Burning by numbers: Cremation and cultural transitions in Late Iron Age and Roman Britain (100BC – AD410).

Doctor of Philosophy

Department of Archaeology

EMILY CARROLL

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DECLARATION

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

E. Carroll

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Abstract

Late Iron Age and Roman Britain witnessed numerous cultural transitions. While these processes have received significant attention with regards to material culture, it is only recently that bioarchaeological research has considered the role of funerary practices and what they can contribute to our understanding of these phenomena. The primary mortuary rite during this period was cremation. Although previously thought to contain limited information compared to inhumation burials, current research now recognises that they hold the potential to reconstruct entire funerary sequences, from the building of the pyre, to the final deposition within the grave. Recent methodological advances in the field allow us to infer a wealth of information concerning burning practices and pyre technology that could not be achieved before.

This study conducted a large survey of 2375 cremation deposits dating from the 1st century BC to the 4th century AD from Britain to establish trends according to both region and settlement type. The results found that while age, grave and pyre goods remained consistent across all settlement types and regions, the male / female ratio and burial type changed following the Roman conquest. This demonstrates the prolonged continuation of Late Iron Age traditions, alongside the uptake of more Roman-styled customs. Further trends were identified primarily rooted in different methodological practices adopted by different analysts and emphasise the need for standardisation. The primary analysis in this thesis focused on 102 cremation deposits from Hertfordshire combining archaeological, environmental, and osteological data. It found that cremation technology differed on an inter-cemetery and settlement type basis. It is possible that this was caused by the introduction of *ustores* or professional cremators to Roman towns, representing increased 'industrialisation' of funerary practices.

This project also developed a new method for quantifying microscopic heat-induced alterations in burned bone using petrography. This technique reduces the risk of inter-observer bias that hinders other, qualitative methods and allows for the statistical categorisation of burning intensity.

Overall, this thesis has demonstrated the value of funerary data (cremation) in the examination of cultural transitions in Late Iron Age and Roman Britain; it highlights how society was a fluid concept characterised by the continuation of pre-conquest ideals, the uptake of Roman customs and the creation of new cultural identities.

Chapter 1: Introduction

1.1 Research Background

1.1.1 Culture Studies in Late Iron Age and Roman Britain

The Late Iron Age to Roman transition in Britain has been a prominent focus in archaeological studies for over a century (Haselgrove and Moore, 2007; Hingley, 2016); a period defined by cultural, social and technological change including the widespread use of continental wares, the introduction of wheel turned pottery and increased urbanisation, scholars have striven to understand the manifestations of cultural change and the mechanisms that caused them.

Research has primarily focused on material evidence as a means of examining this phenomenon (Jones, 1997; Hingley, 1997; Mattingly, 1997; Carr, 2006; Pitts, 2014; 2015). While this approach has its benefits given the wealth and diversity of Roman objects recovered from Britain, it overlooks the many other forms of evidence that can contribute to this field of research, specifically burial data.

Since the 1990s, funerary evidence has become increasingly prominent in Roman studies (Pearce, 2000; 2008). The volume 'Burial, Society and Context in the Roman World' edited by Pearce, Millett and Struck (2000) was instrumental in formulating this new area of research. It concluded with a holistic interpretation of cultural processes that informed the manifestation of provincial burial rituals, cemetery organisation and memorial construction (Yasin, 2002; Rife, 2006).

Following on from this volume, scholars have come to recognise the importance of funerary data to reconstructing cultural transitions in this historical context. Recently, studies have focused on identifying social mobility (physical movement) and migrant communities from burial contexts (Swift, 2010; Eckardt, 2010), establishing the impact of cultural change on health in Roman Britain (Lewis, 2010; Redfern and DeWitte, 2011) and reconstructing the evolution of funerary rituals following the Roman conquest (Fitzpatrick, 2000; Pearce, 2015).

1.1.2 Cremation Research in Late Iron Age and Roman Britain

Despite being the predominant burial rite for large parts of British Prehistory, including the 1st century BC to the 2nd/3rd centuries AD, cremation deposits have been largely understudied compared to other burial practices (McKinley, 1994; 2015a; Williams, 2008; Thompson, 2015a). This is due to the misconception that burned human bone is a poor source of osteological data (Williams, 2008), which deterred many from conducting more in-depth analyses of these burial contexts (Wells, 1960).

Within the last few decades however, there has been a surge in cremation research resulting in significant advances in both the scientific and theoretical examination of these deposits (Schmidt and Symes, 2008; 2015; McKinley 2015a, p.vii; Thompson, 2015a; Cerezo-Román, et al., 2017). In the context of Late Iron Age and Roman studies, Pearce (1997; 1998) has been instrumental in overturning previous perceptions by demonstrating the unique ability to reconstruct funerary process. Drawing parallels from anthropological studies by Metcalf and Huntington (1992) to examine the different stages involved in Late Iron Age and Roman cremation funerals, Pearce (1997; 1998; 2016) has emphasised the impact of Roman customs on provincial burial practices through examining the use of grave goods and their positioning within burial contexts.

The importance of this research cannot be denied; however, this body of work is again heavily focused on the examination of material culture from cremation contexts. While this methodological framework compliments contemporary studies outside of funerary contexts, it is rather one-dimensional and does not make satisfactory use of all of the available burial data. Methodological advances in the analysis of burned human bone have enabled scholars to reconstruct burning conditions (Squires, et al., 2011; Thompson, et al., 2016), while increased application of archaeobotanical analysis has allowed for the examination of practical and ritual fuel use in Roman cremation funerals on the continent (Figueiral, et al., 2010; Deforce and Haneca, 2012). By combining these different types of analyses, a fuller picture of cremation in the past can be ascertained. The selection of certain wood types may indicate differences in social strata, which can help to reconstruct social attitude towards death and identify different cultural groups. Variations in burning conditions, evident from examining the heat-induced alterations in burned bone, can be used to establish different cremation practices, which will in turn reflect varations in socio-cultural dynamics and responses to Roman occupation.

To date, only a handful of papers have adopted a multi-disciplinary approach to examine cremation practices in this historical context (Thompson, et al., 2016; Cerezo-Román, et al., 2017). Despite their scarcity, these studies have successfully examined the different stages of mortuary ritual and explored cultural dynamics following the Roman conquest. Thompson et al., (2016) examined cremation deposits from Roman military sites in the north of Britain. Their combination of macroscopic and microscopic examinations of burned bone alongside material culture studies found that cremation on the norther frontier followed a prescriptive process that may be distinct from other cultural groups. In the context of Gallo-Roman Luxemburg, Belgium, Cerezo-Román and colleagues (2017) combined osteological, archaeological and environmental analyses to examine cremation practices from two contemporary cemeteries. Utilising Roman accounts of cremation funerals as references, they concluded that the many funerary rituals resulted in a changing social persona of the deceased demonstrative of creolization.

1.2 Research Aims and Objectives

This study builds on work examining cremation practices and technology in Late Iron Age and Roman Britain, by employing a multi-disciplinary approach combing archaeological, environmental, and osteological data to examine cultural transitions. The research aims were as follows:

- To survey cremation practices in Late Iron Age and Roman Britain and make chronological comparisons according to region and settlement type based on a meta-analysis of published and unpublished data.
- To conduct a primary analysis of cremation technology (including charcoal analysis, osteological invesigation, as well as the macroscopic and microscopic assessment of heat-induced alteration in burned bone) in Late Iron Age and Roman Hertfordshire, and identify any trends according to cemetery, settlement type, sex, age and number of grave goods.

To achieve the first research aim, a survey of cemeteries dating from the 1st century BC to the 4th century AD was conducted. Burial grounds throughout Britain (excluding Wales) from different social, economic backgrounds (rural and urban settlements) were included in the study sample.

In reference to the second research aim, a total of five cemeteries from Hertfordshire dating from the 1st century BC to the 4th century AD were selected for this primary investigation. These included: Wallington Road, Baldock, Folly Lane, St Albans, Cross Farm, Harpenden, M1 Junction and Spencer Park, Hemel Hempstead. These cemeteries represent a mixed rural and urban group, including both males and females, as well as individuals of different ages and social-status. A multi-disciplinary method combining osteological, archaeological and environmental analyses was employed to reconstruct cremation technology.

1.3 Structure of Thesis

This thesis is organised into nine chapters that examine cultural transitions in cremation practices and cremation technology in Late Iron Age and Roman Britain. It references Roman accounts of cremation funerals and draws parallels with previous archaeological and osteological research.

Chapter 2 reviews research examining the Late Iron Age to Roman transition. Effort is made to discuss the nature of archaeology in Late Iron Age and Roman Britain separately in order to highlight themes of continuity and change in order to fully explore the context in which this research is placed. Debates surrounding theoretical approaches to Roman archaeology are also reviewed to understand evolving perceptions of cultural change during this historical period. The nature of the burial record is described, and focus is given to the way in which scholars have interpreted burial rituals as a means of examining provincial society.

Chapter 3 outlines cremation research by providing a historical overview of the field and drawing out current research themes and limitations. This chapter includes a scientific review of the cremation process, specifically skeletal responses to extreme heat exposure. It discusses both the macroscopic and microscopic heat-induced alterations in burned bone, and reviews current analytical methods.

Chapter 4 describes the primary and secondary datasets compiled in this thesis. Classifications of recorded properties (time period, settlement type, region, burial type, age and sex catgories, grave and pyre goods) are outlined to clarify how regional, chronological and settlement types were defined, alongside other terminologies employed. The archaeological background of all five cemeteries from Hertfordshire examined in the primary analysis is provided to establish the condition of the archaeological material, and also draw attention to the social and economic context from which these populations derive. The methods employed in both the primary and secondary investigations are outlined, as well as the statistical analyses and the inter-observer studies conducted to establish the reliability of the data and techniques employed. The new quantitative petrographic method developed out of this research is also described and discussed.

Chapter 5 presents the results of the survey of cremation practices from Late Iron Age and Roman Britain. Each aspect is examined in relation to region and settlement type. Any cremation deposits recorded as 'Undated' are not included in this analysis.

Chapter 6 outlines the results from the primary analysis of Hertfordshire. The Roman cremation deposits are first examined, and then comparisons are made with the few Late Iron Age individuals included. The results from both inter-observer studies are also presented, as well as the categorising system generated from the quantitative petrographic results.

Chapters 7 and 8 review the application of quantitative petrography in the analysis of burned human bone, specifically drawing parallels with qualitative methods, and discuss trends in cremation practices and technology identified in the context of Late Iron Age and Roman Britain. References are made to Roman literature and previous osteological and archaeological research to identify continued Late Iron Age practices, the uptake of new Roman innovations and the creation of new cultural identities.

This is followed by the conclusion (Chapter 9) that summarises the results and contextualises them more broadly to characterise the nature of society and cultural transitions during this period. Finally, recommendations for future research are discussed in relation to the benefits and limitations identified in this study.

Chapter 2: Literature Review - The Late Iron Age to Roman Transition

2.1 Conceptualising Culture Change

The Late Iron Age to Roman transition in Britain is characterised as a period of immense cultural change, whereby settlements, societies, material culture, and burial practices developed. Understandably, this period has been a major focus in archaeological studies for large parts of the 20th century. As a result, considerable debate surrounds the utilisation of certain terminologies and chronologies. Before reviewing the research field, it is imperative to first establish how these aspects will be defined in this thesis.

2.1.1 Chronology of the Late Iron Age to Roman Transition

Various chronological models have been used to characterise this period (Table 2.1). However, scholars have yet to reach a consensus, which makes comparative research challenging. Hawkes' (1959) original A B C classification of the British pre-Roman Iron Age that was used up until the early 1960s was dismissed by Hodson (1962) for being overly-complicated and not reflecting the changes seen in material culture (Hodson, 1964; Haselgrove and Moore, 2007). It was consequently replaced by a simpler model that distinguished between the Early pre-Roman Iron Age (up to 100/50BC) and the Late pre-Roman Iron Age (100/50BC – 43AD). Underlying this model was the idea of steady development from the Bronze Age followed by a shorter period of change in the run-up to the Roman conquest (Cunliffe, 1974; Haselgrove and Moore, 2007).

More recently, studies have tended to employ their own chronologies rather than using a standard timeline. Papers including those by Haselgrove and Moore (2007), as well as Haselgrove and Pope (2007) separate the Iron Age into 'Earlier' (800 – 300 BC) and 'Later' (400 – 300 BC – Roman Conquest), to emphasise the level of continuity during this time period.

With regards to the funerary record, Stead's (1976) analysis of the Aylesford cremation burials separated the Late pre-Roman Iron Age into 'Welwyn' (50 – 15 BC) and 'Lexden' (15 BC – AD 40) phases based on the grave goods recovered from King Harry Lane (Niblett, 2001). While this categorisation would seem appropriate in the context of funerary studies, Stead's chronology does not acknowledge that these items may not have been contemporary with their deposition; as pointed out by Parker Pearson (1999) grave goods have their own life cycles and could have quite easily been heirlooms or antiques when placed within a burial. More recently, Fitzpatrick (2000) has pointed out the uncertainty of the absolute chronology of these phases from King Harry Lane cemetery, especially whether phases 2 - 3 were pre or post conquest. The uncertain nature of the Late Iron Age chronology has been confirmed by the radiocarbon dates ascertained for the cremation burials from Westhampnett, Sussex (Fitzpatrick, et al., 2017). Initially, the cemetery was thought to be active between 90 – 50BC based on the brooches recovered from the graves. However, based on the 14C dates Fitzpatrick et al., (2017) proposed a new start date in the Mid to Late 2nd century BC. These results are significant because they push back cremation practices by several decades, changing the threshold of cultural transition in the burial record.

Based on this review of chronological models this thesis defines the Late Iron Age to Roman transition as the 2nd/1st century BC to the 2nd century AD. This timeline combines previous concepts of the Late Iron Age with recent burial evidence and emphasises the level of continuity which is a major focus in current research (Haselgrove and Moore, 2007).

Table 2.1 Chronologies of the British Iron Age / Roman transition employed in the literature.

Publication	Chronological Phase	Date Range
Hawkes (1959)	Iron I	550 – 350BC
	Iron 2	350 - 150BC
	Iron 3	150BC - onwards
Hodson (1964)	Early pre-Roman	Up to 100 / 50BC
	Late pre-Roman	100 / 50BC - 43AD
Stead (1976)	Welwyn / Early	50 - 15BC
	Lexden / Late	15BC - 40AD
Stead and Rigby (1989)	1	1- 40AD
	2	30-55AD
	3	40-60AD
	4	60-160AD
Cunliffe (2005)	La Tene I	550BC - 350BC
	La Tene II	350 - 250BC
	La Tene III	250 - 50BC
Haselgrove and Moore (2007)	Later Iron Age	400 / 300BC - Roman conquest
Hill (2007)	La Tene C2	175 - 125BC
	La Tene D1	125 - 80BC
	La Tene D2	80 - 20BC
	Early Roman	20BC - 45AD

2.1.2 Defining 'Romanisation'

The term 'Romanisation' is a highly controversial one, which despite countless re-definitions over the last century continues to spark debate (Alcock, 2001; Merryweather and Prag, 2002). This paradigm is not a Roman concept but does have an impressive legacy in Roman studies (Mattingly, 2010). The reason why it has attracted such attention are the negative connotations rooted in colonialist imperialism, western superiority and classism (see Section 2.3 for a historical overview of paradigm).

Most scholars that still use this term today give it a new definition that is appropriate for their own research context; this is usually a rather general classification with the intention of evading criticism. For instance, James (2001, p.206) applies 'Romanisation' in its broadest sense to describe Britain becoming 'outwardly' Roman. Although some have argued that this approach yields a weak interpretation of the past (Merryweather and Prag, 2002), others suggest that it is a useful solution (James, 2001). As such, this thesis will employ a broad definition of 'Romanisation' that will describe any changes during this period, even if they are not necessarily a result of Roman influence.

2.2 The Late Iron Age

Late Iron Age studies for the first half of the 20thcentury were dominated by the 'Belgic Invasion' theory defined by a colonialist mentality. It hypothesised that cultural change in this period was a result of invading Belgic forces from the continent that brought their own material culture and burial rites. Although many scholars agreed that there was a clear link between Britain and Gaul, particularly Gallia Belgica, a few were cautious towards this simplistic invasion hypothesis (Holmes, 1907). Cunnington (1932) highlighted that the change to wheel-turned pottery was a natural progression following the introduction of the potter's wheel and did not require a migration event to be achieved. Similarly, Hodson (1964) argued that it was ill-considered to associate these changes with specific cultural groups; instead, he proposed that these new practices were an imitation of styles by marginal communities.

The edited volume 'Oppida: The beginnings of urbanisation in barbarian Europe' borne out of the processualist movement in archaeological studies provided a new socio-economic framework for studying the Late pre-Roman Iron Age (Cunliffe and Rowley, 1976). Scholars saw cultural change as a response to the intensification of urbanisation caused by increased trade with the continent (Cunliffe and Rowley, 1976; Haselgrove, 1976; Rodwell, 1976). Despite this approach challenging previous colonialist attitudes, it was not particularly popular and was later criticised for externalising cultural change (Fitzpatrick, 2007), and assuming that oppida were urban centres, even though the true function of these sites still eludes scholars today (Woolf, 1993).

The 1980s saw the introduction of the 'Core-Periphery' model in Late Iron Age studies (Haselgrove, 1982; 1984; 1987; Cunliffe, 1988). This theoretical approach inspired by Structural Marxist principles was based on the premise that social elites monopolised trade with the continent, which led to the development of powerful core settlements that smaller communities were dependent on (Hill, 2007).

At the time, this framework was able to combine social, cultural and economic transformation into one over-arching model. However, it has been challenged by Hill (1995; 2007), and Willis (1994) for its emphasis on prestigious goods and elite individuals, as well as its inability to understand the social context in which goods were traded and exchanged.

2.2.1 Settlement Organisation and Landscapes

One extensively researched area in Late Iron Age studies that has been used to explore cultural transitions is the prevalence of enclosed settlements. This phenomenon is characterised by the construction of boundary ditches, banks and pit alignments. Unfortunately, studies are often hindered by fragmentary site chronologies where the phasing of different features is unclear. In addition, there appears to be a tendency in research to focus on individual sites and avoid cross-regional analyses because of the degree of geographical diversity (Moore, 2006).

In his examination of the Later Iron Age landscape of Oxfordshire, Hingley (1984) proposed that the introduction of isolated, enclosed settlements represented a shift towards social and economic independence from neighbouring communities; this in turn suggested the development of new concepts of identity. He did however argue that this transition was regionally specific, referencing the open settlements found in the Upper Thames valley that he considered to be more socially integrated than others found in Oxfordshire. This concept is still widely held today and formulates the basis for current settlement studies (Ferrell, 1995; Hill, 1996; Moore, 2006). Moore (2007) for instance discusses the use of boundaries to define household identities and highlight the complexities of inter-group relationships in the Seven-Cotswolds. These studies recognise how cultural change in the Late Iron Age was not a simple process, and that it varied between individual communities and regions.

Another area of research that has dominated Late Iron Age studies for several decades is the introduction of oppida to the pre-Roman landscape; this has been used primarily to infer transformations of social stratification and culture (Woolf, 1993; Grant, 2002; Moore, 2017). These monuments have been interpretated as urban settlements (Cunliffe, 1976; Haselgrove, 1976), fortified homes of rural social elites / royalty (Wendling, 2013), religious centres and trading hubs (Creighton, 2000). These approaches have been challenged for comparing British oppida with contemporary settlements found on the continent and presuming an affiliation with urbanisation or high-status individuals (Collis, 1984; Hill, 1995; Moore, 2017). The continued referral to oppida as ‘centres’ or ‘core’ settlements has also been criticised, as they are commonly found on the margins of pre-existing complexes (Hill, 1995). The work by Moore (2012; et al., 2013; 2017) has been instrumental in addressing these criticisms by discussing oppida within their wider landscape, and examining the many crafts practiced within them. More recently, he has suggested that they acted as stages/assembly points where leaders could mobilise communities and express power (Moore, 2017).

Unfortunately, because these sites are so diverse and only small areas of them have been excavated, their function and social organisation is still unknown, despite the scope of research conducted. The formation of other site types during this time, including banjo enclosures (a central area enclosed by a ditch and outer bank with a single entrance) (Lang, 2016), and poly-focal complexes (comprising an assortment of enclosed buildings) (Moore, 2012) have been comparatively understudied as a result. This has created a rather inconsistent impression of cultural transitions in Late Iron Age Britain.

2.2.2 Material Culture

The adoption of the potter's wheel during the Late Iron Age period saw a change in ceramic technology, and a simultaneous increase in the diversification of vessels (Hill, 2002). While large bodies of work have focused on establishing typologies based on the morphology of these items, few scholars have explored the specialised function and use of these new objects. Hill (2002) argues that the simultaneous development of new pottery types in the south-east and the continued use of Middle Iron Age traditions in other areas represents a break in the social discourse or social norm, and a shift in behaviour that focused on meals. By extension, this change became a means of expressing different communal identities. Unlike previous imperialist approaches that attributed this shift in technology to continental influences, Hill argues that it was a result of internal changes that increased the demand for exotic foodstuffs. Similarly, Pope (2003) suggests that changes in the use and function of vessels was caused by indigenous development and increased external contact.

