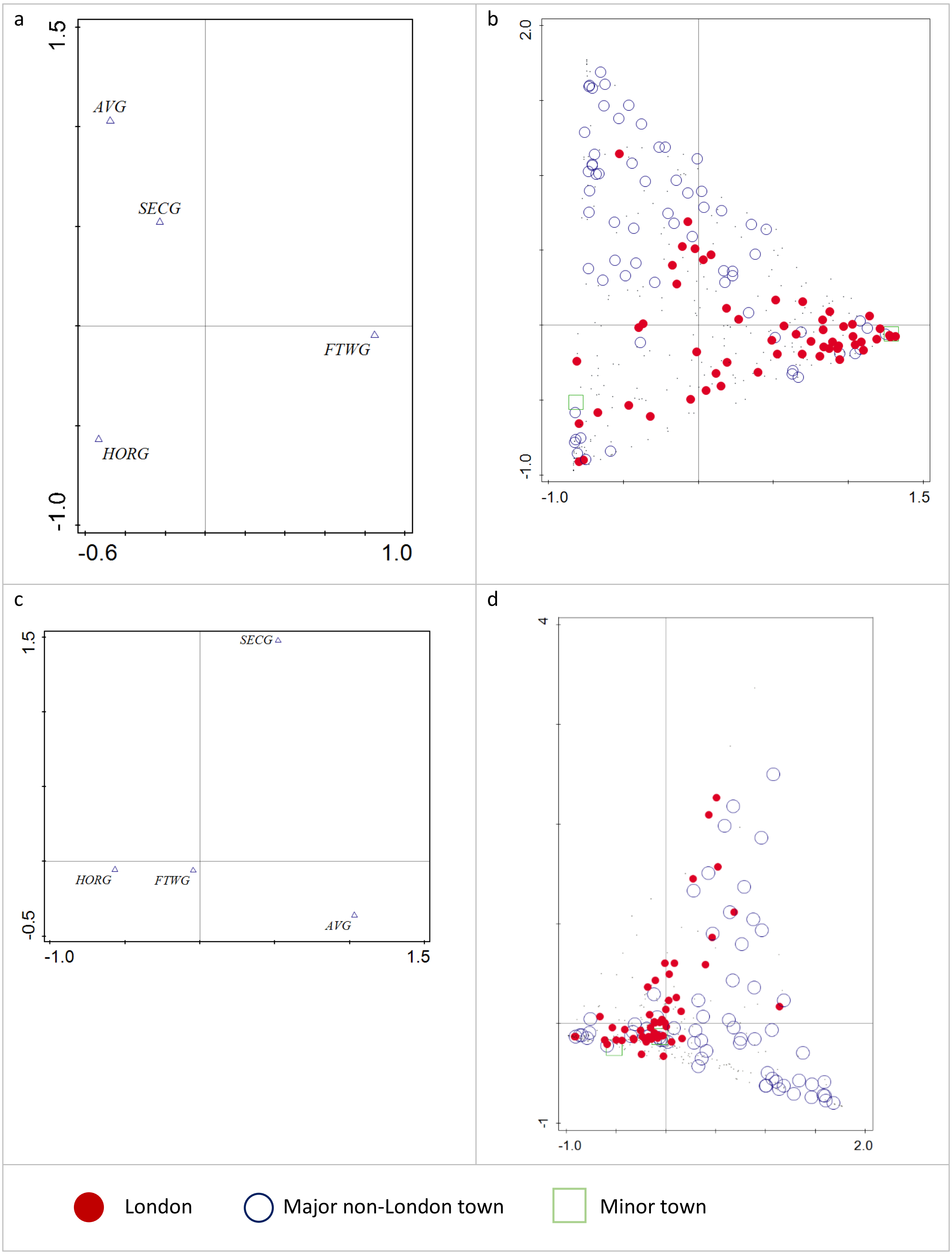


Figure 5.21. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with urban samples highlighted and coded by town size (Axes 1x2), (c) species plot (Axes 2x3), (d) sample plot with urban samples highlighted and coded by town size (Axes 2x3). Taxa codes are given in Table 5.4.