The increase in continental ceramic imports in the British Late Iron Age is well established. Scholars have primarily used this corpus of evidence in debates surrounding provincial Roman theory (Millett, 1990; Hingley, 1997; Jones, 1997; Mattingly, 1997). Discussions have taken the occurrence of continental wares in Late Iron Age contexts as an indication of increased contact with the continent. Studies have been heavily criticised for assuming they functioned as elite or high-value items and were treated differently from local wares (Willis, 1994). Pitts (2004; 2005; 2006; 2014) has been instrumental in challenging this school of thought by giving equal importance to both local and imported items and employing a 'bottom up' approach (starting from low status to high status). Pitts (2014) argues that an object's function and use is not fixed but varies depending on the contextual and social dynamics. Like Hill (2002), Pitts (2014) has stressed the use and function of imports as expressions of individual and communal identity. He uses the example of Elms Farm to suggest that the presence of amphora represents the creation of distinct identities and social divisions.

Current research in Late Iron Age studies focuses on examining regional and communal identities, as well as individuals as agents of change through the study of landscapes, material culture, and to a lesser extent burial practices (Sharples, 1990; Hill, 1997; 2007; Moore, 2003; Hamilton, 2007; Pearce, 2015). High-status individuals are still the primary focus of contemporary studies (Creighton, 2000; Pearce, 2015), while non-elites remain comparably understudied (Joy, 2012). Efforts have also been directed towards examining internal causes of change rather than looking to the continent (Fitzpatrick, 1989; Hill, 2007; Thurston, 2009), and greater importance has been placed on continuity from the Middle Iron Age into the Late Iron Age and Roman periods (Hill, 1995; Champion, et al., 2001; Haselgrove and Moore, 2007).

2.3 The Late Iron Age to Roman Transition

The term 'Romanisation' was first applied in the Late 19th and Early 20th century to describe what had been interpreted as the civilising of barbarian culture by replacing it with Roman customs, including art, language, religion and architecture (Mommsen, 1885; Haverfield, 1912). This theoretical framework characterised by western imperialistic values formed the basis for understanding the Late Iron Age to Roman transition in contemporary literature for most of the 20th century (Rivet, 1958; Frere, 1967); today, it is still considered influential with its emphasis on the 'homogenisation' of cultures (Woolf, 1998; Webster, 2001, p.211). Collingwood (1932), who was Haverfield's successor in Romano-British archaeology (Carr, 2006), highlighted several issues with this school of thought and was the only real alternative to Haverfield's work prior to the post-colonialist movement of the 1990s. Instead, he proposed the concept of cultural fusion that led to the development of a hybrid culture; by extension, he suggested the possibility of native resistance, as well as acceptance of Roman culture without the desire for becoming Roman.

In the late 20th century, Millett (1990) redefined 'Romanisation', and suggested that it was the native elites through their emulation of Roman customs that led to the spread of Roman culture. This redefinition was heavily criticised for its lack of sympathy towards local groups and conquering parties, as well as its bias towards high status individuals (Hingley, 1997; Woolf, 1997). This approach saw social elites as instrumental in cultural transformations. Their engagement in Roman customs, with the intention of distinguishing themselves from other social groups, would have resulted in other locals adopting Roman practices. This approach is still used by some today to characterise the interaction between native Britons and Roman material culture (Dannell and Mees, 2015).

In response to this theory of social emulation, the concept of native resistance to Roman customs gained momentum, and studies examining the Late Iron Age to Roman transition turned to post-colonialism (Webster, 1996; Mattingly, 1997). This framework emphasised the importance of native identities, but simultaneously created an unhelpful dichotomy between natives and Romans (Mattingly, 2011; Woolf, 1997). This body of work made a point of avoiding the term 'Romanisation', and instead discussed what it meant to be 'Roman' and 'local'. This led to several important studies, including Mattingly (1997), Hingley (1997) and Jones (1997), who presented new interpretations of material culture that are still very influential in studies today; objects are viewed as socially-embedded, and demonstrative of both individual and communal identities. In other words, what was considered to be a 'Roman' object could have a different meaning for different people (Carr, 2006).

Alongside this change in material culture studies, the post-colonialist movement also influenced funerary research. In his cross-comparison of the cremation cemeteries of Westhampnett, Sussex, Clemancy, Luxembourg, and Acy-Romance, France, Fitzpatrick (2000) proposed that 'Romanisation' was ill-equipped to explain the diversity and complexity of localised beliefs and burial rites. Instead, he suggested that research should focus on incorporating the heterogeneity of mortuary rituals into the concept of 'Romanisation'. This argument embodies the general dissatisfaction with the definition of this process. Pearce (2015, p.223) has recently criticised this argument however, for focusing on the continuity of local, native Iron Age traditions. He states that it underestimates the degree of change that was taking place. Instead, he proposes that the recurring objects placed in graves represented a desire to express an urbane sociability that epitomises 'Roman'- style savoir faire.

In response to the general dissatisfaction with the discipline's terminology, Webster (2001) suggested the concept of 'Creolization' to replace the highly criticised 'Romanisation'. This model was adopted from modern linguistic studies to describe the creation of a new hybrid culture through the mixing of two or more groups. It was Webster's intention for this new model to solve the long-standing issues surrounding the 'Romanisation' debate. However, it has been criticised for being too doctrinaire, by imposing a new universal model that overlooks the complexity of cultural change (Mairs, 2010). In addition, its use of the term 'hybrid' suggests an element of superiority that is not politically neutral (Hingley, 2017). A few studies have applied this theoretical framework in the examination of personal adornment, dress items (Carr, 2006) and cremation burials (Cerezo-Román, et al., 2017).

A project based at the University of Reading employed 'Diaspora' as a theoretical tool to examine cultural identities in Roman Britain. It emphasised social dispersal away from a homeland under varying circumstances, and the cultural repercussions of migration (Eckardt, 2010; Leach, et al., 2010). A combination of material culture, osteological and isotope research was conducted to identify incomers and establish how they differed from those belonging to the host society. This research remains one of the most high-profile, multi-disciplinary examinations of cultural transitions in Roman

Britain. Despite the success of identifying social dispersal, this methodological approach has not been applied more widely.

A recent edition of 'Archaeological Dialogues' edited by Versluys (2014) suggested globalization as a new approach to examine the Late Iron Age and Roman transition. This framework proposes that cultural change was induced by local and global networks created by the Roman Empire that reached beyond provincial boundaries (Hodos, 2017). This concept has once again been primarily explored through the examination of material culture (Hingley, 2005; Pitts, 2014; Pitts and Versluys, 2015). Pitts (2015) in particular argues that this new model creates a shift in the understanding of artefacts, whereby they are vehicles of identity separated from social practices and do not consist of fixed meanings or uses.

2.3.1 Settlement Organisation and Landscapes

The landscape during the Late Iron Age to Roman transition in Britain was characterised by increased urbanisation, which heightened the dichotomy between rural and urban populations (Redfern, et al., 2015). Research has primarily focused on the development of towns and capitals in order to explore cultural changes (Pitts, 2014; Rogers, 2016), as well as the impact of urban complexes on rural communities (Pitts, 2016). In Pitts and Perring's (2006) investigation of Late Iron Age and Roman Colchester for instance, they concluded that variations in the deposition of pottery before and after the conquest reflected transitions in socio-cultural groupings and identities. Despite the large scope of research conducted, studies have traditionally focused on urban sites and have tended to stereotype rural settlements as villas and farmsteads owned by social elites. More recently however, scholars have started to recognise that the rural landscape was not only inhabited by those of high status; Mattingly (2006) for instance in his 'An Imperial Possession: Britain in the Roman Empire' examined the concept of the rural non-elite. This introduced an entirely new social dynamic that has been considerably understudied (Fulford, 2018). Most recently, the 'Rural Settlement of Roman Britain' project has showcased the archaeology of the Roman countryside (Smith, et al., 2016; Allen, et al., 2018). This project has not only demonstrated the extent of rural archaeology available, but also emphasises the importance of rural communities during the Late Iron Age to Roman transition. The research potential for comparing different site types has been demonstrated by Eckardt (2005), Mattingly (2006), and Swift (2010) to name a few, where substantial variation has been identified between rural, urban and military sites. Future research should use a similar methodological approach.

2.3.2 Material Culture

The increased diversification and quantity of material culture during the Roman period is well established (Blagg and Millett, 1990; Pitts and Versluys, 2015; Gardner, 2016). The function and use of these items have been extensively examined in relation to theoretical frameworks and cultural identity, as previously discussed (see section 2.3). Current research focusses on developing large dataset of material evidence in order to trace patterns in material culture on both a regional and continental scale. Swift (2010) for example examined bracelets from burial contexts to reconstruct the migration of individuals from the continent to Britain in the Late Roman period. More recently, Pitts' (2017) investigation of the burial inclusions from King Harry Lane demonstrated multiple styles of consumption, which simultaneously reflected a pan-regional cultural milieu. These insights are a testament to the benefits of using large datasets to identify patterns within the archaeological record. Future research would greatly benefit from applying a similar approach.

One recurring theme in Late Iron Age and Roman studies is the primary focus on material culture, even when examining funerary contexts (Cremation burials); rarely have scholars applied a multi-disciplinary approach, combining different types of archaeological evidence. The few that have are either based on continental evidence (Cerezo-Román, et al., 2017), or focus on individuals from one settlement or settlement type only (Leach, et al., 2010; Thompson, et al., 2016).

2.4 The Burial Record of Iron Age and Roman Britain

The Late Iron Age and Roman burial record is characterised by complex practices that were subject to regional and inter-cemetery variation. To provide context the following section briefly describes the many types of funerary practices identified in the Iron Age.

2.4.1 The Early and Middle Iron Age Burial Record

2.4.1.1 Cremation Under Barrows

In the region of Yorkshire, Norfolk and Sussex in the 8th century BC and lasting roughly 200 years, cremation was commonly employed as a burial rite (Cunliffe, 2005). This tradition involved burying burned bones, either urned or unurned, under individual squared-ditched barrows (Whimster, 1981) as seen at Skipworth Common (Stead, 1965) and Ampleforth Moore (Wainwright and Longworth, 1969) in Yorkshire. The construction of these single burial monuments emphasises the importance of individual identities (Harding, 2017). It is thought that this practice was the normative mortuary rite used by all members of the local population (Whimster, 1979). However, to date no osteological analysis has been conducted to confirm this theory.

2.4.1.2 The Arras Culture

Inhumation burials, some placed under barrows and others with chariots, dating from the 5th to the 1th centuries BC have been identified at Garton Slack, (Brewster, 1971), and Wetwang Slack, East Yorkshire (Dent, 1985) as well as Newbridge, Edinburgh (Carter, et al., 2010), Kirburn, Wetwang Village, and Garton Station (Jay, et al., 2012). Females, males, and non-adults are associated with this tradition (Jay, et al., 2012), which has parallels in northern Gaul, demonstrating strong links with the continent. Some have argued that the practice was brought over by migrating groups and used by social elites (Harding, 2017). More recently as part of her PhD thesis, Anthoons (2011) has argued that this inhumation tradition demonstrates the impact of long distance elite networks created through marriage, clientship, hostageship and fosterage. Recent isotopic analysis by Jay et al. (2012) found that most individuals from the chariot burials of Wetwang, Garton Slack, and Kirkburn were born in the area and continued to live locally.

2.4.1.3 Warrior Burials

In the late 2nd century BC and continuing until the Roman invasion a distinct group of inhumation burials emerged where individuals were buried with weapons, mirrors and bowls (Cunliffe, 2005) as seen at Mill Hill, Kent (Parfitt, 1995), Whitcombe, Dorset (Collis, 1973), North Grimston, Yorkshire (Whimster, 1977), and the Isle of Scilly (Johns, 2006). While these burials have traditionally been interpreted as those of male warriors due to the inclusion of weaponry, recent research has challenged this assumption (Jordan, 2016). One example included an individual furnished with both a sword and mirror; osteological analysis provided an age range of 20-25 years, but the sex could not be determined (Johns, 2006).

2.4.1.4 Inhumations and Deposits of Human Bone

Across Britain, human remains of adults and non-adults have been deposited in a variety of ways from the 5th century BC onward (Cunliffe, 2005). At Sudden Farm and Danebury in Hampshire crouched and supine inhumation burials of infants, as well as adult males and females have been uncovered (Stevens, et al., 2013). Cist burials of both adults of unknown sex and children were identified at Mount Batten, Harlyn Bay, Treland Barrow, Trevone and Trehellan in Devon (Cunliffe, 2005; Whimster, 1979). At Wandlebury in Cambridge selected human bones have been found deposited in non-funerary contexts (Hartley, 1957). These discoveries highlight the regional diversity of the Early and Middle Iron

Age burial record, and emphasis the lack of obvious connections between these smaller social groups (Cunliffe, 2005; Harding, 2015).

2.4.2 The Late Iron Age and Roman Burial Record

2.4.2.1 Inhumation Burials

Inhumation continued to be practiced throughout the Late Iron Age and Roman period, and over took cremation as the predominant burial rite in the 2/3rd century AD (Pearce, 2015). This rite was practiced throughout Britain and varied from interment directly into the ground or within wooden and lead-lined coffins or stone sarcophagi (Toynbee, 1971; Pearce, 2016); these different types of burials have been found in the same burial ground, but are often kept separate (Petts, 2016). Males, females and non-adults were subject to inhumation during this period, and often buried with objects ranging from consumption vessels and toilet instruments to items of personal adornment including bracelets, rings and hairpins (Carr, 2006; Eckardt, 2014). While this tradition is not homogenous and has regional variations, it coincides roughly with the spread of Christianity (Petts, 2016), and has been argued to represent the 'Romanisation' of burial customs (Pearce, 2008) where the uptake of this new ritual united an empire that was otherwise falling apart (Morris, 1992, p.68).

2.4.2.2 Cremation Burials

From the 2nd and 1st centuries BC and continuing until the Late Roman period, cremation spread from central-southern Britain to become the predominant burial rite across Britain, for example as seen at King Harry Lane, Hertfordshire (Stead and Rigby, 1989), Brougham, Cumbria (Cool, 2004), and Westhampnett, Sussex (Fitzpatrick, 1997). The burned remains of males, females and non-adults were buried, either urned or unurned, in individual pits. These graves were usually furnished with consumption vessels and sometimes buried with food; however, burials also included other items such as brooches, toilet articles, mirrors and animal bone (Niblett, 2001) (Figure 2.1). Often cremation assemblages included burned artefacts and animal bone, which are the remains of items placed with the individual on the pyre.

The rite originated on both sides of the English Channel, with the earliest British sites having very strong links with continental Europe (Fitzpatrick, 1997). Cremation deposits almost identical in form have also been found in northern France, Belgium and north-west Germany, sporadically distributed throughout the region. The cremation rites practiced at Acy-Romance in the French Ardennes, for instance, show clear parallels with the burials found at Westhamppnett cemetery in west Sussex. Both burial grounds show evidence for cremating the dead, sacrificing animals, and the placing of goods on the funeral pyre (Fitzpatrick, 2000). These similarities persisted beyond the Caesarean conquest of Gaul and Claudian conquest of Britain, meaning that near identical graves could be found in both provincial ‘Roman’ Gallia Belgica’ and ‘Iron Age’ Britain, making these labels highly problematic.

There are several historical accounts available that describe the customs and rituals involved in a Roman cremation funeral (see Table 2.2). These resources are considerably useful because they explain the physical processes involved (Thompson, et al., 2016). They are however biased toward high status individuals from Rome and are therefore not directly comparable with the funerals performed in the provinces (Cerezo-Román, et al., 2017). Also, they are based on Latin translations that are not entirely reliable and subject to the assumptions and interpretations of the translator (Weekes, 2008).

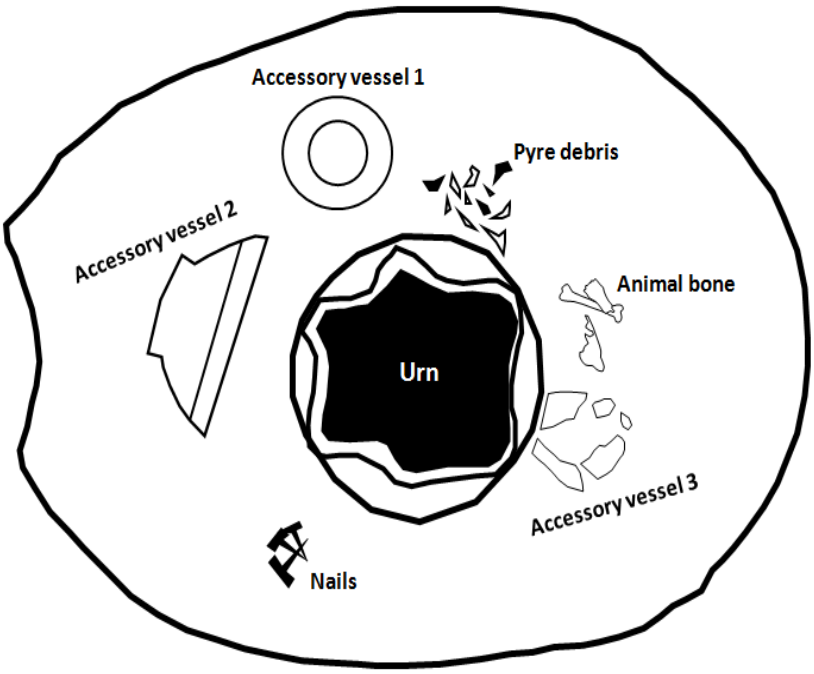


Figure 2.1 Schematic diagram of a cremation burial from Wallington Road cemetery, Baldock, showing the inclusion of urned calcined bone, three accessory vessels, burned animal bone and burned iron nails (adapted from Burleigh and Fitzpatrick-Matthews, 2010, p.121).

Table 2.2 Processes involved in cremation according to historical accounts from Roman literature.

Publication	Historical Source	Cremation Process
Erker 2011; Cerezo-Román et al., (2017)	*Virgil* (Aeneid 6, 218 - 220)	Body was washed by the family of the deceased and *ustores* (professional cremators).
Thompson et al., (2016)	*Vitruvius* (On Architecture, 2.9.15)	The pyre was constructed from layers of wooden logs that were placed at right angles to each other.
Cerezo-Román et al., (2017)	Tacitus (*Germania, 27*)	While no reference has been made to particular wood species, Tacitus states that the bodies of famous men were burned using certain types of wood.
Noy (2005)	Sidonius (*Ep, 3.13.5*)	The burned bones (*ossilegium)* were then collected by the family or a professional cremator.
Toynbee (1971); Cerezo-Román et al., (2017)	Cicero (De Legibus, ii, 22, 57)	The grave of the deceased only became legal when a pig was sacrificed.
Hope (2007)	Cicero (On the Laws, 2.22.55-57)	The grave was then buried or at least covered with soil to ensure a proper burial.

2.5 Cremation in Late Iron Age and Roman Britain

At the turn of the 20th century a hitherto unknown burial tradition was first described in Aylesford, Kent by Sir Arthur Evans (1890). He described the deposition of calcined bone within a pit, which was accompanied by earthenware vases, a bronze pail, a pan, and two fibulae; these artefacts were dated to after 150BC based on parallels found in western-central Europe (Figure 2.2). It was Evans' belief that these unusual items were unlike any previously found in Britain and argued that they demonstrated an association with northern Italy. Further discoveries of similar burial customs dating to 75BC were found in Welwyn, Hertfordshire (Smith, 1912) and Swarling, Kent (Bushe-Fox, 1925). In line with the 'Belgic Invasion' hypothesis, it was proposed that this practice of cremating the dead and depositing the remains in pits was introduced by invading Belgic parties (Hawkes and Dunning, 1930; Brooke, 1933).

Conditioned by ideals of western imperialism, few scholars during this culture-historical phase of British archaeology challenged this interpretation (Hodson, 1964; Whimster, 1977); for those that did, it was mostly out of caution regarding the limited archaeological evidence available. In Whimster's (1977) description of these cremation burials for example, he stated that:

'*Whether these flamboyant burials belong to members of immigrant lineages or reflect the imitative fancies of a 'nouveau-riche' native group anxious to emulate continental fashions cannot yet be determined'* (Whimster, 1977, p.925).

Figure 2.2 A schematic depiction of the Aylesford grave-pit by Evans (1890).

This externalisation of cultural change was furthered by Haselgrove (1982) with his core-periphery model that developed out of the processualist movement in British archaeology (See section 2.2). Partially based on the analysis of the grave goods from cremation cemeteries, he argued that change was stimulated by trade with the continent in prestigious and luxurious items, which induced further change in mortuary customs. This approach has been heavily criticised by Fitzpatrick (2000) because it placed great emphasis on trade, and the assumption that continental contact resulted in cultural change (see Fitzpatrick, 2007).

The focus on grave goods, and particularly imports recovered from cremation burials, dominated research for the next few years. However, in a move away from reconstructing wealth hierarchies, scholars focused on identifying family groups and kinship, as a means of exploring localised and communal identities. In Stead and Rigby's (1989) volume on King Harry Lane, they concluded that the burials uncovered represented ordinary family groups, although this interpretation was rejected by Fitzpatrick (1991, p.327) for its 'functional empiricism' and restricted interpretations. Later revaluations of the cemetery by Millett (1993) and Haselgrove and Millett (1997) suggested that the decline in the number of grave goods placed in the cremation pits represented a shift towards more nucleated communities with smaller extended networks, which would have allowed greater social mobility during the years after the conquest. However, Fitzpatrick (2000, p.16) pointed out that this was not that different from previous theoretical models:

'It does little more than alter the equation of 'pots = wealth of deceased' to the slightly larger one of 'pots = mourners of deceased = social status of the deceased' (Fitzpatrick, 2000, p.16).

A fundamental shift in this field of research was a consequence of the work by Pearce (1994; 1997; 1998; 2000). Rather than viewing cremations as a single event, Pearce pioneered the examination of cremation rituals. The aim of this was to explore ideologies, and the construction of identities that were created, contested and adapted during the funeral. In his analysis of the cremation burials from King Harry Lane he observed seven different stages of the cremation process (Table 2.3) (1998, p.102). Here, Pearce draws references from anthropologists Metcalf and Huntington (1992) who describe three universal stages in death rituals that are evident across different cultural groups. These are rites of separation, transition and incorporation. He concluded that the changing rituals that became less lavish and more homogenised over time represented a 'collective identity' that idealised adult male 'citizenry', which later influenced the socio-cultural dynamics of Verulamium. It is always a risk to draw parallels from modern frameworks that are based on ethnographic studies, which are removed from the historical context in question. In addition, this approach still focused on material culture; however, it did make use of the available contextual and osteological data (Pearce, 1997; 1998). For instance, in his review of the funerary rites at King Harry Lane, Pearce (1997) compared the stages of the cremation process, including the deposition of pyre and grave goods, according to age and sex. His analysis found that during the intial stages of the cremation ceremony, age, gender and individual identities were expressed, but were not distinguishable in the later stages. Pearce's (1997; 1998) framework reconstructing the stages involved in cremation is still actively used in contemporary studies of Late Iron Age and Roman cremation practices (Williams, 2004; Thompson, et al., 2016; Weekes, 2016; Cerezo-Román, et al., 2017).

Table 2.3 The seven stages involved in cremation funerals as described by Pearce (1998).

Stage	Source of Evidence
Pre-pyre rituals	Cemetery structures, cremated bone
Pyre – location, orientation, construction, efficiency, pyre goods	Pyre and bustum sites, pyre debris, cremated bone
Pyre – side ritual	Pyre debris *Aschengruben*
Collection from pyre	Cremated bone, presence/absence of pyre debris
Grave – size, orientation arrangement and deposition of grave goods	Cemetery and grave plan, grave goods
Marker	Tombstone, mausoleum, barrow, enclosure and other markers
Commemorative feasting, sacrifice etc.	*Aschengruben,* animal deposits, ceramics, coin hoards etc.

Over the last few decades research examining Late Iron Age and Roman cremation deposits has continued to rise (Figure 2.3). The majority of recent publications collected from the *Rural Settlement of Roman Britain* database and HE records, highlighted in Figure 2.3, are predominantly osteological analyses that form part of excavation reports and not academic syntheses of cremation in Late Iron Age and Early Roman Britain. This has not only vastly improved our understanding of this funerary rite, but also the cultural dynamics of this transitional period of British prehistory. However, several issues still underpin current research. Firstly, the bias towards examining a small selection of elite burials (Pearce, 2013). Secondly the almost exclusive use of burial data from the south-east of England, primarily associated with urban settlements (Pearce, 2016). Thirdly, the focus on material culture and lack of multi-disciplinary analyses using other types of data (Cerezo-Román and Williams, 2014). And finally, the focus on individual cemetery examinations or cross-continental comparisons without exploring variability between Romano-British cemeteries (Cerezo-Román and Williams, 2014). While these biases in research are understandable given the wealth of grave goods recovered from this transitional period as well as the excellent preservation and documentation of elite burials, it does limit the scope of mortuary studies from this time period, which is already considerably understudied.

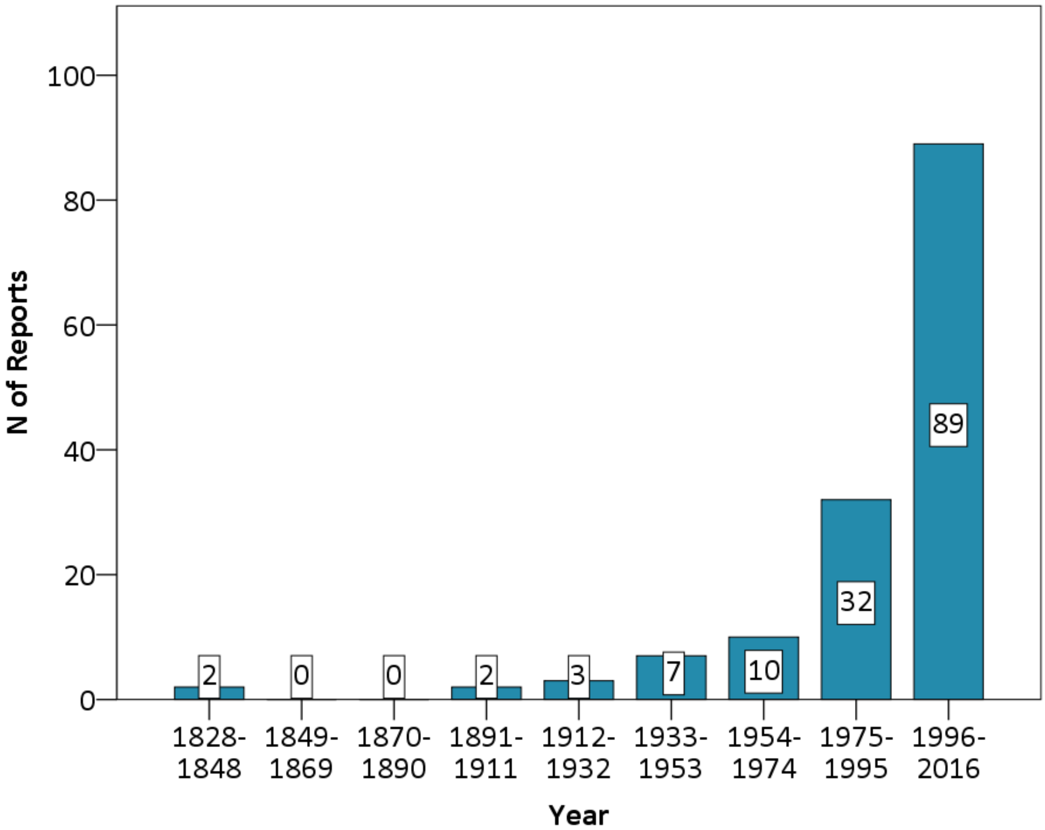


Figure 2.3 Number of published and unpublished UK cremation reports from 1828 to 2016. Data collected by author collected from the *Rural Settlement of Roman Britain* database and HE records.

2.6 Cremation in Late Iron Age and Roman Hertfordshire

In this study, the modern county of Hertfordshire was chosen as the case study area for the primary investigation of cremation technology. This is because the south-east of the country is where the majority of cremation deposits are found dated to this time period. Hertfordshire is well known for its wealth of Late Iron Age and Roman archaeology following the excavations conducted at St Albans and Wheathampstead in the 1930s by Mortimer Wheeler and Tessa Verney Wheeler (Bryant and Niblett, 1997). The area also consists of six large settlement complexes, amongst which a minimum of 150 occupation sites have been identified (Bryant and Niblett, 1997). In particular, several famous cremation cemeteries that define this field of research, King Harry Lane and Folly Lane for instance, are both in Hertfordshire. The region includes the highest concentration of cremation deposits in the country with over 7000 having been recorded over the last century (Fitzpatrick-Matthews, 2007) (Figure 2.4). As such, it is ideally suited for this research project.

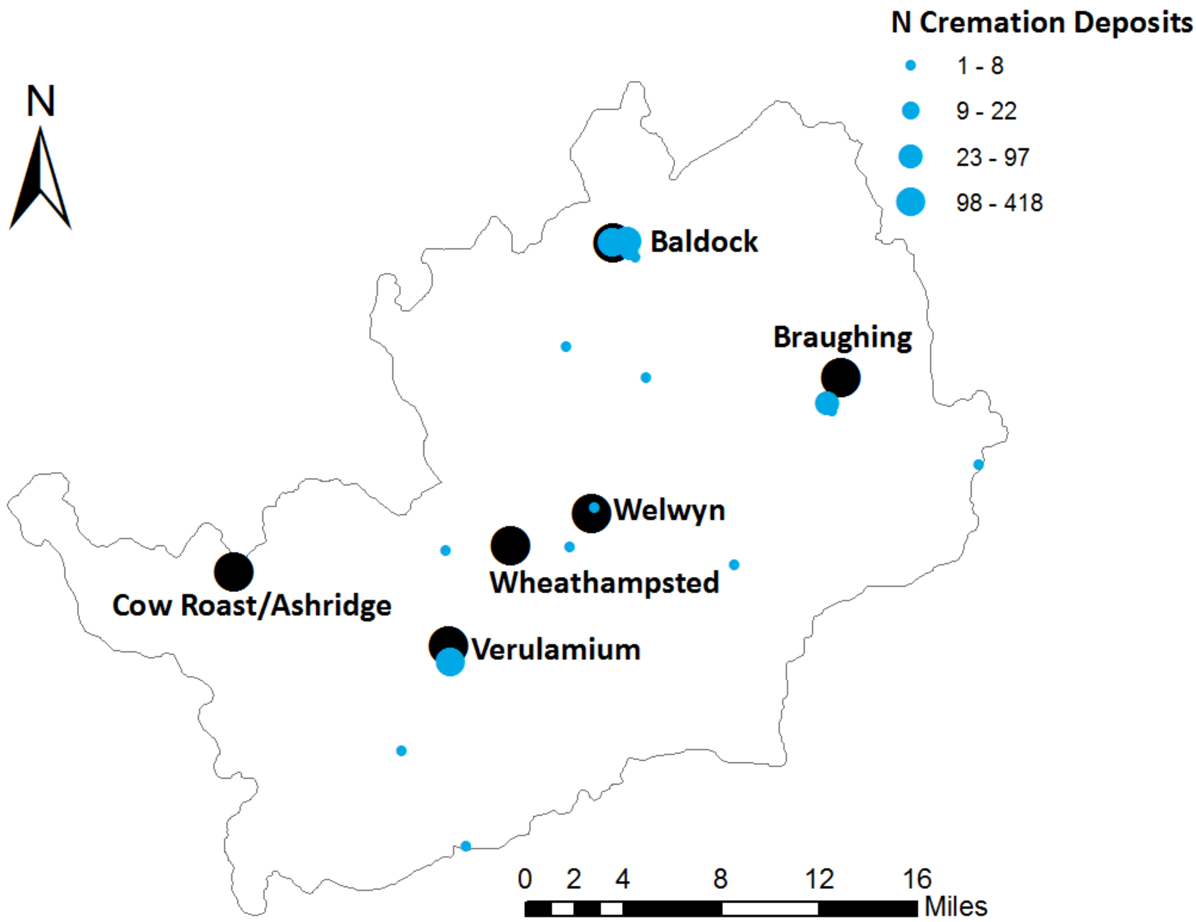


Figure 2.4 The six Late Iron Age and Roman settlements of Hertfordshire and the contemporary cremation burials excavated to date. Settlement data provided Bryant and Niblett (1997). Burial data collected by author.

Despite this corpus of burial data, Bryant and Niblett (1997) have pointed out that the quality of archaeological and burial information from the region is relatively poor; remarkably, this has not fundamentally changed since 1997. This is because these cemeteries were subject to rescue excavations conducted by volunteers. Unfortunately, the available literature is limited to individual cemetery examinations, or inter-cemetery analyses that focus on material culture, with few exceptions. To date, no attempt has been made to conduct a multi-disciplinary analysis of these cremation deposits, and no effort has been made to examine the cremation technology across the region.

2.6.1 Inter-Cemetery Variation of Late Iron Age and Roman Hertfordshire

The cremation tradition of south-east England described in section 2.4 also dominated the Late Iron Age and Roman burial record of Hertfordshire (See Stead and Rigby, 1989; Niblett, 1999; 2001; Niblett and Thompson, 2005; Burleigh and Fitzpatrick-Matthews, 2010). However, certain practices have also been identified amongst the Hertfordshire cemeteries that have not been found elsewhere. While these differences have been described, mostly in passing, they have not been subject to detailed research. The following section discusses these observations, to show that future studies would benefit from examining the spatial and temporal differences in cremation practices within regions in Britain, before attempting to make cross-continental comparisons.

Alongside the deposition of burned human remains and grave goods, the Late Iron Age cremation burials of Verulamium, St Albans incorporated different burned animal bone inclusions. Pig bone was most common at King Harry Lane, pig and chicken remains were more prevalent at St Stephen's, and sheep bone dominated the Folly Lane burials (Niblett and Thompson, 2005). Unfortunately, the reason for this variation has not been explored. It is unlikely to simply reflect the use of local animal resources, as all three burial grounds are associated with the same settlement complex. Instead, these practices may elucidate different social groups and varying practices, based on the diversity of grave goods found at each cemetery.

The cremation burials from Baldock also displayed differing practices. Fitzpatrick-Matthews (2007) describes how two of the Baldock cemeteries, Yeomanry Drive North and Royston Road, contained an unusually high number of unurned cremation burials compared to the other cemeteries; in some instances, the burned bones were placed in wood lined pits, which have not been identified at any other burial ground in this region. It has been suggested that these different practices could represent varying group identities and local styles that were being expressed by the mourners attending the funeral (Fitzpatrick-Matthews, 2007).

Burleigh (1993) also points out that a difference in cremation efficiency is evident amongst the Roman Baldock cemeteries. The average weight of burned bone from the Wallington Road urned cremation burials was 750g, while for the Royston Road urned cremation burials it was 619g. While this interpretation would seem fair, burned bone weight is influenced by multiple external factors, including sex, age, firing conditions and post-deposition damaged (see section 3.2.4). As such, weight should be considered in relation to these other factors before any conclusions are drawn.

2.6.2 Hertfordshire Cremation Burials and the Late Iron Age to Roman Transition

Section 2.5 has already discussed cremation in the wider context of 'Romanisation'. As the majority of data from these studies derive from Hertfordshire, it is not necessary to repeat those arguments here. Instead, this section will review the local cremation traditions found amongst the large settlement complexes of Hertfordshire and how they have been viewed in relation to cultural change.

Similar to the shift in settlement organisation discussed in section 2.2.1, Burleigh and Fitzpatrick (2010) describe how in the years following the Roman conquest, the boundary of Wallington Road cemetery, Baldock, became increasingly defined through the construction of a ditched enclosure. This separation of the burial ground from the settlement complex has also been identified at the local Late Iron Age cemeteries of Folly Lane (Nibeltt, 1999) and King Harry Lane (Stead and Rigby, 1989) both located in St Albans. Some scholars have argued that this process represents the adoption of Roman-style mortuary practices, as similar customs have been found in Germany, Switzerland and Austria (Pearce, 2002; Stead and Rigby, 1989). However, others have argued that this process reflects social fragmentation where communities are responding differently to Roman influences (Fitzpatrick, 1997; Moore, 2006). In relation to Wallington Road, Baldock Burleigh and Fitzpatrick (2010) stated that the enclosing of the cemetery reflected the increasing pressures of Roman authority on the province because Roman Law required the physical separation of the living from the dead (Jessup, 1959).

A further theme that has been extensively discussed in Late Iron Age and Roman studies and is visible in the burial record of Hertfordshire is the increased use of imported wares. Across the region cremation burials show a preference for the inclusion of continental vessels related to the provision of food and drink (Burleigh and Fitzpatrick, 2010). Many have interpreted these inclusions as the adoption of a 'Roman' identity (Creighton, 2000; 2006; Pearce, 2015), specifically practiced by elite groups to distinguish themselves from non-elites (MacMullen, 1990). Stead and Rigby's (1989) analysis of King Harry Lane, St Albans argued that this practice is indistinguishable from that found on the other side of the channel, expressing strong links with the continent. Alternatively, Pearce (2013) argues that the deposition of cooking vessels within mortuary contexts shows the development of local traditions, where items from the continent are given new meanings.

The examination of the Late Iron Age and Roman cremation burials from Hertfordshire have been largely limited to cemetery development and material studies, with few osteological investigations conducted (see Stead and Rigby, 1989; Niblett, 1999; Burleigh and Fitzpatrick, 2010). With the recent methodological advances made in the field of cremation research, it is now possible to extract further information concerning cremation technology that could introduce a new dynamic to this study area.

2.7 The Late Iron Age and Roman Environment

2.7.1 The Landscape of Late Iron Age and Roman Britain

It is now well established through environmental archaeology that the landscape at the Late Iron Age to Roman transition consisted largely of arable land and open pastures. This was a consequence of largescale woodland clearance that allowed increased agricultural activity, specifically cereal cultivation and animal husbandry (Dark, 1999; 2000; Hingley and Miles, 2002; Hingley, 2007). Due to the relative scarcity of tree cover, communities would have become adept at woodland management, and practiced coppicing (cutting trees down to ground level and allowing them to regrow) to replenish the available resources (Hingley and Miles, 2002; Hingley, 2007).

Early pollen diagrams suggested that this woodland clearance coincided with the Claudian invasion and was a consequence of Roman occupation (Davies and Turner, 1979; Turner, 1979; Dumayne, 1993; Dumayne and Barber, 1994). However, these studies were hindered by the poor pollen evidence from before the Iron Age, which would have established if the onset of changes in the landscape happened prior to this time period. As pointed out by Dark (2000), woodland clearance in Redmere and Willingham in East Anglia had started as early as the Bronze Age. As such, this dramatic change in the landscape was subject to temporal and spatial variation. Unfortunately, current pollen records are still biased towards certain geographical areas where preservation of macrofossils is high (Turner, 1981; Dark, 2000). It is therefore not possible to comment on the wider impact of Roman occupation on the British landscape.

This is not to say that the Roman conquest did not have an impact on farming and food production in Britain. A recent survey of archaeobotanical data from the 1st century BC to the 4th century AD in Britain identified the introduction of at least fifty new plant foods, predominantly fruits, herbs and vegetables (van der Veen, et al., 2008). More recently, Lodwick (2017) identified agricultural innovations through the adoption of new oil crops used as animal fodder at Late Iron Age and Early Roman Silchester, demonstrating the introduction of new agricultural techniques.

2.7.2 The Landscape of Late Iron Age and Roman Hertfordshire

To date, relatively little environmental data exists for Hertfordshire from the 1st century BC to the 4th century AD (Niblett, 2001). Research is generally limited to individual site evaluations from recent commercial excavations (Rackham, 1998; Wainwright, 1990; Bonsall, et al., 2012). Although Niblett's (2001) review of Early Roman Verulamium (St Albans) provided a brief description of the Hertfordshire landscape, no attempt has been made to conduct a regional survey of the available archaeobotanical data. However, it is apparent that the area was largely characterised by open habitats of pasture and arable land (Anon, 1990; Niblett, 2001; Snelling, 2001; Allen, 2008).

With regards to the arboreal taxa found, settlements from the region show a mix of deciduous woodland and shrub types. In Wainwright's (1990) analysis of Gorhambury, St Albans, traces of cherry type species (*Prunus*) and hazel (*Corylus avellana*) were identified and thought to be used as firewood, while Rackham (1998) recorded fragments of oak (*Quercus sp.*) at Hartfield, Baldock, that may have been used by smelters and iron smiths.

Currently, the only study to examine temporal changes in arboreal taxa in Hertfordshire was conducted by Bonsall et al., (2012) for the post-excavation assessment of the widening of the M25. Their examinations suggested that a higher number of Late Iron Age features were dominated by hardwood, in particular oak (*Quercus sp.*), while the Late Roman deposits were characterised by increased diversification of species including oak (*Quercus sp.*), cherry type species (*Prunus*), maloideae, ash (*Fraxinus excelsior*), and hazel/alder (*Alnus*). As this was a cursory investigation, it is unclear whether this difference is due to the variety of features sampled or represents a significant trend in the data.

This scarcity of environmental, specifically arboreal, data is a consequence of the lack of specialised analysis conducted in the region of Hertfordshire (Bryant and Niblett, 1997) (see section 2.6). Charred wood identification is a laborious process that involves visually assessing the fragments' microstructure and comparing it to known samples (Campbell, 2004); as such, the outcomes of this method are dependent on the examiner. Only a few specialists are trained in this manner of analysis, and not all of them will have sufficient reference collections to confirm identifications. In this case the reliability of the results depend on the specialist's knowledge. Even though this mode of analysis is becoming more common in commercial projects, it is still reserved for largescale excavations that can justify the expense.