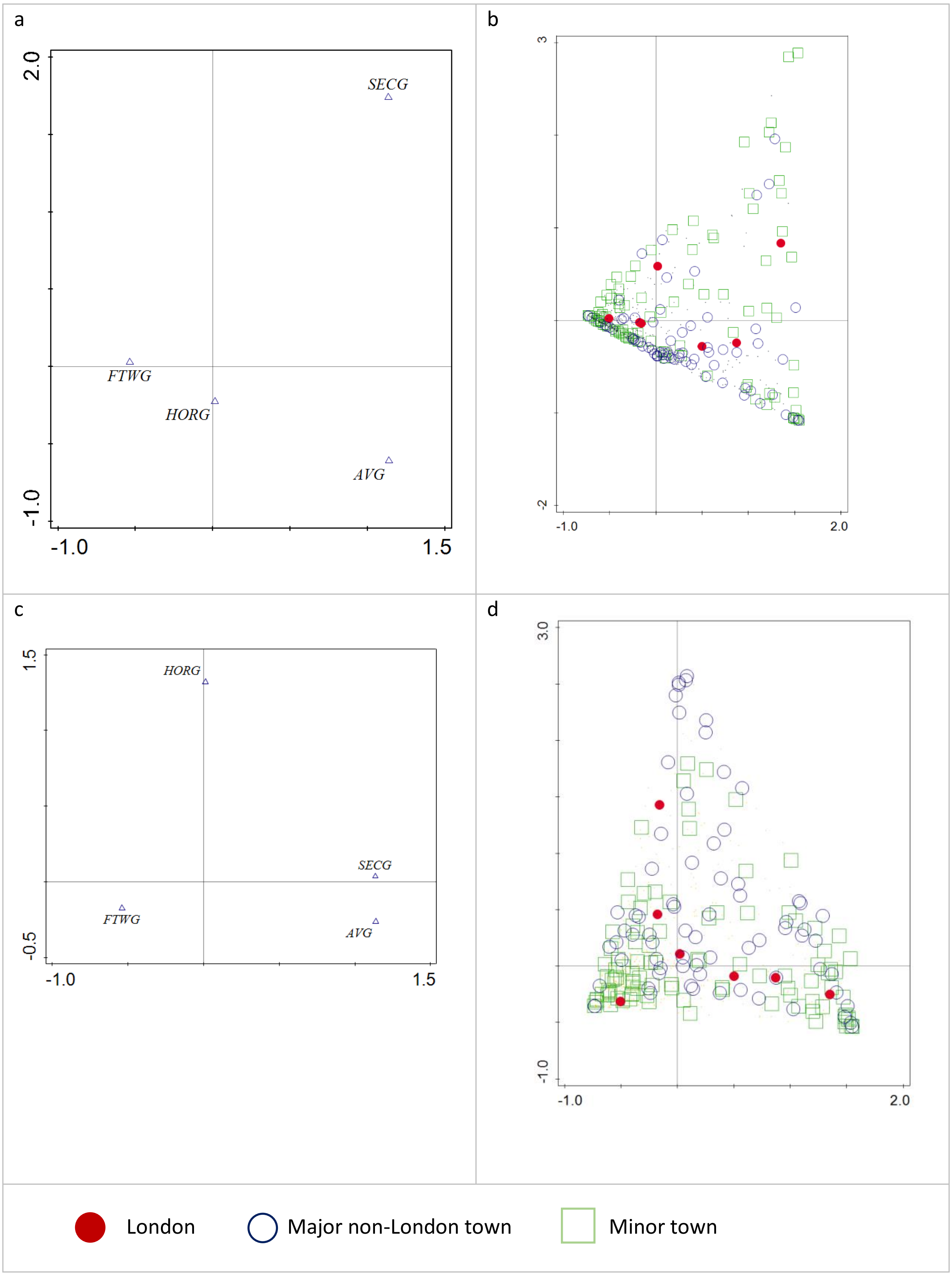


Figure 5.22. Correspondence analysis plots of free-threshing cereal grain content of Medieval fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with urban samples highlighted and coded by town size (Axes 1x2), (c) species plot (Axes 1x3), (d) sample plot with urban samples highlighted and coded by town size (Axes 1x3). Taxa codes are given in Table 5.4.