Chapter 3: Literature Review - The Field of Cremation Research

3.1 Historical Review of Research Field

Historically, burned human bones have been understudied relative to unburned, inhumed and mummified remains in archaeology; this is not only because the latter are more aesthetically appealing, but also because the consensus for large parts of the 19th and 20th century was that their analysis could provide greater insight into the past (McKinley, 1994; 2015; Williams, 2008; 2015; Thompson, 2015a).

It is well established that antiquarian scholars regularly discarded burned human bones when recovered from an excavation. Often referred to as 'ash' or 'dust', it was their belief that these burned skeletal remains divulged little valuable archaeological or osteological information (Jessup, 1974, p.139; McKinley, 2015, p.vii). This attitude was a product of its time, and demonstrative of the limited knowledge of burned bone in antiquity. Wells (1960) explains that the fragmentation and distortion of this material, which made osteological assessment difficult, discouraged others from studying it. This school of thought remained the overriding opinion until the late 20th century. Some practitioners did publish descriptions of cremation contexts from archaeological sites (Faussett, et al., 1856; Ward, 1900; McKinley, 2015). However, these accounts continually lacked standardised recording techniques, and any osteological observations made were limited to describing the location or arrangement of the burned bones uncovered (McKinley, 2015). In Massey's (1868) report of the discoveries from Kings Newton, Derbyshire he noted that:

'*In one or two cases the calcined bones were placed upon a small flat stone and the urn inverted over them. No teeth were ever found with the bones*' (Massey, 1868, p.3).

Over the succeeding decades further isolated and preliminary studies of cremated bone were produced, most of which attempted to determine the age and sex of the identified individuals (; Krogman, 1939; Haury, 1945; Gejvall, 1947; 1955; 1959; Weiner, 1951; Baby, 1954; Lisowski, 1956; 1958; 1959; Wells, 1960; Binford, 1963; Merbs, 1967; Buikstra and Swegle, 1989; Thompson, 2015a). In the 1980s researchers had started publishing observations from cremation/burning experiments and proposing new approaches to the analysis of burned bones (Thurman and Willmore, 1982; Gilchrist and Mytum, 1986; Buikstra and Swegle, 1989; Spenneman and Colley, 1989; Shipman, et al., 1984). The intention of this body of work was to advise practitioners on how to handle, analyse and interpret these remains, as well as to establish criterion for determining the duration, temperature and type of burning achieved from the heat-induced changes in bone (Merbs, 1967; Shipman, et al., 1984). The experiments lacked adequate standardised laboratory procedures, which made the replication of results difficult, while the publications mostly advised the employment of basic osteological analyses, including sex and age assessment. However, they demonstrated that burned skeletal remains could be used to reconstruct both ancient and modern firing practices, and therefore deserved its own scientific discipline. Research that followed on from these papers was focused on identifying the nature of heat-induced change in burned bone and what this can reveal about the firing process, including reconstructing temperatures, oxidization and burning conditions (Nicholson, 1993; Holden, et al., 1995a; Herrmann and Bennett, 1999; Thompson, 2002; Hiller, et al., 2003; Koon, et al., 2003; Thompson, 2015a).

Within the last few years there has been a surge in cremation research, both in the study of burned bone, as well as the burial rite of cremation (Schmidt and Symes, 2008; 2015; McKinley 2015, p.vii; Thompson, 2015a; Cerezo-Román, et al., 2017). Current research is primarily focused on reviewing methodologies and developing new scientific techniques to analyse the microscopic changes in burned bone in order to reconstruct burning conditions in archaeological and forensic contexts (Mayne Correia, 1997; Piga, et al., 2008; 2009; Ubelaker, 2009; Squires, et al., 2011; Thompson, et al., 2013; Ellingham, et al., 2015a; 2015b; 2018; Vassalo, et al., 2016). Pioneering work by Snoeck and colleagues (2014a; 2014b; 2016) designed a method for measuring isotopic signatures, specifically strontium and oxygen, in calcined bone. From a theoretical standpoint, scholars are currently developing new frameworks that allow the cultural and ritual dynamics involved in ancient cremation practices to be more widely explored (Williams, 2004; 2008; 2015; Brück, 2006; Cerezo-Román and Williams, 2014).

Despite these advances made in the field over recent years, cremation research is still hindered by an overall lack of standardisation and shared terminology (Thompson, 2002; Quinn, et al., 2014). This has made collaborative research increasingly difficult. Most osteologists try to infer age, sex and pathology, alongside examining heat-induced changes to establish burning intensity. The current methods used to conduct osteological analyses were originally developed on unburned bones; research would greatly benefit from developing new techniques designed specifically for burned skeletal remains (Thompson, 2002; Gonçalves, et al., 2013). Even now, most human bone specialists lack sufficient knowledge and training in the analysis of cremation deposits. This is arguably a primary reason for the underrepresentation of burned bone analyses in archaeological research. More effort should therefore be made to introduce this topic at undergraduate and postgraduate levels.

3.2 Understanding the Cremation Process

Standard analyses examining burned human remains include trying to reconstruct demographic profiles such as age, sex and pathology, as well as fragmentation, weight, and heat-induced alterations (McKinley, 2004; 2017). However, due to the degree of taphonomic alteration caused by extreme heat exposure the structure and morphology of bone changes dramatically. This process hinders sex and age assessments and could lead to erroneous results; this type of information should therefore be used with caution (Thompson, 2002; 2005). It is not the intention of this thesis to re-assess cremation deposits in relation to sex, age and pathology, but to reconstruct cremation technology and firing conditions focusing on the heat-induced alterations in burned bone. As such, the following section will discuss how these taphonomic alterations manifest on a macroscopic and microscopic level, and how they are measured.

3.2.1 Skeletal Responses to Extreme Heat Exposure

Bone is a complex material made of both organic (mostly collagen) and inorganic (mostly calcium phosphate) components, as well as water (Thompson, et al., 2013; Snoeck, et al., 2014b). It's structure is comprised of an outer periosteal layer, an inner cortical bone layer, and an endosteal core that is made up of compact bone and spongy bone (Thompson, et al., 2013).The mineral phase of bone is an impure, non-stoichiometric and poorly crystalline form of hydroxyapatite (also called bioapatite) that has a simple nano-sized apatite structure ($Ca_{10}(PO_4)_6(OH)_2$) (Mkukuma, et al., 2004; Wopenka and Pasteris, 2005; Thompson, et al., 2013).

Bone undergoes four transitional phases of alteration when burned (Mayne Correia, 1997; Thompson, 2004; Ellingham, et al., 2015b) (Table 3.1). Macroscopic and microscopic heat-induced alterations occur at these different phases and are used by researchers to reconstruct burning conditions to infer cremation and pyre technology. It has been demonstrated that microscopic alterations are more accurate for assessing burning intensity, because they are less susceptible to external influences (Thompson, 2004). However, current research recommends the examination of both to achieve a more holistic interpretation of firing conditions (Squires, et al., 2011; Thompson, et al., 2016).

Table 3.1 Phases of heat-induced alteration in bone (Ellingham, et al., 2015).

	Phase	Description
1	Dehydration	The breaking of hydroxyl-bonds and loss of water bound to the bone matrix
2	Decomposition	The organic component of bone is removed by pyrolysis
3	Inversion	The elimination of bone carbonate
4	Fusion	The coalescing and melting of the crystal matrix

3.2.2 Heat-Induced Alterations in Burned Bone: Colour Change

On a macroscopic level, the best-studied heat-induced alteration that occurs in bone is colour change (Shipman, et al., 1984; Stiner and Kuhn, 1995; Munro, et al., 2007; Beach, et al., 2008; Alunni, et al., 2014; Delvin and Hermmann, 2015; Ullinger and Sheridan, 2015). This has been used by researchers to infer firing temperature, exposure time, body position in relation to the fire, and oxygen availability (Ellingham, et al., 2015b), all of which can help to reconstruct the manner and quality of cremation. Experimental research has firmly established that a skeletal element will pass through a sequential spectrum of colour change that is caused by the combustion of bone's organic and inorganic components, and is subject to oxygen availability (Shipman, et al., 1984; Ubelaker, 2009; Ellingham, et al., 2015b; Reidsma, et al., 2016; Ullinger and Sheridan, 2015) (Figure 3.1).

Figure 3.1 Experimentally burned animal bone displaying several stages of heat-induced colouration (Carroll and Smith, 2018, p.953).

Initially, bone will change from its normal ivory colour to brown, and then black. This charring effect is induced by the combustion of the organic components of carbon and collagen. Next, a grey pigmentation manifests that is caused by the polarisation of organic compounds. Finally, when all of the organic material has been removed, and the mineral component of bone has completely fused, the skeletal element will turn white (Mayne Correia, 1997; Ellingham, et al., 2015b). While this sequence of colour change is always consistent, experimental research has reported that these stages can occur at varying temperatures (Ellingham, et al., 2015b).

It is important to consider that colour change in burned bone can be influenced by staining from minerals within the soil matrix, or the melting of extraneous artefacts that are either worn or placed with the individual at the time of cremation (Brady, 2006; Dupras and Schultz, 2013). It is also common for a bone fragment to display several different colours following extreme heat exposure (Ubelaker, 2009; Thompson, et al., 2016) (Figure 3.1). This is because of the varying distribution of soft tissue on a single skeletal element (e.g. the epiphyses of a long bone compared to the diaphyses) (Carroll and Smith, 2018; Symes, et al., 2012).

3.2.3 Heat-Induced Alterations in Burned Bone: Warping and Fracture Patterns

The structural mechanics of a skeletal element weaken when subject to extreme heat, which causes bone to become warped, and develop fissures (Gonçalves, et al., 2011) (Figure 3.2). These heat-induced changes are complex and are subject to multiple external and internal stimuli. For those that do record these traits, examiners have used these alterations to infer the burning of fleshed (soft tissue remaining) or green (soft tissue removed soon after death) bone which can provide insight into funerary rituals and the preparation of the deceased prior to burning (Gonçalves, et al., 2011; 2015).

Over the years research in this area has proposed several hypotheses as to what causes these changes (Vassalo, et al., 2016). Initially, experimental studies found that these alterations only occurred when individuals were burned with their remaining soft tissue (Baby, 1954; Binford, 1963; Thurman and Wilmore, 1982). However, later studies were also able to artificially recreate warping and fracture patterns in archaeological bone with no preserved flesh (Spennemann and Colley, 1989; Buikstra and Swegle, 1989). More recent experimental research suggests that these mechanical deformities are linked to the preservation of collagen, recrystallization at the inorganic stage, maximum firing temperatures and burning durations (Gonçalves, et al., 2015; Vassalo, et al., 2016). Alternatively, studies have also suggested that forces of gravity and bone mass could influence heat-induced warping (Vassalo, et al., 2017), while fracture patterns could be related to thermal stress or shock

(Depierre, 2014). As such, the reliability of these alterations as indicators of pre-burning conditions is uncertain (Gonçalves, et al., 2015).

Figure 3.2 Heat-induced warping and thumbnail fractures in experimentally burned human bone (Gonçalves, et al., 2011, p.1310-1311).

3.2.4 Heat-Induced Alterations in Burned Bone: Size Change and Weight Loss

Burned bone can both expand and shrink in size when subject to extreme heat (Bradtmiller and Buikstra, 1984; Shipman, et al., 1984; Thompson, 2005; Bertrand and Oxenham, 2015; Ellingham, et al., 2015b). Research has established that size changes are minimal until temperatures reach above 700°C, where alterations become statistically significant (Thompson, 2005). These heat-induced alterations coincide with changes in crystal structure (Gonçalves, et al., 2011), and are related to the dehydration and removal of bones' organic component (Thompson, 2005). As a result, the accuracy of osteological techniques used to establish age and sex from burned bone will be reduced (Thompson, 2002; 2005).

Firing also causes weight loss in burned bone, which is a result of the evaporation of water, combustion of organic compounds and release of CO_2 (Ellingham, et al., 2015a). Recent research has found that weight loss is subject to bones' exposure to different temperatures and varying heating regimes (Ellingham, et al., 2015a), which can help to gain a more comprehensive understanding of firing conditions. In their examination, Ellingham and colleagues (2015) heated sheep rib bone fragments in aluminium oxide crucibles from 20°C to 1100°C. The samples were heated in triplicates at rates of 6°C/min, 12°C/min, and 24°C/min. Three distict changes of weight loss were identified, occurring at slightly different rates. Peaks in weight loss were identified at 100-150°C, 350-400°C and 750-800°C. The first phase of weightloss was affiliated with the evaporation of water. The second was the most sever and linked to the combustion of the organic components which led to hydroxyapatite recrystallistion. At the final stage the minerals in bone started to melt. This small study highlights the clear relationship between bone weightloss and an increase in firing temperature. These findings resemble the firmly established phases of alteration in burned bone found in other experimental studies (see Thompson 2005; Thompson, et al., 2013) showing their reliability.

3.2.5 Heat-Induced Alterations in Burned Bone: Histological Changes

On a microscopic level, the ultra-structural morphology of bone has been found to change at varying stages of the cremation process and can infer the temperatures reached during cremation (Ritchie, 2006; Thompson, et al., 2009; Squires, et al., 2011; Ellingham, et al., 2015b) (Figure 3.3). Of the few studies that have been conducted, the results obtained have been somewhat contradictory and equivocal (Ellingham, et al., 2015b, p.184). Specifically, opposing observations have been reported concerning the change in osteon size on heating (Forbes, 1941; Bradtmiller and Buikstra, 1984; Nelson, 1992; Hummel and Schuttkowski, 1993; Cattaneo, et al., 1999; Absolonová, et al., 2012), the preservation of bone microstructure above 800°C (Herrmann, 1977; Brain, 1993; Squires, et al., 2011; Castillo, et al., 2013; Wolf, et al., 2017), and the carbonisation of the organic component (Hermann, 1977; Brain, 1993; Squires, et al., 2011) (Table 3.2).

The pioneering research by Squires, et al. (2011) established a set of criteria that identified three stages of change in bone microstructure between 300°C and 900°C+. More recently, Castillo et al. (2013) observed four stages of alteration in collagen fibres and bone mineral when samples were burned between 100°C and 1100°C. It is important to be aware that microstructural changes can vary according to sex, whereby increasing temperatures result in more compact and elongated osteons in females than in males (Absolonová, et al., 2012; Elingham, et al., 2015).

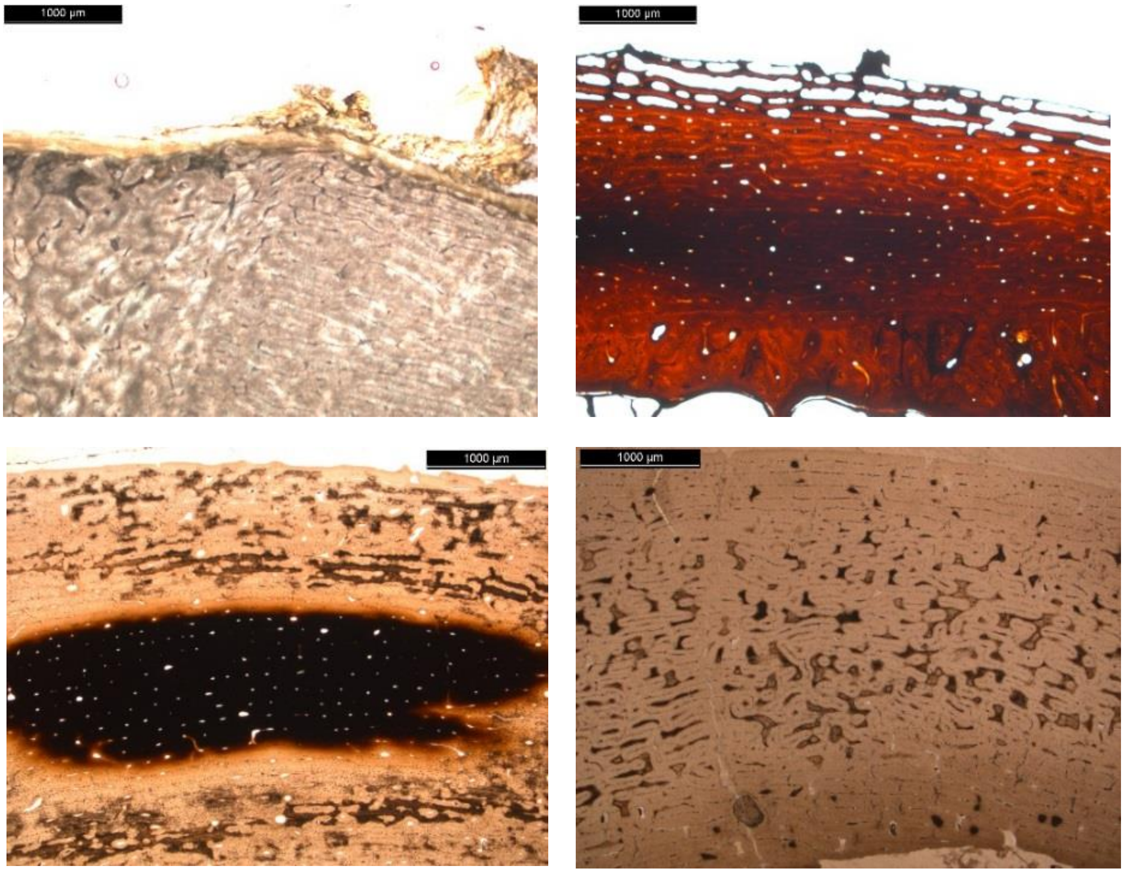


Figure 3.3 Thin-sections of experimentally burned animal bone. Top left: 100°C. Top right: 300°C. Bottom left: 500°C. Bottom right: 700°C (Carroll and Squires, submitted).

Table 3.2 Microscopic changes in burned bone histology according to published literature. * ^ = increase in temperature.

Publication	Temp. °C	Observation
Forbes (1941)	^ Temperature	Decease in osteon size
Hermann (1977)	< 700 - 800	Carbon colouration
	> 700 - 800	Organic matter cremated. Crystals fused
Bradtmiller and Buikstra (1984)	600	Microstructure preserved. Increase in osteon size
Nelson (1992)	^ Temperature	Decrease in osteon size. Increase in haversian canal diameter
Brain (1993)	200	Carbon in lacunae. Microstructure preserved
	300	Lamellar is carbon. Cracks through bone matrix
	400	Cracks continue to develop
	500	Carbon has oxidised, producing pale colour
	600	Microstructure visible. Cracks
	700	Matrix shrunk
	800	Microstructure disappeared; Fusion of crystals
Hummel and Schutkowski (1993)	^ Temperature	Decrease in osteon size
Cattaneo, et al., (1999)	< 800	Osteons shrink
	< 1000	Significant changes in microstructure
Hanson and Cain (2007)	0 - 470	All histological structures are visible
	380 - 482	Carbon Accumulating; Cracking emanating from Haversian canals
	590	Accumulation of carbon is minimal; No cracking
	482 - 620	Histological structure has disappeared. Carbon deposits extensive; Cracks spreading from Haversian canals
	462 - 705	Carbon deposits still occur; Cracks spreading outwards from the Haversian canals
Squires, et al., (2011)	300 - 600	Preservation of microstructure, organic material with some crystal fusion; Dark in colour
	600 - 900	Less microstructure and > 50% organic material; Hydroxyapatite fusion
	900+	No microstructure; Complete hydroxyapatite fusion
Absolonová, et al., (2012)	600	Microstructure similar to unburned bone
	700	Osteon and Haversian Canals shrink
	800	Osteon and Haversian Canals shrink further
Castillo, et al., (2013)	100 - 300	Collagen deformation
	400 - 600	Vitreous crystalline formations; Crystalline polymers
	700 - 800	Rounded and cubical crystals; Loss of homogeneity
	> 900	Granular surface
Wolf. et al., (2017)	750 - 850	Inorganic bone structures are in good condition

3.2.6 Heat-Induced Alterations in Burned Bone: Crystallinity

The term crystallinity refers to the structure within a bone's crystal lattice (Ellingham, et al., 2015b). Fresh bone has low crystallinity where crystals are small and poorly organised (high strain); however, with an increase in temperature the crystals become larger and better organised (less strain) (Piga, et al., 2009; Thompson, et al., 2013; Ellingham, et al., 2015b). As well as being used to determine the species of bone mineral (Rogers, et al., 2010; Becket, et al., 2011) and differentiate between pathological and non-pathological bone (Nagy, et al., 2008), crystallinity has been employed to reconstruct burning intensity from archaeological cremated bone (Squires, et al., 2011; Thompson, et al., 2016).