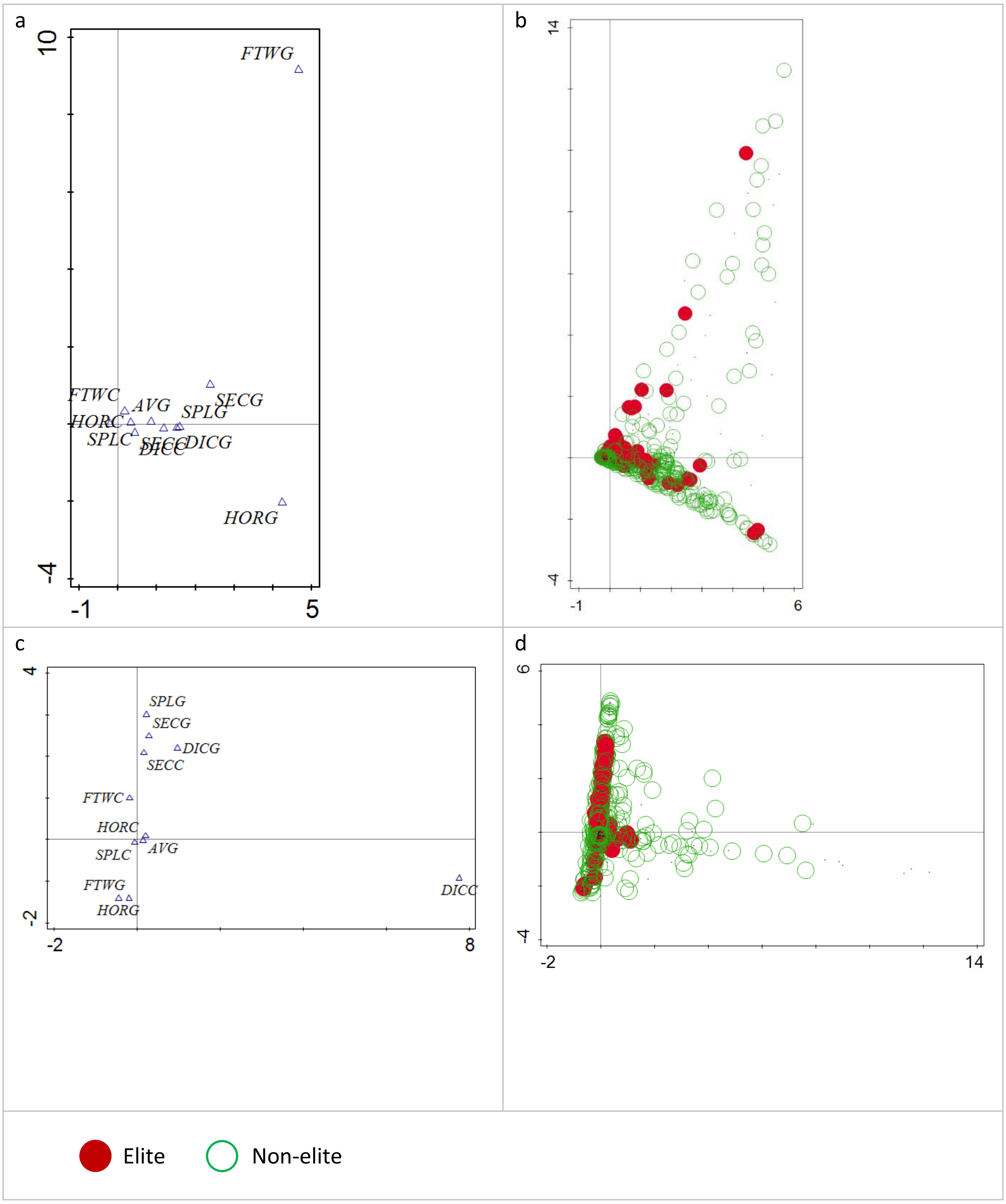


Figure 5.23. Correspondence analysis plots of cereal content (grains and chaff) of Romano-British fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples from rural secular sites highlighted and coded by elite or non-elite status (Axes 1x2), (c) species plot (Axes 3x4), (d) sample plot with samples from rural secular sites highlighted and coded by elite or non-elite status (Axes 3x4). Taxa codes are given in Table 5.4.