Research has more commonly examined this process by calculating the CI (Crystallinity Index) or 'Splitting factor'. This numerical value measures the structural order of crystals (Stiner, et al., 2001; Thompson, et al., 2009) and increases with a rise in temperature (Bartsiokas and Middleton, 1992; Thompson, et al., 2009; Squires, et al., 2011). However, studies have also employed the C/P (Carbon to Phosphate) ratio which decreases with a rise in temperature (Squires, et al., 2011). These values have been used together for a greater understanding of temperature and duration (Squires, et al., 2011; Thompson, et al., 2011; 2013). Several publications have called into question the validity of CI for measuring burning intensity (Koon, et al., 2003; Thompson, et al., 2013; Thompson, 2015b). Piga et al., (2008) argued that it is an arbitrary numerical construct that has been applied so widely simply because it has been used in previous research (Thompson, 2015b, p.331). This critique is furthered by Koon et al., (2003) who points out that CI is poor at identifying lower burning temperatures, and is only an 'average' measure of heat-induced mineral change (Thompson, 2015b, p.331).

In response to these criticisms, Thompson et al., (2013) examined the validity of CI in osteological studies. Their research identified five additional spectral indices that can be used to calculate changes in heat-induced crystallinity, these are: CO/P (1650 cm^{-1}/1035 cm^{-1}), CO/CO_3 (1650 cm^{-1}/1415 cm^{-1}), CO_3/P (900 cm^{-1}/1035 cm^{-1}), Phosphate High Temperature (625 cm^{-1}/610 cm^{-1}), and Line Width (The full width at half maximum of the phosphate peak at 1035cm^{-1}). The combined use of four indexes including CI obtained a correct classification rate of 97.2% for burning temperature, while the use of CI alone achieved 66.7%.

It is important to be aware that the relationship between crystallinity and burning intensity is not linear and fluctuates substantially over the heating process (Figure 3.4) (Thompson, 2015b). The CI value increases slowly when burning begins and then accelerates at 500°C; recrystallisation starts at 600°C, but only when bones' organic component has been removed (Etok, et al., 2007; Frederick, et al., 2012; Thompson, 2015b). CI then continues to increase rapidly, before dropping at temperatures over 1000°C (Thomson, 2015b, p.329). In addition, similar crystal values of burned bone can also be achieved by archaeological bone that has not been fired (Thompson, 2015b). This is because diagenesis also results in large crystals in a more organised structure with less strain (Thompson, 2015b). As such, measures of crystallinity should not be used in isolation but combined with other methods to examine burning intensity from cremated bone.

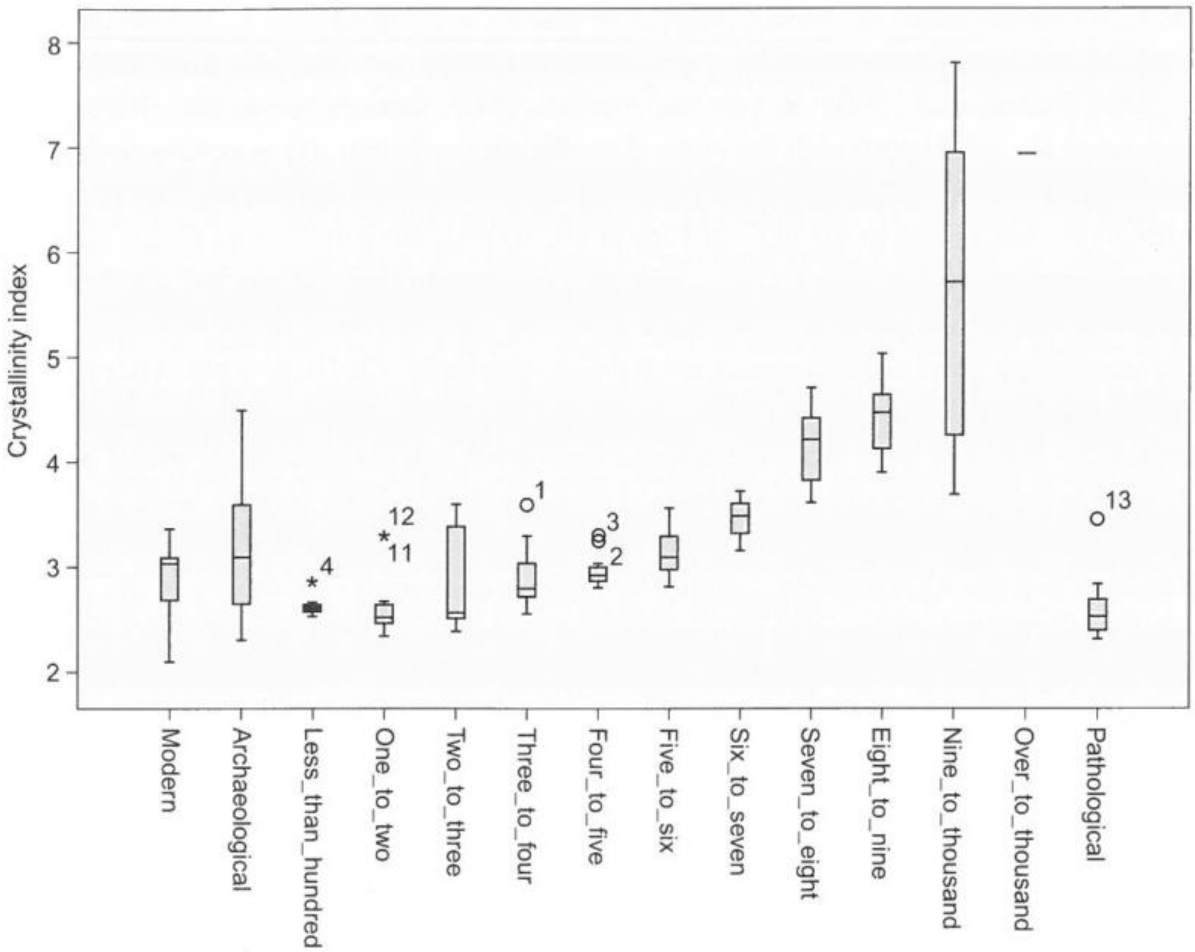


Figure 3.4 Heat-induced changes to CI using FTIR-KBr method from published literature (Thompson, 2015, p.330).

3.3 Methodological Review of Assessing Heat-Induced Alterations

3.3.1 Techniques used to Assess Heat-Induced Alterations: Colour Change

According to a recent review of 84 studies, macroscopic colour change is the most commonly recorded heat-induced alteration and is included in 91% of studies (Gonçalves and Pires, 2017). Traditionally, colour alterations have been recorded using a Munsell colour chart (Shipman, et al., 1984; Delvin and

Herrmann, 2015). This involves comparing the hue, value and chroma of all surface colours observed to the reference chart, and specifying which colours are dominant and which are minor (Shipman, et al., 1984). This technique is useful because it is a quick and easy (Devlin and Herrmann, 2015). However, as this is a visual based assessment multiple factors can influence the results obtained, including variation in lighting and the examiners' perception of colour (Delvin and Herrmann, 2015; Ullinger and Sheridan, 2015).

Other qualitative methods used for examining macroscopic colour change are simpler and involve using a colour gradient form that ranges from 'normal' (unburned bone) to white; this scale developed out of experimental burnings of modern deer bone (Munro, et al., 2007; Thompson, et al., 2016) (Figure 3.5). This approach is again a quick method that involves minimal sample preparation and effort. Also, as the gradient was developed based on experimentally burned animal bone at temperatures ranging from 25°C to 900˚ C, it is more appropriate for cremation studies than a Munsell colour chart. However, it is again subjective because of its qualitative nature, and its susceptibility to external agents.

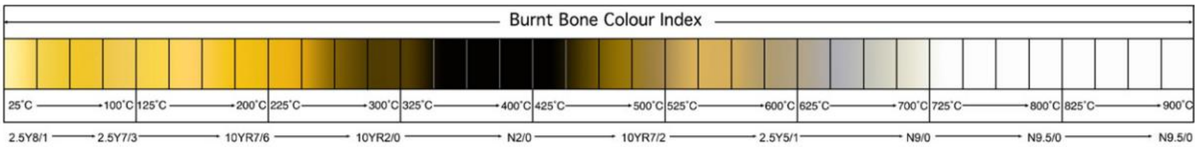


Figure 3.5 Burned bone colour index (Munro, et al., 2007, p.94).

Alternatively, recent experimental studies have used a spectrophotometer combined with a CIELAB (a colour space that expresses colour as three numerical values) system to analyse the surface colour of burned bone (Devlin and Herrmann, 2015; Ullinger and Sheridan, 2015). This approach quantifies the colour spectra of the sample in three dimensions, including: $L*$ (darkness/lightness), $a*$ (range of green to red in object) and $b*$ (amount of blue or yellow) (Fairchild, 2005; Ullinger and Sheridan, 2015). Delvin and Herrmann (2015) used this method in the analysis of the burned bone from Walker-Noe, Kentucky, and found that it produced a robust dataset that enabled the comparative examination of individual colour dimensions. In order to assess how this new quantitative method compares to older qualitative approaches, Ullinger and Sheridan (2015) used a Munsell colour chart and a spectrophotometer to analyse the burned human remains from Bab adh-Dhra, Jordan. Interestingly, the results from both methods were consistent with each other and produced similar interpretations of the burning conditions achieved.

3.3.2 Techniques Used to Assess Heat-Induced Alterations: Histological Changes

To date, histological examinations have predominantly involved creating thin-sections of burned bone and visually assessing the heat-induced changes using light microscopy; comparisons are then made with burned bone standards fired at known temperatures and durations in order to establish the phase of decomposition (Nicholson, 1993; Squires, et al., 2011; Absolonová, et al., 2012; Castillo, et al., 2013). Even though this approach has proven successful, it is hindered by inter-observer biases and lacks a shared terminology (Table 3.2).

Forthcoming research by Carroll and Squires (submitted, see Appendix 8) aims to tackle this issue by proposing a new quantitative petrographic approach. This technique statistically categorises burned bone according to its stage of thermal decomposition. This is achieved by counting the microscopic, heat-induced changes observed in a thin-section of burned bone (see section 4.3.1.4 for full description of method). A handful of alternative quantitative methods are also available, which measure the diameter of osteons and Haversian systems to infer burning conditions (Forbes, 1941; Bradtmiller and Buikstra, 1984; Nelson, 1992; Hummel and Schuttkowski, 1993). Unfortunately, the results from these studies are contradictory and only focus on one or two microscopic features, rather than the complete microstructure (see section 3.2.5).

3.3.3 Techniques used to Assess Heat-Induced Alterations: Crystallinity

Scanning electron microscopy (SEM) is one of the oldest methods employed to investigate burned bone crystallinity (Shipman, 1981; Shipman, et al., 1984; Nicholson, 1993; Holden, et al., 1995a; 1995b). This qualitative method involves visually examining the microscopic topography of burned bone samples for changes in crystal structure and form (Thompson, 2015b). For instance, Holden et al., (1995b) identified a range of crystallite morphologies, including spherical, hexagonal, platelets, rosettes and irregular, in bone samples burned between 200°C and 1600°C. In addition, crystal growth was found to occur at over 600°C, fusion took placed between 1000°C and 1400°C, and by 1600°C bone mineral had melted. More recently, Figueirdo et al., (2010) also presented a criterion for assessing crystal formation within animal and human bone samples fired at 600°C, 900°C, 1200°C. This study also found that crystal growth occurred with increasing temperatures, specifically at 600°C. In recent years however, SEM analysis has become less popular with the increased use of quantitative methods such as Fourier Transform Infrared spectroscopy (FTIR) (Thompson, et al., 2013) and X-Ray Diffraction (XRD) (Piga, et al., 2008).

Powered X-Ray Diffraction (XRD) has become increasingly popular within cremation research over the last twenty years, following its initial application in Shipman and colleagues (1984) pioneering burning experiments (Etok, et al., 2007; Piga, et al., 2008; Figueirdo, et al., 2010; Thompson, 2015b). This method is based on the principle that each sample has a unique diffraction pattern (Ellingham, et al., 2015b; Thompson, 2015b). The heating of bone results in a sharpening of these diffraction patterns, which is caused by the increase in crystallite size and decrease in lattice strain (Piga, et al., 2009). Unlike other methods, XRD can infer burning duration, as well as temperature. A study by Piga and Thompson (2009) found that the growth rate parameter of crystallites is higher with shorter burning durations. This technique is particularly useful for detecting crystal size for temperatures over 700°C (Ellingham, et al., 2015b). However, it struggles with measuring lower temperatures, and peaks can only be identified if the crystals are larger than 3nm (Ellingham, et al., 2015b; Thompson, 2015b).

Fewer studies have utilised Raman spectroscopy to examine bone tissue, or further heat-induced crystallinity (Morris and Finney, 2004; Draper, et al., 2009; Ellingham, et al., 2015b). This approach involves stimulating an interaction between the electromagnetic wave and the molecular polarizability of the molecular vibration, which essentially produces a molecular fingerprint of the sample (Thompson, 2015b; Mamede, et al., 2017). Raman spectroscopy is particularly useful because it requires minimal sample preparation, and it produces a high spatial resolution (Ellingham, et al., 2015b). However, this approach is hindered by the presence of fluorphores within the bone's matrix, which can overrule the Raman bands and produce inaccurate readings (Mamede, et al., 2017).

Like Raman spectroscopy, Inelastic Neutron Scattering spectroscopy (INS) is a comparatively under applied technique in the scope of burned bone crystallinity (Loong, et al., 2000; Taylor, et al., 2001; Marques, et al., 2016; Mamede, et al., 2017). It works on the principle that firing a neutron beam at a burned bone sample (nucleus) causes inelastic scattering and produces signals that can then be used to reconstruct the molecular composition of burned bone (Mamede, et al., 2017). Taylor, et al. (2001) pioneered this method in his examination of the composition of ox femurs, demonstrating its potential for analysing bone ageing and pathology (Mamede, et al., 2017). To date, only one paper has employed this technique in the examination of unburned and burned human skeletal remains (Marques, et al., 2016; Mamede, et al., 2017). Like other spectroscopy methods (FTIR and Raman) this approach can be used to identify hydroxyl groups in bones crystal lattice. However, as pointed out by Mamede, et al. (2017) it is an expensive technique that requires dedicated facilities.

Fourier Transform Infrared Spectroscopy (FTIR) is the most well-documented and widely applied method for examining burned bone crystallinity (Mkukuma, et al., 2004; Munro, et al., 2007; Thompson, et al., 2009; 2013; Squires, et al., 2011; Snoeck, et al., 2014a; Reidsma, et al., 2016; Thompson, et al., 2016). This approach provides an infrared spectrum of the organic (and at times inorganic) composition of burned bone based on the absorption of electromagnetic radiation at specific wavelengths/vibrations (Squires, et al., 2011; Ellingham, et al., 2015b; Mamede, et al., 2017). FTIR consists of two methods, Attenuated Total Reflectance (ATR) and KBr. The former allows samples to be directly measured in their solid or liquid state, and therefore requires minimal sample preparation (Ellingham, et al., 2015b). The latter involves grinding or mulling the sample with potassium bromide powder and pressing it into a pellet (Mademe, et al., 2017). It is widely accepted that KBr is more problematic. The sample must be evenly distributed within the pellet to avoid scattering the infrared beam (Mademe, et al., 2017). In addition, over grinding the sample can result in a net decrease in the CI or splitting factor value (Surovell and Stiner, 2001). According to Thompson et al. (2013, p.417), FTIR is a preferred method for measuring crystallinity because it can identify contaminant material, as well as substitutes in the bone structure, and it is more accurate at measuring lower burning temperatures.

Small angle X-ray scattering (SAXS) is a further method that can be used to measure the thickness and shape of crystals (Thompson, 2015b). However, unlike XRD the measurement is taken in the smallest dimensional plane (Etok, et al., 2007). It works by directing an X-ray beam at the sample and recording the scattering of radiation. Experimental burnings conducted by Hiller, et al. (2003) found that SAXS can detect crystal changes at temperatures as low as 500°C. Unfortunately, this method has been understudied compared to other methods as this technology is not widely available (Thompson, 2015b).

3.4 Environmental Analysis in Cremation Research

Environmental analysis in cremation research is a multi-disciplinary field that includes archaeobotany and zooarchaeology to identify food offerings and fuel selection in cremation deposits (Bond, 1996; Gale, 1997; 1999; Campbell, 2004; Worley, 2008; Deforce and Haneca, 2011; 2012). While burned and unburned animal remains were recorded as part of the primary analysis conducted in this thesis, the investigation did not yield any discernible trends and were not included in the Results chapters (see Appendix 1 and 2). Consequently, the following section discusses archaeobotany in relation to firewood selection for cremation and methodological limitations.

3.4.1 Firewood Selection from Late Iron Age and Roman Cremation Deposits in Britain

Very few excavations of cremation deposits from Herefordshire sampled the grave and urn fills, resulting in little information concerning fuel selection. The available data are limited to the funerary shaft and burial pit from Folly Lane, St Albans (Gale, 1999) and the cremation features from Wallington Road, Baldock (Murphy, 1990; Burleigh and Fitzpatrick-Matthews, 2010).

The material recovered from the funerary contexts at Folly Lane show the utilisation of oak (*Quercus sp.*), hazel (*Corylus avellana*), cherry type species (*Prunus*) and blackthorn (*Prunus spinosa*). At Wallington Road in Baldock, only a few fragments of oak were recovered from a single cremation deposit (Burleigh and Fitzpatrick-Matthews, 2010). Some have suggested that the selection of fruit-bearing trees would have produced sweet smells to mask the odour of the body during the cremation process (Moskal-del Hoyo, 2012). In addition, ancient accounts of Roman cremations state that specific wood types were used to burn the bodies of famous men (Cerezo-Román, et al., 2017). However, as these taxa from Hertfordshire were also found in other non-funerary contexts it is more likely that local woods available for use were sourced as fuel for cremation.

Considering Roman Britain more widely, it would seem that the firewood used for cremation during this period was primarily sourced from local woodlands and consisted of a variety of species that were used as both fuel and kindling (Gale, 1997; 1999; Campbell, 2004; Bojko, et al., 2007). At Brougham, Cumbria, the dominance of poor wood-burning types including birch (*Betula*) and alder (*Alnus glatinosa*) confirms the use of whatever wood was available.

With regards to the south-east of the country, the material from Late Iron Age Stanway, Colchester, demonstrates higher proportions of good-fuel woods including ash (*Fraxinus excelsior*) and oak (*Quercus sp.*). This indicates that wood selection here was practically motivated to ensure a well-managed fire (Bojko, et al., 2007). Similar results were also ascertained from the Late Iron Age and Roman cremation deposits of Westhampnett, Sussex (Gale, 1997).

To date, most wood analyses of Late Iron Age and Roman cremation contexts have only been used to identify tree types to establish if they are local or invasive. Comparisons with wood from different contexts would help identify ritual activity, while examinations of different settlement types or social groups would reconstruct socio-economic dynamics. A similar approach has been applied by Deforce and colleagues (2011; 2012; Cerezo-Román, et al., 2017) in their surveys of charred wood from Roman cremation contexts in Belgium. This research found that firewood selection for cremation deposits was practically motivated and there is no significant difference between the taxa assemblages of urban and rural cemeteries.

3.4.2 Methodological Review of Archaeobotany: Charcoal Identification

Charcoal identification is a laborious process that involves visually assessing the fragments' microstructure and comparing it to known samples (Campbell, 2004); as such, the outcomes of this method are dependent on the examiner. Only a few specialists are trained in this manner of analysis, and not all of them will have sufficient reference collections to confirm identifications. In this case the reliability of the results depends of the specialist's knowledge. Even though this mode of analysis is becoming more common in commercial projects, it is still reserved for largescale excavations that can justify the expense.

Chapter 4: Materials and Methods

In order to examine cultural transitions in Late Iron Age and Roman Britain, a multi-disciplinary approach combing archaeological, environmental, and osteological data was employed to examine cultural transitions. This was achieved by conducting a primary and secondary analysis involving a survey of cemeteries throughout Britain (excluding Wales) and an indepth investigation of cremation deposits from five Hertfordshire cemeteries, dating from the 1st century BC to the 4th century AD.

4.1 Classification of Recorded Properties

In order to compile data in this thesis, it was necessary to design a classification system for all of the recorded properties. The intention of which was to establish a standardised format so that further quantitative analysis could be conducted. The classifications, described below, were taken from similar publications to enable continuity with contemporary research. These classifications were used in both the primary and secondary analysis.

4.1.1 Time Period

A series of overlapping time periods (Table 4.1) were adjusted from Pearce (2008, p.33). Pearce used four time periods to categorise the Roman period, spanning from Early to Late. For the purposes of this investigation a Late Iron Age phase was added to categorise burials that pre-dated the Roman Conquest. Every cremation deposit from the primary analysis and each cemetery from the secondary dataset was assigned a time period based on the relative date range provided by the original excavation report (see Appendix 1 and 2 for list of cemeteries and key references). With regards to the primary data, when a cremation deposit had not been dated the associated grave goods were used to assign a time period by the author using the Atlas of Roman Pottery (Tyers, 1996). In terms of the secondary data, when cemeteries were active for more than one time period, each cemetery phase was recorded separately. When this could not be done because individual burial dates were not provided by the excavation report, the cemetery could not be precisely dated and was classified as 'Undated'.