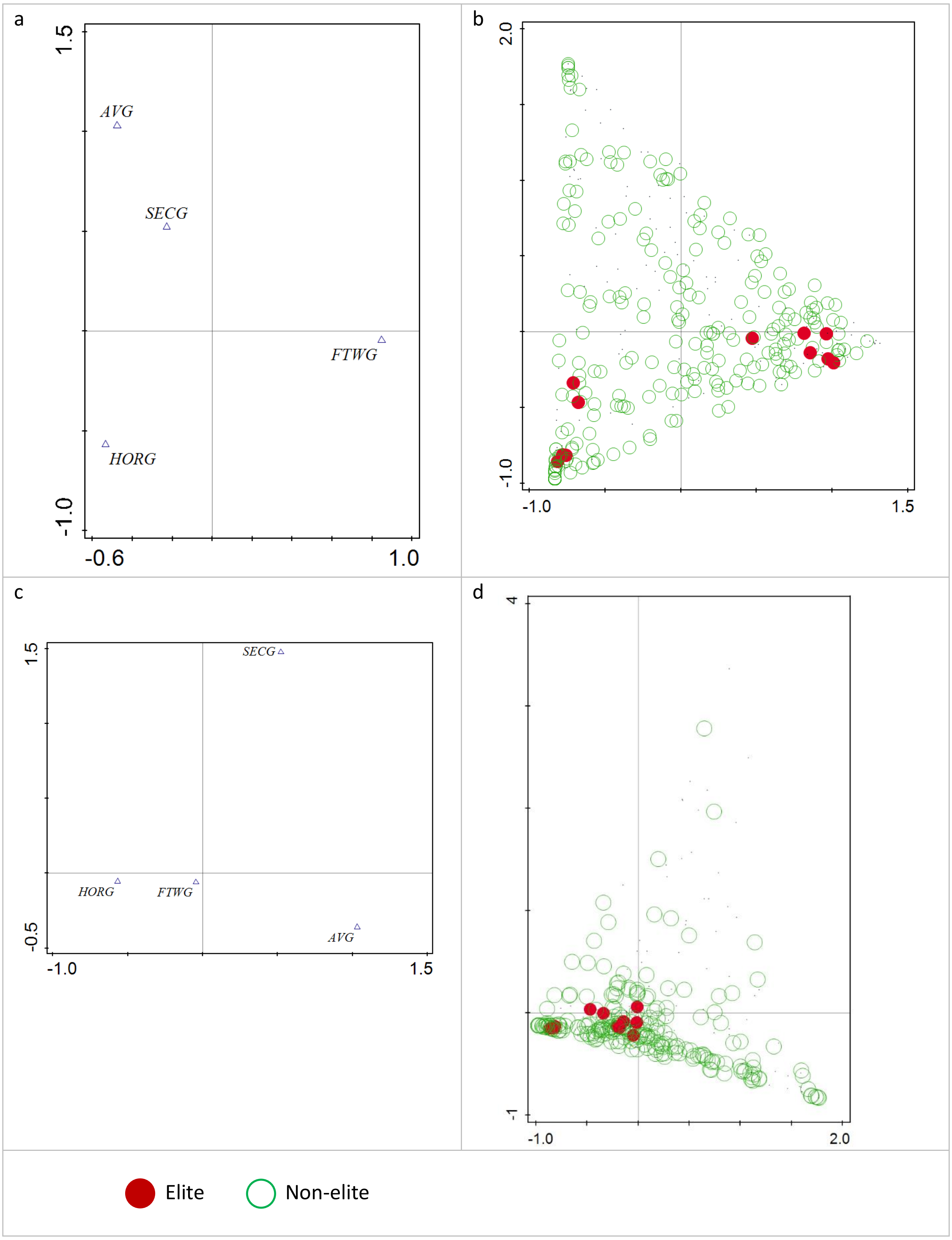


Figure 5.24. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples from rural secular sites highlighted and coded by elite or non-elite status (Axes 1x2), (c) species plot (Axes 2x3), (d) sample plot with samples from rural secular sites highlighted and coded by elite or non-elite status (Axes 2x3). Taxa codes are given in Table 5.4.