Table 4.1 Time periods adjusted from Pearce (2008, p.33).

Time Period	Definition
Late Iron Age	Before 43 AD
Early Roman	1st – 2nd century AD
Middle Roman	1st or 2nd centuries AD – Mid to Later 3rd to Early 5th century AD
Late Roman	3rd – Early 5th century AD
Undated	Date unknown

4.1.2 Settlement Type

The settlement types (Table 4.2) used to characterise each cemetery were adapted from Pearce (2008, p.34). Pearce's study included five categories including those lised in Table 4.2 plus military sites and villas. Both military and villa cemeteries were not included in this investigation because very few were found in the meta-analysis, creating a very small sample. Settlement type was assigned based on the general size of the cemetery sample, as well as the archaeology of the wider landscape and associated settlements. Overall, this classification was relatively straightforward. The only issue that arose concerned isolated cremation deposits that were not adjacent to any known Late Iron Age or Roman settlements. It is possible that these features were situated on the periphery of larger complexes. However, if there was no archaeological evidence for nearby urban settlements these features were classified as 'Rural'. With regards to the Late Iron Age, several cemeteries have been classified as 'Major Urban'. It is acknowledged here that during this time period there were no large towns, but settlements defined as oppida were placed in this category.

Table 4.2 Settlement types adjusted from Pearce (2008, p.34).

Settlement Type	Definition
Rural	Villages, individual or small groups of structures, production sites, fields, track ways, and isolated / small groups of burials
Minor Urban	Small towns, and roadside settlements
Major Urban	*Civitas* capitals, *municipia,* and *coloniae*

4.1.3 Region

The geographical regions assigned to each cemetery were adapted from Taylor's (2007, p.40) characterisation of settlement patterns in Roman Britain (Figure 4.1, Table 4.3). Taylor's examination of Roman Britain included eight regional categories including those listed in table 4.3 plus the West Midlands, East Midlands, Yorkshire and East Anglia. Due to the uneven distribution of cremation data in this study, Yorkshire was merged with the North East category, and the East and West Midlands along with East Anglia were combined to form one large Midlands region. Cemeteries located in Lincolnshire, which spans two regions, needed to be adjusted to fit the scheme. As a result, Chapel Lane located in the south of Lincolnshire was assigned to the 'Midlands', and The Bridles situated in the north was classified as 'North-East'.

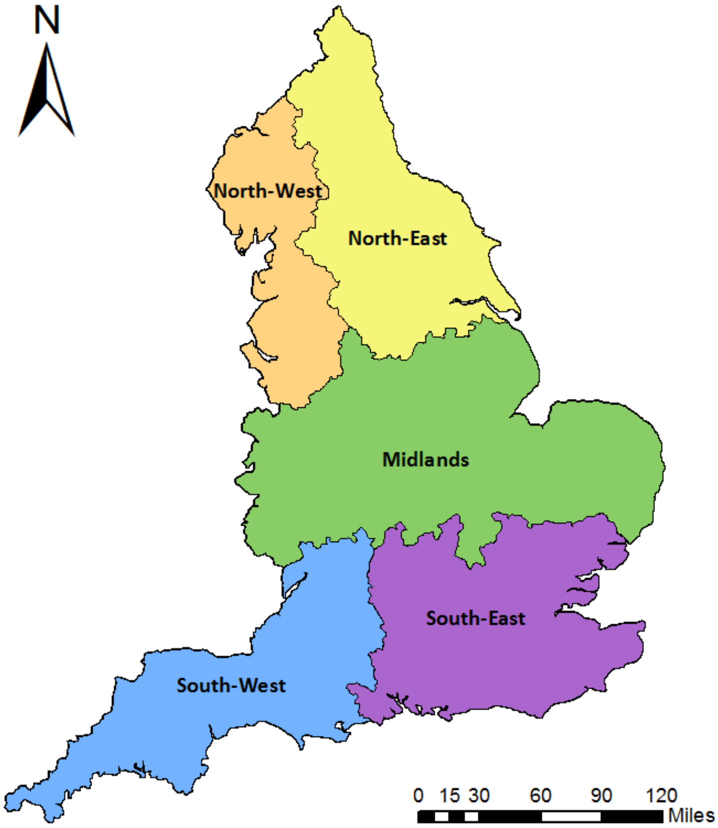


Figure 4.1 Geographical regions adapted from Taylor (2007, p.40).

Table 4.3 Geographical regions and modern-day counties used in this thesis.

Region	Modern-Day Counties
North-West	Cumbria
North-East	Country Durham; North Lincolnshire; Northumberland; Yorkshire
Midlands	Bedfordshire; Cambridgeshire; Derbyshire; Herefordshire; Leicestershire; Northamptonshire; Shropshire; South Lincolnshire; Suffolk; Warwickshire
South-East	Berkshire; Buckinghamshire; Essex; Hampshire; Hertfordshire; Kent; London; Surrey; Sussex; Winchester
South-West	Oxfordshire; Gloucestershire; Somerset; Wiltshire

4.1.4 Burial Type

Burial types (Table 4.4) used to characterise each cremation context were adapted from Boston and Marquez-Grant (2010, p.405), based on the descriptions provided by the excavation report. Boston and Marquez-Grant's examination of the crematon burials from Lankhills included the categories listed in table 4.4, apart from 'Unknown'. This type was added for this investigation as numerous cremation deposits examined did not include any contextual burial information. If a deposit had been damaged beyond recognition or no contextual information had been recorded, the feature was classified as 'Unknown'. Often, deposits included concentrations of burned human bone with a defined outline that was interpreted as an organic container (i.e. cloth bag or wooden box) which had not survived. In these cases, the feature was marked as 'Unurned'.

Table 4.4 Burial types adapted from Boston and Marquez-Grant (2010, p.408).

Burial Type	Definition
Urned	A deposit of burned human bone found within a container
Unurned	A deposit of burned human bone that is not in a container but may have been placed within an organic container (fabric bag or wooden box) that has not survived
Bustum Burial	A pyre site that may have functioned as a grave, characterised by the inclusion of burned human bone and a bed of charcoal
Pyre Site	A deposit found on the ground surface characterised by large quantities of charcoal with relatively little burned bone
Redeposited Pyre Debris	A small deposit of burned human bone recovered from pits, ditches, and in the backfill of intercutting cremation burials
Unknown	Burial type unknown

4.1.5 Age Categories

It became apparent in the early stages of this research that there are no standard age categories used by osteologists for burned human bone. As a result, comparing age data from multiple cemeteries was not easily possible. In order to overcome this three broad age categories were created: 'Less than 13 years', '14 to 18 years' and 'Over 18 years'. These categories reflect established milestones of the Roman life course in Britain outlined by Gowland (2001; 2007), and they combine the categories used in previous research examining cremation burials in Late Iron Age and Roman Britain (McKinley, 1997; Mays, 2007). When individuals fell within two or more categories, their average age was used. If no age assessment was conducted, or if the age of the individual could not be established, then 'Unknown' was assigned.

4.1.6 Sex Categories

It is common for osteologists examining burned human bone to use 'Probable' and 'Possible' in their assessment to indicate the level of confidence in their identification (McKinley, 1993b). While both 'Probable' and 'Possible' identifications were recorded in this research, this level of detail proved unnecessary when examining the demography of Late Iron Age and Roman cremation deposits. This is because it would not have enhanced the interpretation of the results obtained. Instead, the sex categories used here were simplified to 'Female', 'Male' and 'Unknown'.

4.1.7 Grave and Pyre Goods

The definition of grave and pyre goods was taken from McKinley (1994, p.133; Table 4.5). Distinguishing between grave and pyre goods is important because they play very different roles in the cremation rite. Occasionally, objects in the grave showed signs of burning (e.g. a vessel with scorch marks). These artefacts were recorded as grave goods because it was not clear whether the burning was a result of the cremation, or from use prior to deposition. Pyre goods were identified through their removal from the burned bone assemblage by the osteologist during examination, or their fusion to skeletal elements indicating their placement on the body.

Table 4.5 Definition of grave and pyre goods according to McKinley (1994, p.133).

Object	Definition
Grave goods	Objects added at the time of burial
Pyre goods	Objects placed on the pyre along with the deceased

4.2 Materials

The study sample comprised detailed primary data of individuals collected by the author using sites within Hertfordshire. The secondary data were characterised as summary data from cemeteries collated from published and unpublished cremation reports from Britain (excluding Wales).

4.2.1 Primary Study Sample

Hertfordshire was chosen as the primary study area due to its wealth of Late Iron Age and Roman burial archaeology (see Section 2.6; Bryant and Niblett, 1997). Five urban (minor and major) and rural cemeteries dating from the 1st century BC to the 4th century AD were selected for this study: Wallington Road, Baldock; Folly Lane, St Albans; Cross Farm, Harpenden; M1 Junction and Spencer Park, Hemel Hempstead (Figure 4.2) (see Appendix 1 for list of cemeteries and key references). Their selection was based on the quality of the archive, and the accessibility of the material. On more than one occasion, access to material was denied either because museum stores were closed to researchers, or the cemetery archives were so poor that they could not be comprehensively studied and sampled. It also proved difficult to locate rural cemeteries that had been subject to post-excavation processing; often the archives included cinerary urns that had been block lifted, but not subsequently excavated. This created a bias in the sample towards individuals from urban cemeteries.

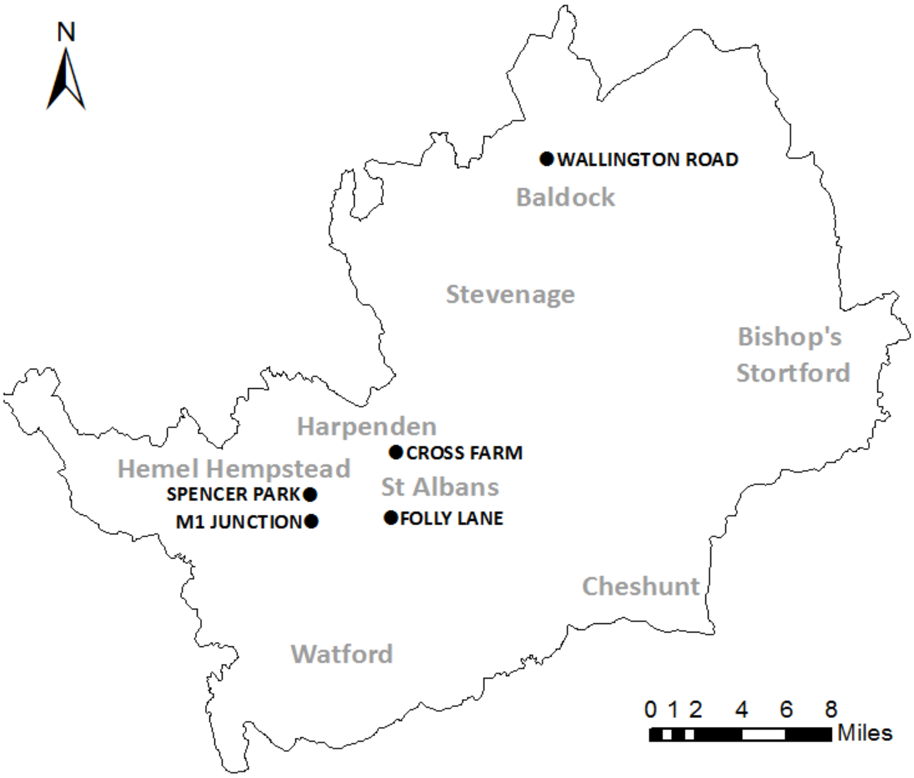


Figure 4.2 Modern county of Hertfordshire and the location of cemeteries making up the primary study sample. The cemeteries are highlighted in black, and modern towns are in grey.

4.2.1.1 Wallington Road Cemetery (Baldock): 1st Century BC to 4th Century AD

4.2.1.1.1 Background

Wallington Road cemetery is located on Westell Close in north-east Hertfordshire, c.1.9 miles east of the Late Iron Age – Late Roman oppida of Baldock (TL254339) (Figure 4.3). The burial ground was part of the Baldock complex of cemeteries and was in use for c.350 years from the mid 1st century BC to the mid 4th century AD, where both inhumation and cremation was practiced. During the Late Iron Age to Roman transition, Baldock flourished as an urban complex for native Britons (Niblett and Thompson, 2005). The lack of fortifications and overall absence of artefacts associated with the military suggests that it did not become a Roman stronghold following the conquest (Burleigh and Fitzpatrick-Matthews, 2010). The settlement of Baldock was first discovered by Percival Westell in 1925 while excavating the Roman cemetery of Walls Field. Additional cemeteries were uncovered from 1978 to 1994. Alongside human remains, pits, ditches, roads and enclosures were identified leading to the classification of Baldock as an oppida. This site spans roughly 80ha and is situated along the Roman road that leads south towards the Roman town of Braughing (Burleigh and Fitzpatrick-Matthews, 2010).

Wallington Road cemetery was discovered when digging the foundation trenches of a new housing development. As such, the burials were subject to salvage excavation; only a small sample of the entire population from Wallington Road was recovered. The excavations were carried out by a team of archaeological enthusiasts within a strict time frame. As a result, the burials were denied standard excavation procedures. The recording process involved photographing the cremation deposits *in situ* before being excavated, but not afterwards or during. Consequently, the paper archives are at times sparse and lack accurate documentation. However, Wallington Road was subject to complete post-excavation processing and publication, and all of the material was available for sampling for this study (Burleigh and Fitzpatrick-Matthews, 2010).

4.2.1.1.2 Burial Phase 1: Mid 1st Century BC to Mid 1st Century AD

The first phase of burial activity showed no signs of organisation or maintenance. The period comprised sporadically deposited inhumation burials that were not enclosed, nor defined by boundary ditches despite the contemporary expansion of the Late Iron Age settlement (Burleigh and Fitzpatrick-Matthews, 2010).

4.2.1.1.3 Burial Phase 2: Late 1st Century AD

Around AD 75 a ditch was dug along the northern edge of the cemetery that took the form of a semi-oval enclosure, indicating the start of organised funeral activity. During this phase the main burial rite shifted from inhumation to cremation and included both urned and unurned burials. For the remainder of this period cremation deposits continued to be placed within this area, which was thought to be marked above-ground because the boundary ditch had filled in with silt by this point (Burleigh and Fitzpatrick-Matthews, 2010).

4.2.1.1.4 Burial Phase 3: Early 2nd Century AD

Around AD 125 the nature of the funerary practices changed, and the burial enclosure previously dug was no longer used. Instead, two separate groups of cremation burials were deposited in different areas of the cemetery; one in the eastern region, and another further south. The reason for this adjustment in burial location is unclear, as space was still available within the enclosure (Burleigh and Fitzpatrick-Matthews, 2010).

4.2.1.1.5 Burial Phase 4: 3rd Century to 4th Century AD

By AD 200 funerary practice had returned to cremation deposits within the original enclosure in the northern region of the cemetery. This custom continued until its abandonment in the early 4th century

AD, which is thought to have coincided with the Roman town of Baldock falling into disuse (Burleigh and Fitzpatrick-Matthews, 2010).

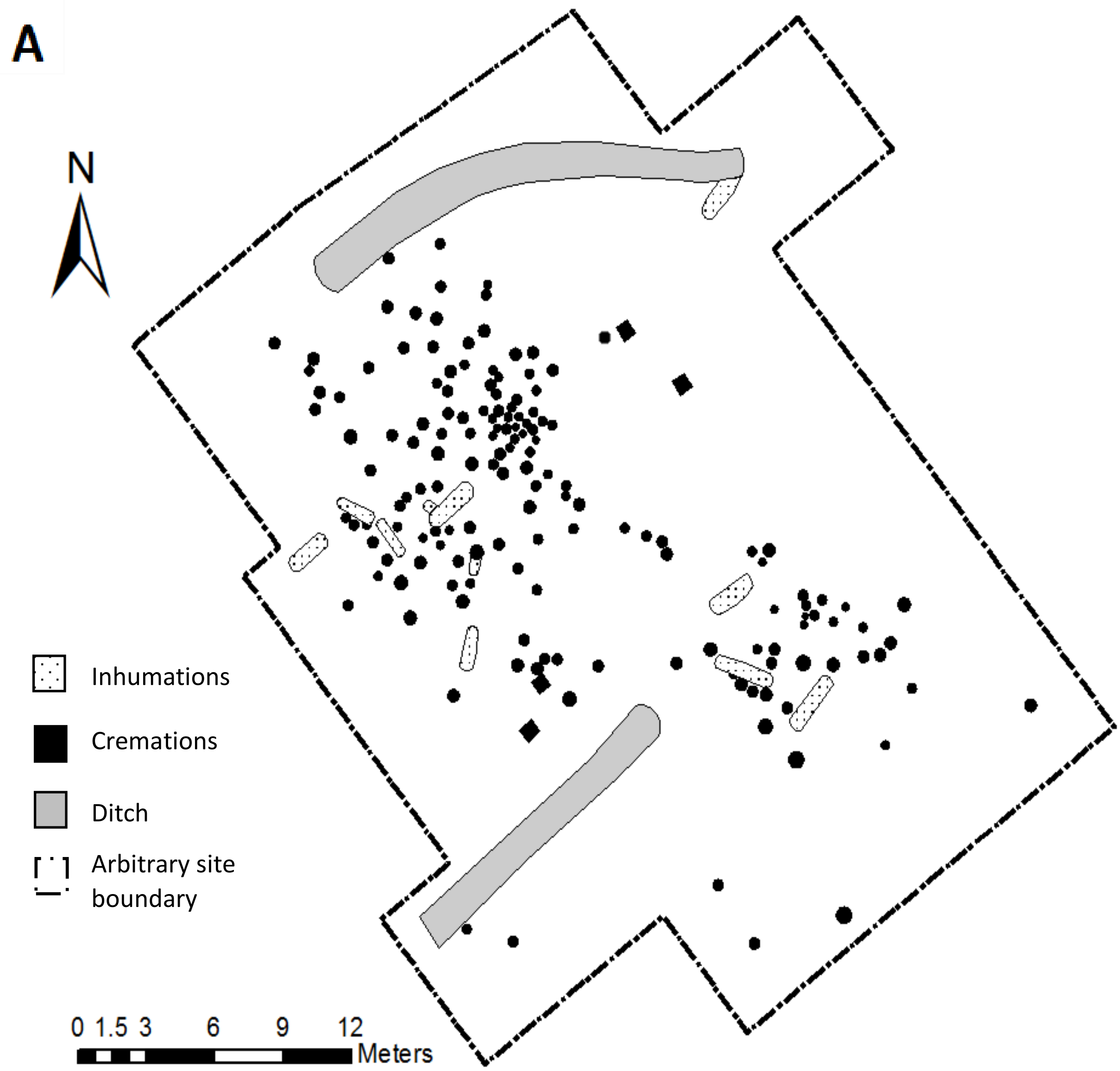


Figure 4.3 A) Plan of Wallington Road cemetery adapted from Burleigh and Fitzpatrick-Matthews (2010, p.33).

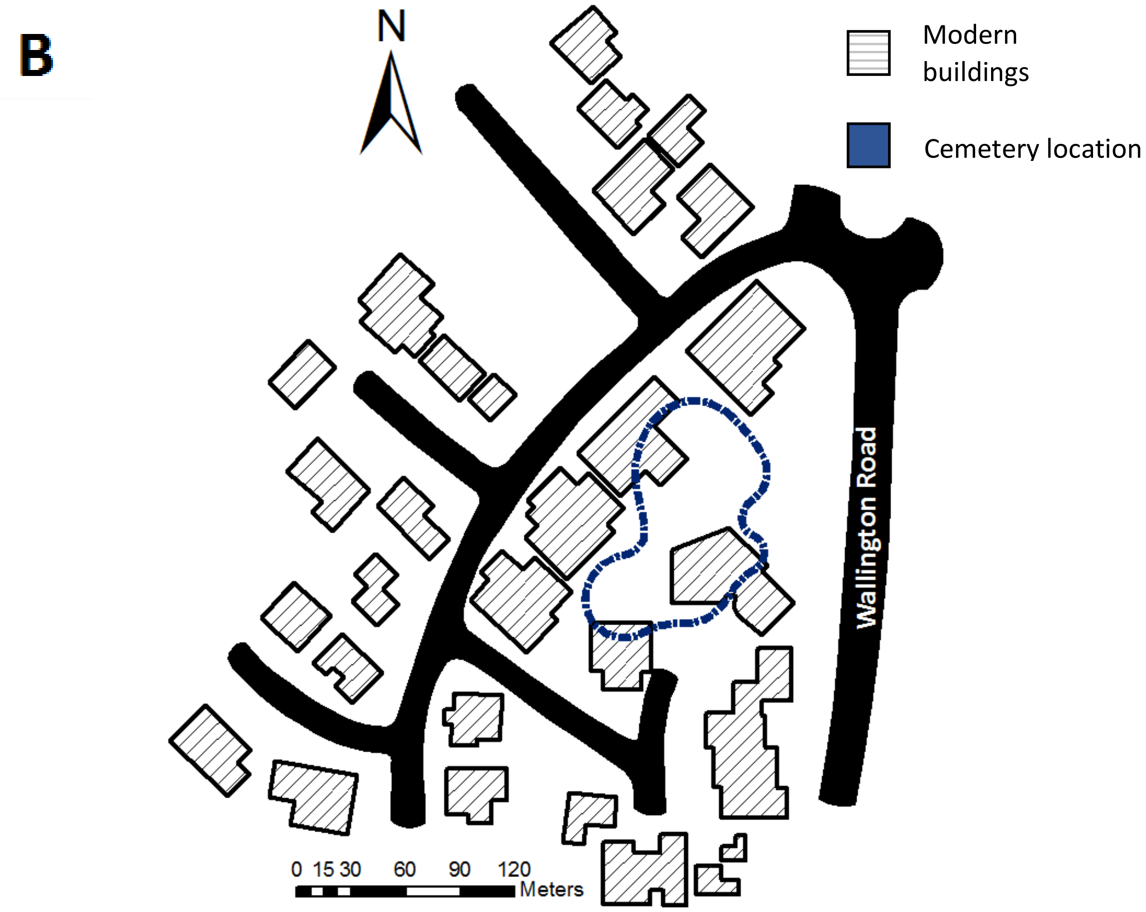


Figure 4.3 B) Location of Wallington Road cemetery adapted from Burleigh and Fitzpatrick-Matthews (2010, p.26).