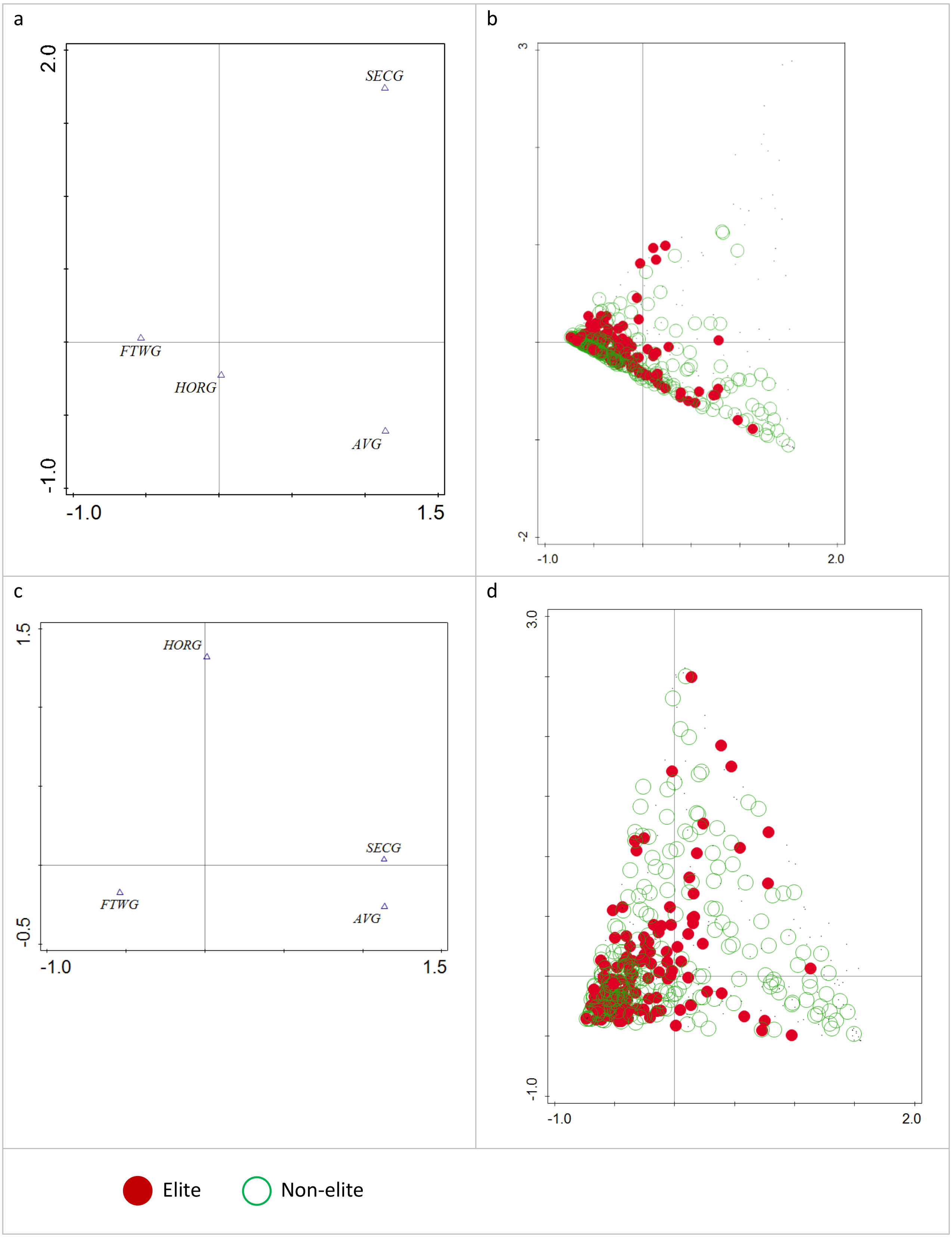


Figure 5.25. Correspondence analysis plots of free-threshing cereal grain content of Medieval fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples from rural secular sites highlighted and coded by elite or non-elite status (Axes 1x2), (c) species plot (Axes 1x3), (d) sample plot with samples from rural secular sites highlighted and coded by elite or non-elite status (Axes 1x3). Taxa codes are given in Table 5.4.

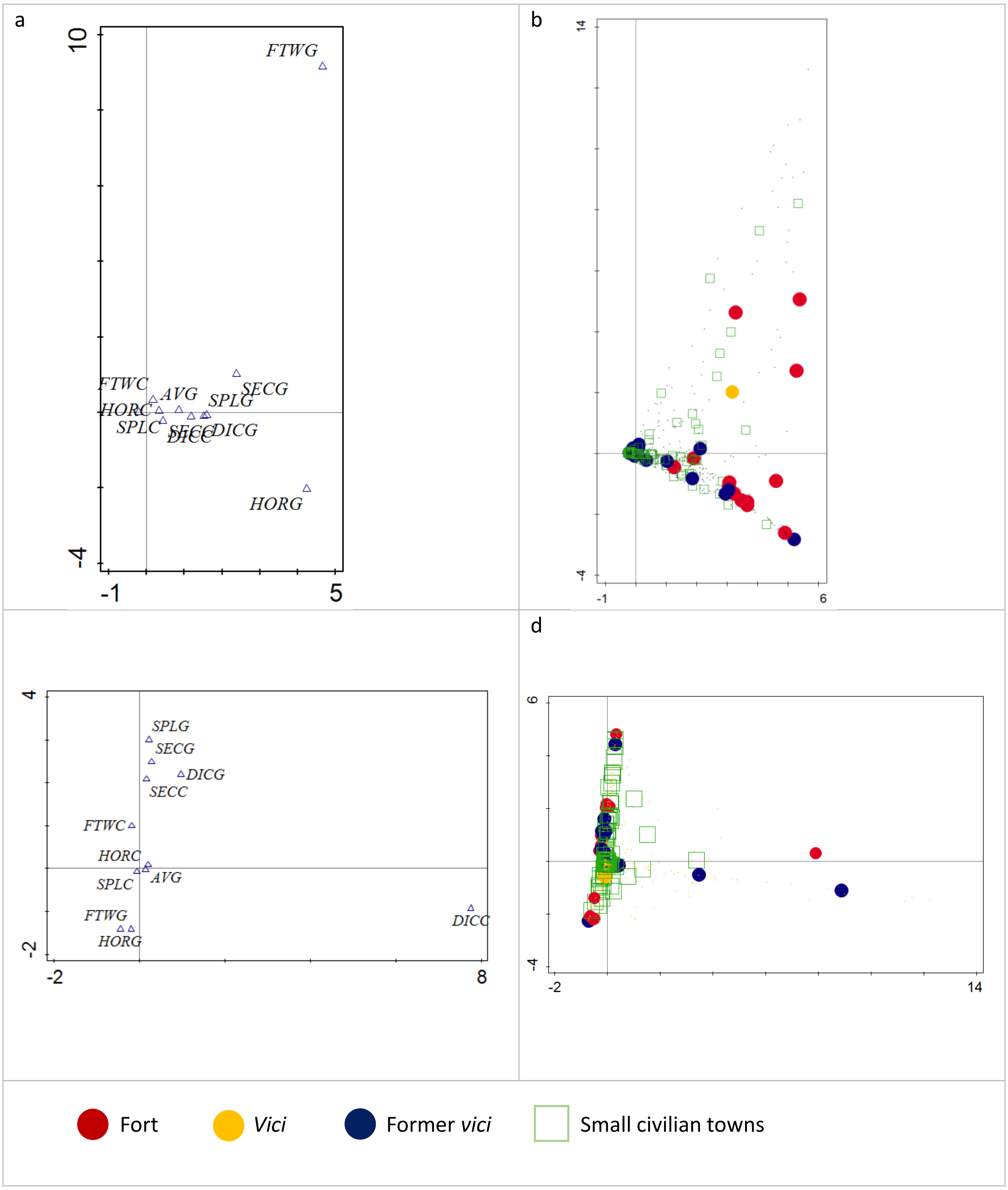


Figure 5.26. Correspondence analysis plots of cereal content (grains and chaff) of Romano-British fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples from forts, *vici,* former *vici*, and small civilian towns (with no military influence) highlighted and coded by site type (Axes 1x2), (c) species plot (Axes 3x4), (d) sample plot with samples from forts, *vici*, former *vici*, and small civilian towns (with no military influence) highlighted and coded by site type (Axes 3x4). Taxa codes are given in Table 5.4.