4.2.1.2 Folly Lane Cemetery: 1st Century BC to 3rd Century AD

4.2.1.2.1 Background

Folly Lane is located in south-west Hertfordshire, c.0.9 miles north-east of Verulamium (TL 143077) (Figure 4.4). The cemetery, which was associated with the Roman town of Verulamium, spanned several centuries from the Late Iron Age to the Late Roman period and comprised of both inhumations and cremations. The pre-Roman settlement of *Verulamion* has been described as a client kingdom, which later became the *municipium, Verulamium,* following the Roman conquest (Niblett, 1999). The extensive funerary shaft found at the site, which was later replaced by a Roman temple, alongside the inclusion of a high-status cremation burial suggests that this cemetery was, at some point, reserved for social elites (Niblett, 1999). The site was first discovered in 1991 as a result of a series of archaeological projects set out to survey the area. It spanned 4.5ha and lies just beyond the eastern gate of the Roman town of Verulamium, linking Chester Gate with Akeman Street (Niblett, 1999).

Due to the time restrictions of the project, as well as limited financial support, a full excavation of Folly Lane cemetery could not be conducted. Instead, focus was given to areas of the cemetery that would otherwise be destroyed by the housing development to follow and were considered to be archaeologically significant. Consequently, the full extent of the cemetery was not identified, and there is a possibility that further burials and ceremonial features remain within the area. However, Folly Lane continues to be one of the most famous Romano-British burial grounds in the country; its inclusion in this project was even more fortunate as gaining access to the material from King Harry Lane, St Albans, the other well-known burial ground from Verulamium was unsuccessful (Niblett, 1999).

4.2.1.2.2 Burial Phase 1: Mid 1st Century AD

Despite evidence for prehistoric occupation, no burial activity took place at Folly Lane until the Mid-1st century AD. During this period, a rectilinear enclosure ditch was constructed in the centre of the funerary shaft in the north-eastern area of the cemetery, which included a high-status cremation burial and several inhumations (Niblett, 1999).

4.2.1.2.3 Burial Phase 2: Later 1st Century AD to the Mid 2nd Century AD

During this phase the enclosure ditch had pits dug into its terminus and a Romano-Celtic temple was built north-west of the funerary shaft. A small cremation cemetery was also placed outside of the enclosure, and an area dedicated to metal-working was established to the east (Niblett, 1999).

4.2.1.2.4 Burial Phase 3: Mid 2nd Century to Early 3rd Century AD

By this point the ceremonial enclosure established in the 1st century AD was filled in, and several large shafts were dug to the south-west. The road had been replaced by the main Colchester road, and both the cemetery and industrial area continued to be used (Niblett, 1999).

4.2.1.2.5 Burial Phase 4: Mid – Late 3rd Century AD

Between AD c.250 – 300 the burial activity at Folly Lane ceased. The filled in enclosure ditch became a refuse site, and it is thought that the ceremonial enclosure had deteriorated and was no longer maintained (Niblett, 1999).

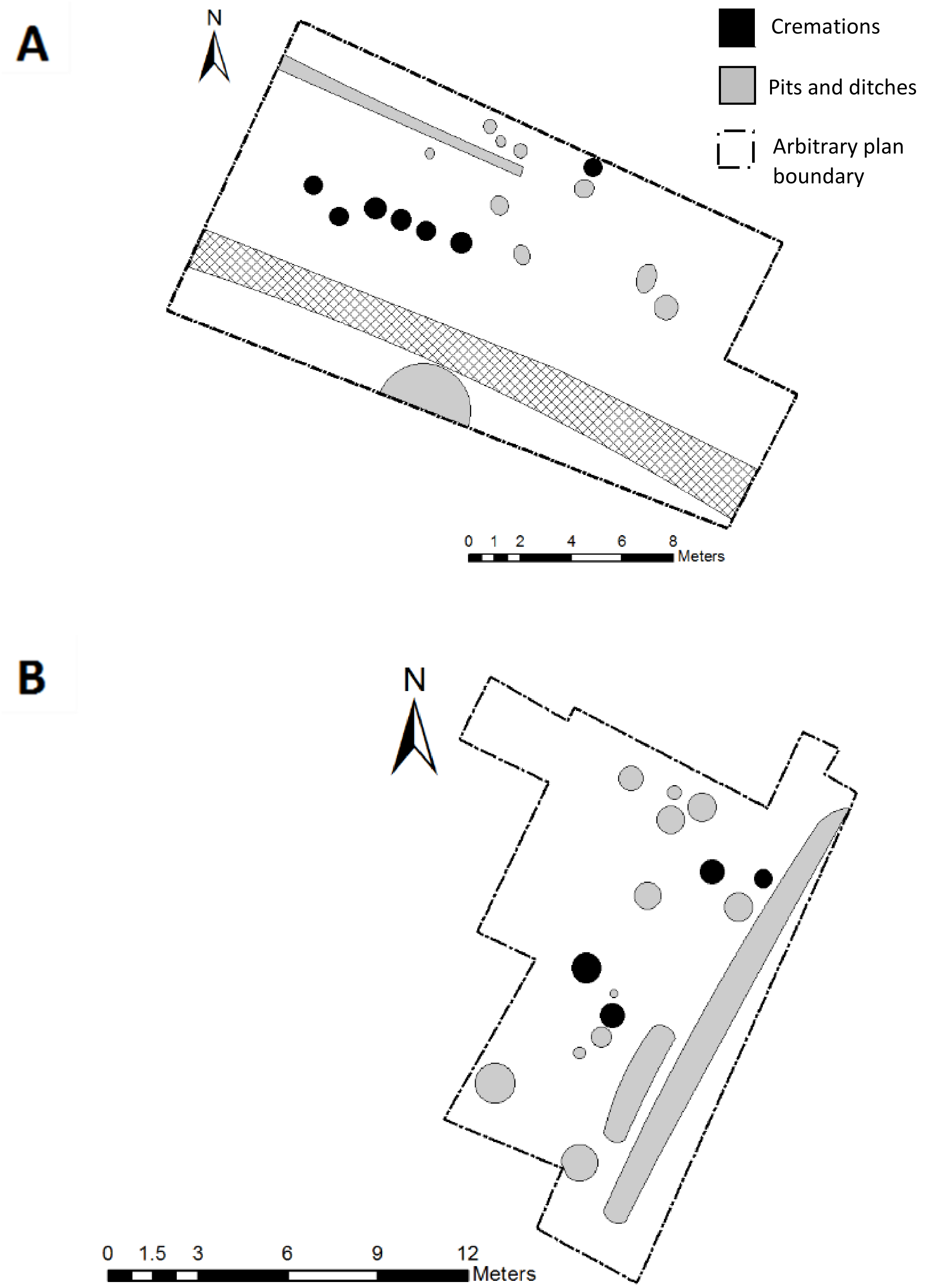


Figure 4.4 Plan of Folly Lane cemetery adapted from Niblett (1999, p.3). A) Area H of site. B) Area K of site.

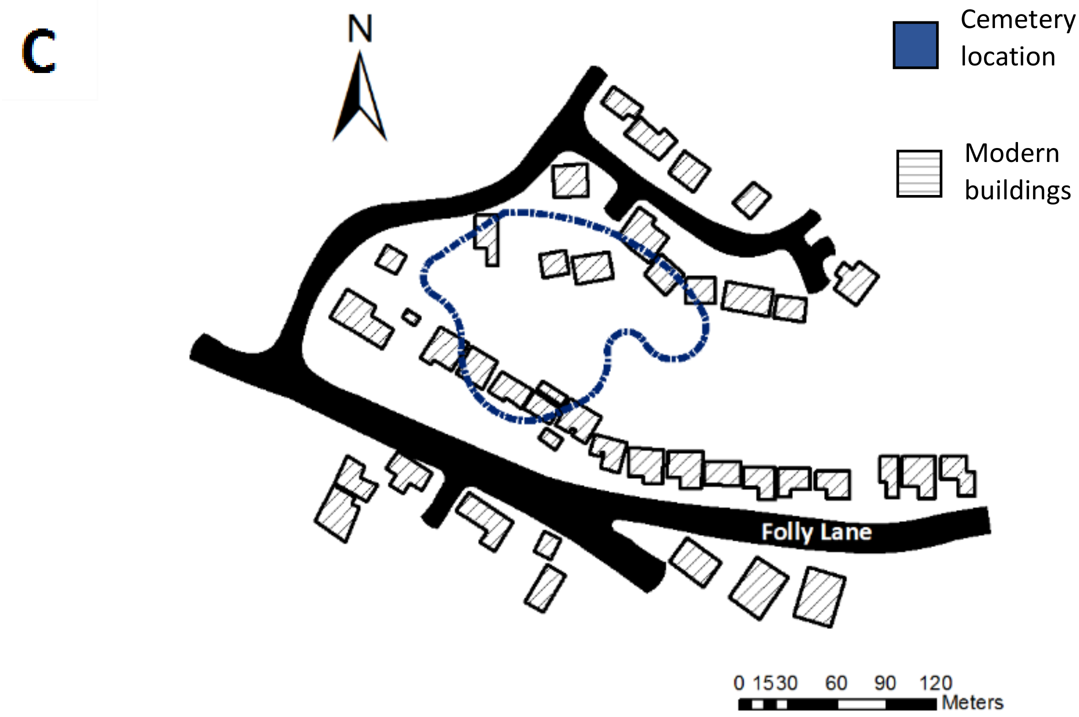


Figure 4.4 C) Location of Folly Lane cemetery adapted from Niblett (1999, p.1).

4.2.1.3 Cross Farm: Late 1st Century to Early 3rd Century AD

4.2.1.3.1 Background

This cemetery is located on Cross Lane in west Hertfordshire (TL147125) (Figure 4.5). The burial ground dates from the 1st to the 3rd centuries AD, and included cremation burials. The identification of a farmstead adjacent to the cemetery suggests that these individuals belonged to a small rural community during the Late Iron Age to Roman transition. Burial ABE was the only cremation deposit where the urn was supported by flint nodules, which may indicate a high-status individual (West, 1994). The site was discovered in 1992 when a disturbed cremation burial was found during a field walking expedition run by St Albans Architectural and Archaeological Society. A further field walking expedition in the same year identified a small Roman building within the surrounding fields of Cross Farm. The area spanned <1ha and is situated on the hinterlands of *Verulamium* (West, 1994).

When Cross Farm was excavated, small trial trenches measuring 2m^2 were placed where the disturbed cremation deposit had been discovered. Due to the volume of material found, a 90m long trench orientated east-west was dug within the same area the following year. Unfortunately, the full extent of the burial ground was never established. In addition, the cremation deposits from this excavation including the grave goods were not recorded thoroughly. Consequently, the paper archive at times lacks vital information, including dates for individual burials. However, all of the excavated material has been subject to post-excavation processing, and the results from the examination of the burned human remains are available (Roberts, 1996; West, 1994).

4.2.1.3.2 Burial Phase 1: Late 1st Century to Early 3rd Century AD

Due to the nature of the excavation and the limited analysis conducted, the cremation deposits have only been given a preliminary date range of Late 1st century to Early 3rd century AD. Consequently, burial dates based on the identified pottery were assessed by the author using the Roman Pottery Atlas (Tyers, 1996), but the different phases of cemetery activity are unknown. Unlike other contemporary cemeteries, no ditches or gullies were identified that may have enclosed the burial ground; this is probably due to the limited archaeological exploration conducted. Interestingly, the cremation deposits recovered were placed at opposite ends of the trench, separated by a large open space; this space was thought to indicate a division between two distinct burial groups. As the burial groups were tightly arranged with no evidence for intercutting or truncated deposits, it is likely that above-ground markers were used (West, 1994).

Figure 4.5 A) Plan of Cross Farm cemetery adapted from Anon (1995, p.1).

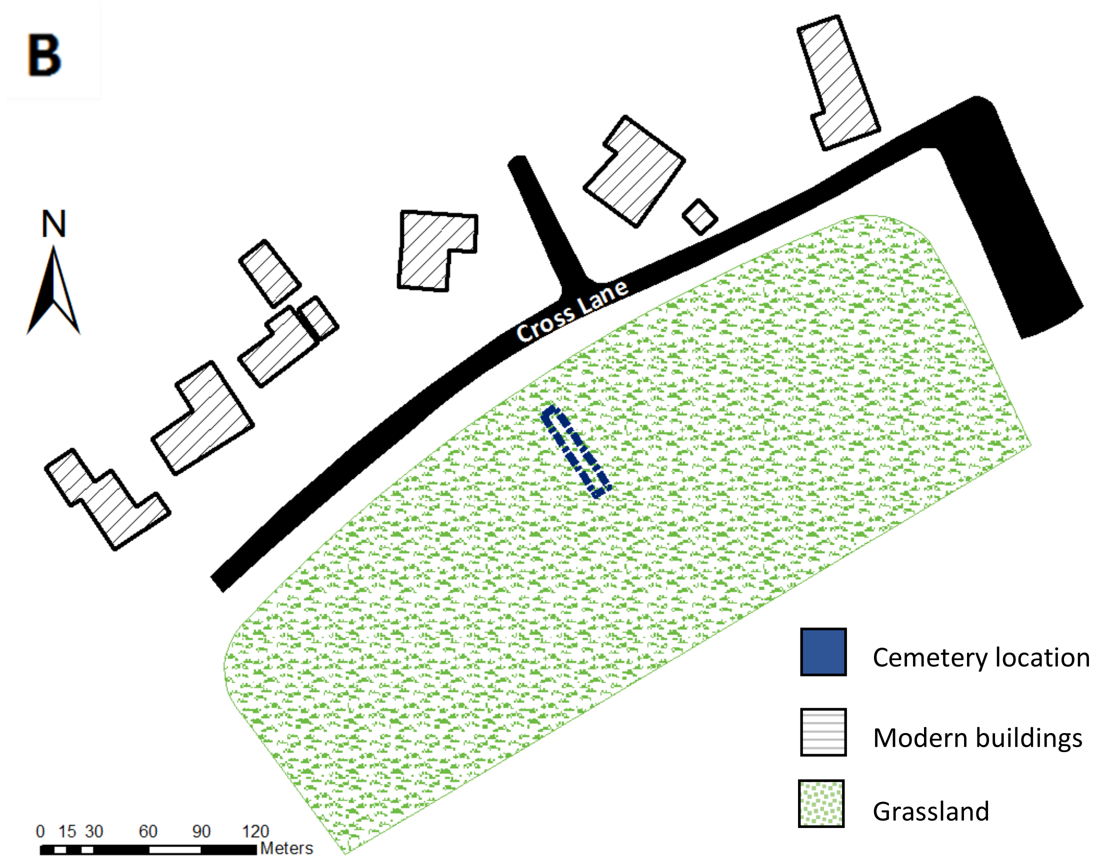


Figure 4.5 B) Location of Cross Farm cemetery adapted from West (1995, p.1).

4.2.1.4 M1 Junction: 1st Century BC to 3rd Century AD

4.2.1.4.1 Background

M1 junction cemetery is located in south-west Hertfordshire (TL084075) (Figure 4.6). The burial ground was in use from the 1st century BC to the 3rd century AD, and only included cremation deposits. During the Late Iron Age to Roman transition this settlement continued as a rural settlement located on the hinterlands of Verulamium. A single high-status burial was found at Junction 8N that was placed in a wooden casket and accompanied by three ceramic vessels (Stansbie, et al., 2012). The site was excavated in the late 2000s ahead of the engineering work planned to expand the M1 by 15km. A series of pits and ditches were uncovered that were interpreted as large enclosures; amongst these were several isolated burial groups (Stansbie, et al., 2012).

The large-scale project undertaken by Oxford Archaeology excavated all areas of archaeological significance. Features were recorded *in situ* and were subject to complete post-excavation processing. Despite the identification of only six cremation deposits, the archive is thorough and all of the results from the excavation have been published (Stansbie, et al., 2012), an uncommon characteristic for the cemeteries of Hertfordshire (Bryant and Niblett, 1997).

4.2.1.4.2 Burial Phase 1: Late Iron Age to Early Roman

Funerary activity was identified at area M and Junction 9. The former consisted of a cremation deposit placed on the inside of a large boundary ditch, suggesting an element of burial organisation. The latter included a cremation deposit situated to the east of another large ditch (Stansbie, et al., 2012).

4.2.1.4.3 Burial Phase 2: Early to Middle Roman

Junction 8N included two cremation pits consisting of four cremation deposits. Both were placed either side of a subdividing ditch that abutted the outside boundary of the southernmost enclosure (Stansbie, et al., 2012).

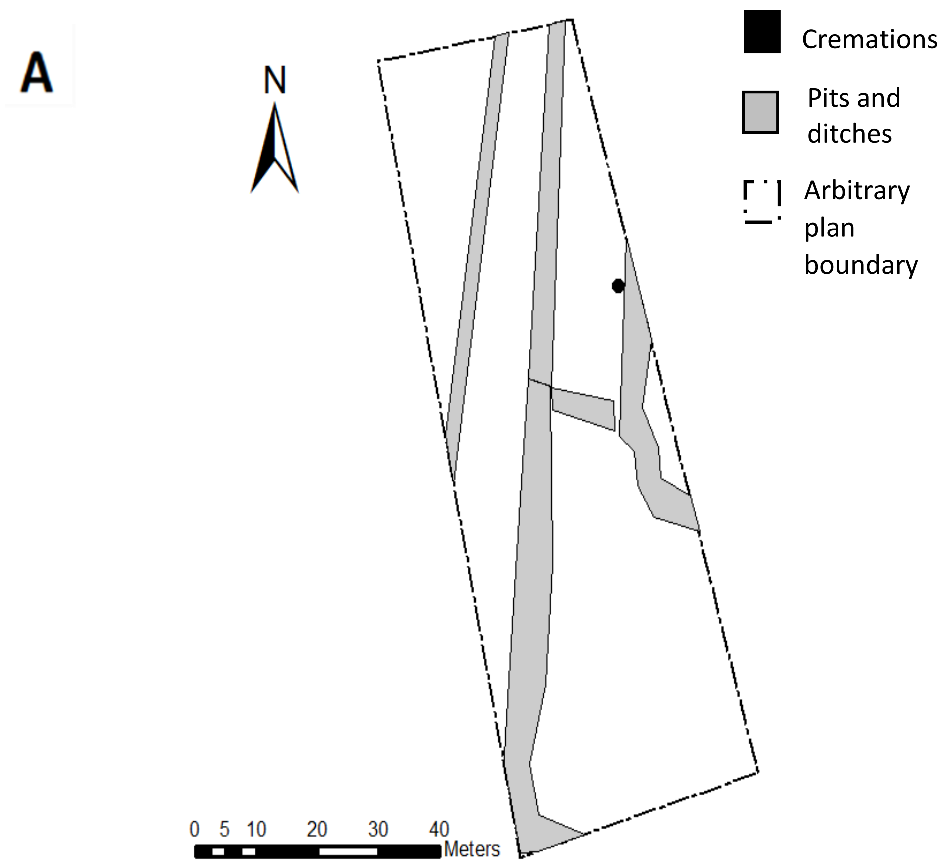


Figure 4.6 A) Plan of Junction 9 of M1 Junction adapted from Stansbie et al., 2012 (p.72).