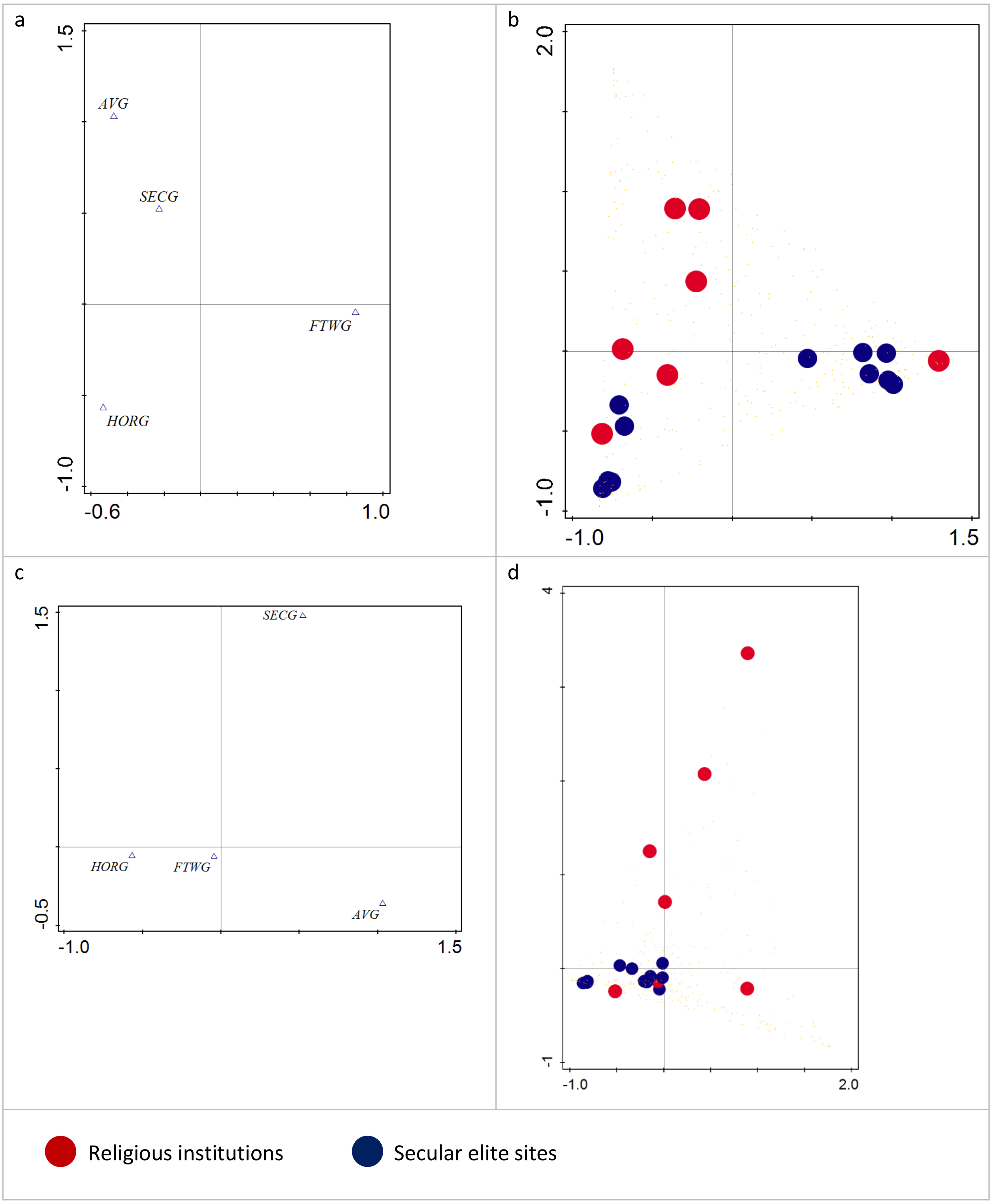


Figure 5.27. Correspondence analysis plots of free-threshing cereal grain content of Saxon fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples from religious institutions and secular elite sites highlighted and coded by site type (Axes 1x2), (c) species plot (Axes 2x3), (d) sample plot with samples from religious institutions and secular elite sites highlighted and coded by site type (Axes 2x3). Taxa codes are given in Table 5.4.

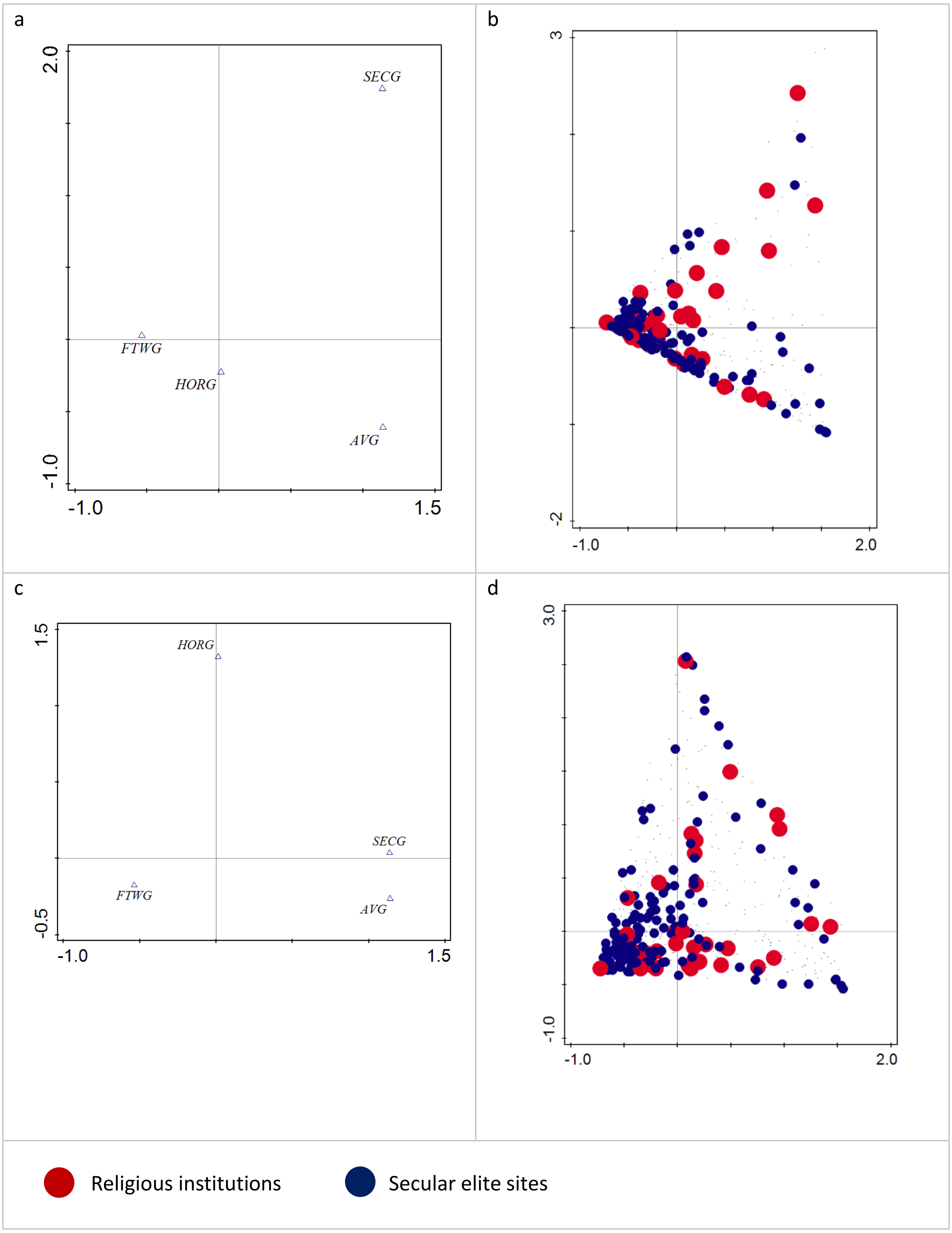


Figure 5.28. Correspondence analysis plots of free-threshing cereal grain content of Medieval fine sieve by-product samples: (a) species plot (Axes 1x2), (b) sample plot with samples from religious institutions and secular elite sites highlighted and coded by site type (Axes 1x2), (c) species plot (Axes 1x3), (d) sample plot with samples from religious institutions and secular elite sites highlighted and coded by site type (Axes 1x3). Taxa codes are given in Table 5.4.