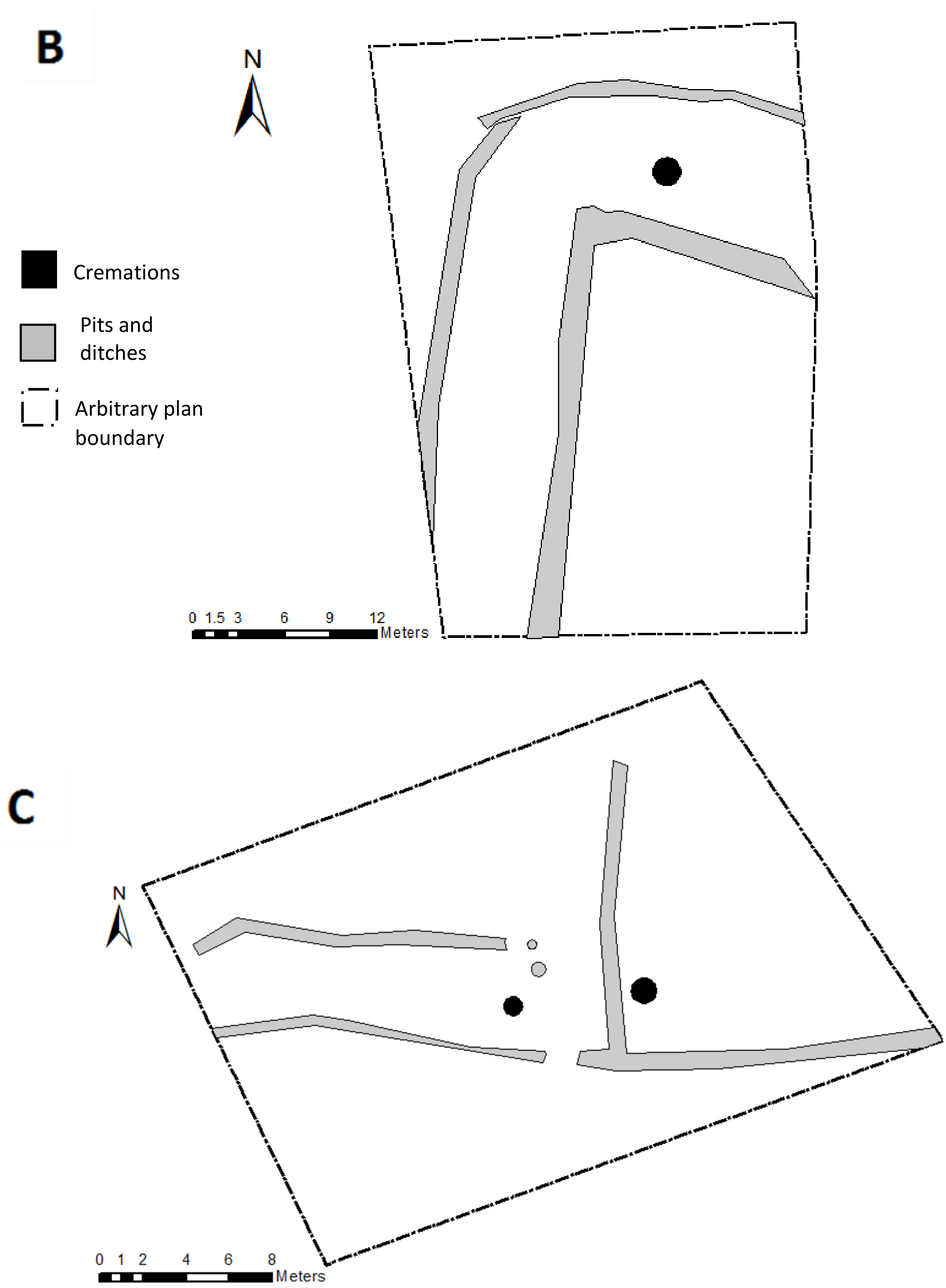


Figure 4.6 Plan of M1 Junction. B) Area M adapted from Stansbie et al., 2012 (p.86). C) Junction 8N adapted from Stansbie et al., 2012 (p.28).

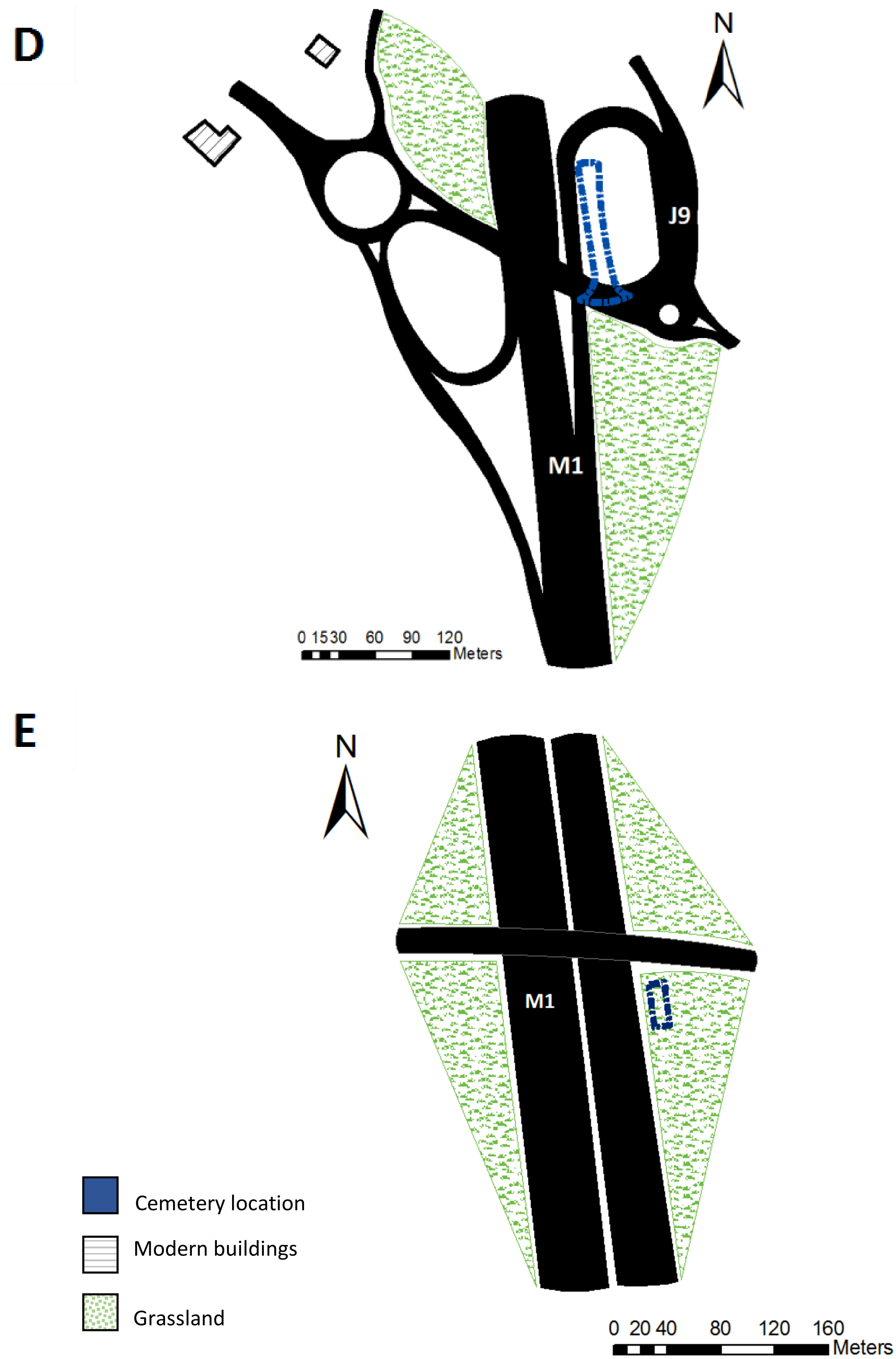


Figure 4.6 Location of M1 Junction cemeteries adapted from Stansbie et al., 2012 (p.4-5). D) Location of Junction 9. E) Location of Area M.

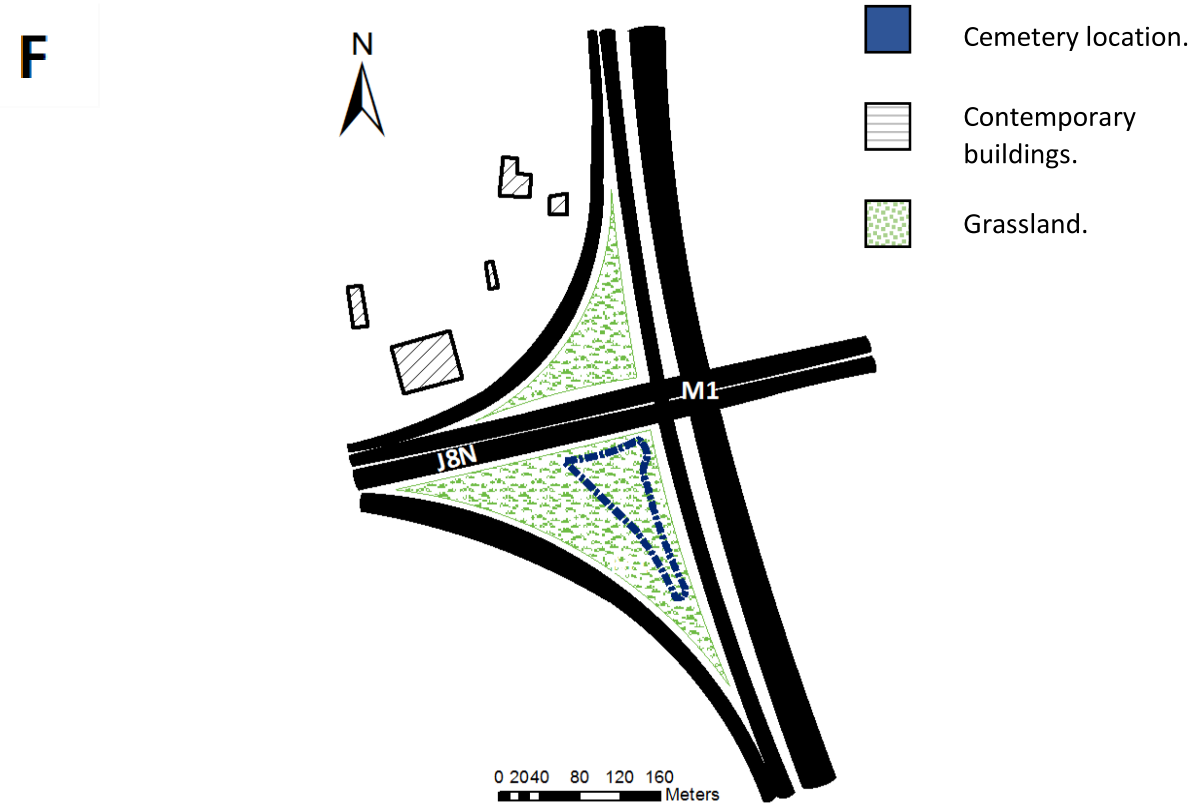


Figure 4.6 F) Location of Junction 8N adapted from Stansbie et al., 2012 (p.4-5).

4.2.1.5 Spencer Park: 1st Century AD to 3rd Century AD

4.2.1.5.1 Background

Spencer Park cemetery is located on the land adjacent to Cherry Tree Lane in south-west Hertfordshire (TL084093) (Figure 4.7). The burial ground dates from the 1st to the 3rd centuries AD and only included cremation deposits. During its period of use, the settlement was characterised as a small rural community. It was noted during analysis that the use of a wooden casket as a funerary vessel suggests the individuals were socially distinguished (Foard, 2008). The cemetery was discovered in 2008, following the proposal for a new housing development scheme. The site spanned 12.9ha and is positioned 2km north-west of the Iron Age plateau fort, The Aubreys, and 4km east of the Roman road of Watling Street that connects London to Chester (Foard, 2008).

The project itself was an archaeological trial trench excavation, the purpose of which was to survey the area to inform a pre-application enquiry. A series of long trial trenches up to 50m long were dug to establish the extent and character of the archaeology, including the small cemetery identified. As this was an evaluation rather than a full-scale excavation, only a sample of the entire cemetery could be examined, and any analysis conducted for the interim report was minimal. However, as this was carried out by a professional archaeology unit, the cremation deposits uncovered, as well as the associated finds were recorded to a high standard and were available for sampling (Foard, 2008).

4.2.1.5.2 Burial Phase 1: Early 1st to 3rd Century AD

Only one phase of activity was identified during the trial trench excavation of Spencer Park. During this period, a series of pits and ditches were dug, as well as a small cemetery consisting of six cremation burials were deposited. The trench in which all the burials were identified also showed evidence of a large ditch aligned north-east to south-west and a gully that partially enclosed the cemetery, suggesting some degree of organisation (Foard, 2008).

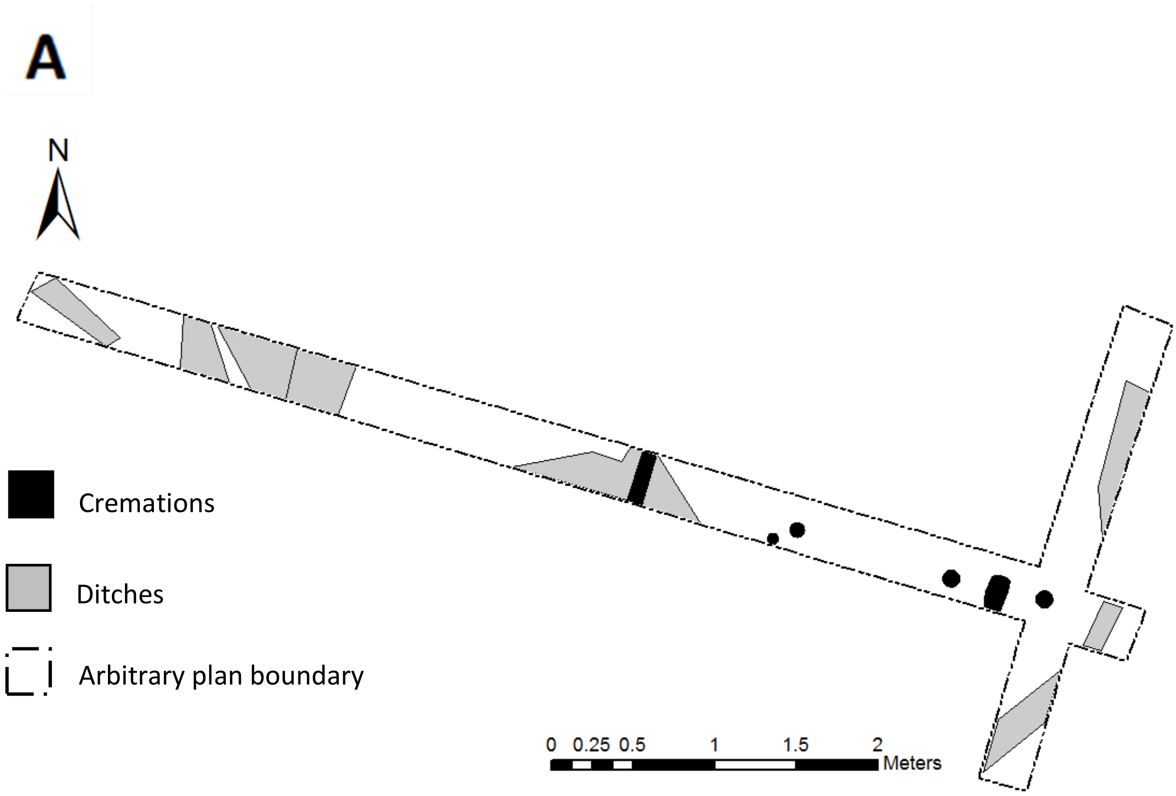


Figure 4.7 A) Plan of Spencer Park cemetery adapted from Foard (2008, p.16).

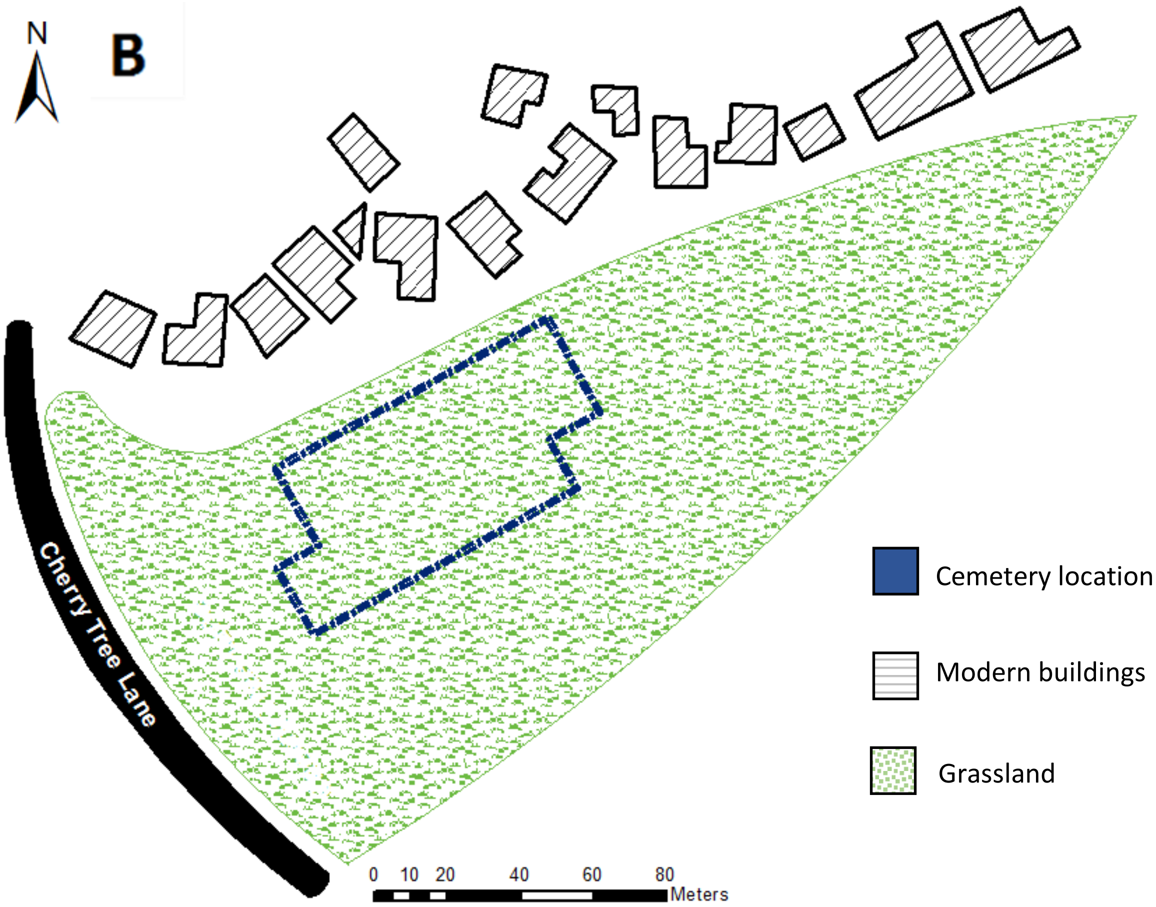


Figure 4.7 B) Location of Spencer Park cemetery adapted from Foard (2008, p.15).

4.3 Methods

4.3.1 Secondary Data

The meta-analysis cemeteries were collected from a variety of urban (minor and major) and rural burial grounds across England, which were active between the 1st century BC and the 4th century AD. All cemeteries, as well individual cremation deposits, which met this criterion were included in the study sample (see Appendix 2 for list of cemeteries, number of cremation deposits and the catalogue of secondary data collected). Sources used included monographs, journal articles, and unpublished excavation reports that were taken from the database of the Rural Settlement of Roman Britain project (Allen, et al., 2018). Additional cemeteries were also sourced from Historic Environment Records (HER) (Heritage Gateway, 2012).

Excavation and skeletal reports were used to record summary data describing the nature of the cremation rites practiced at each cemetery. Table 4.8 presents the information that was recorded and how it was catalogued following the classifications described in section 4.1. Originally, the author intended on recording information from each individual cremation deposit, rather than summary data for each cemetery. However, this was not practical and would replicate the method employed in the primary investigation of Hertfordshire.

Table 4.6 Cremation properties recorded for secondary data.

Cemetery Properties	Categories
Burial Date	Late Iron Age; Early Roman; Middle Roman; Late Roman; Undated
Settlement Type	Rural; Minor Urban; Major Urban
Region	North-West; North-East; Midlands; South-East; South-West
Number of Burial Types	Urned; Unurned; Bustum; Pyre Site; Redeposited Pyre Debris; Unknown
Minimum Number of Individuals (MNI)	Numeric
Number of Double Burials	Numeric
Number of Females	Numeric
Number of Males	Numeric
Number from each Age Group	Less than 13 years; 14 – 18 years of age; 18 years and above; Unknown.
Number of Cremation Deposits with Grave Goods	Numeric
Number of cremation deposits with Pyre Goods	Numeric

4.3.1.1 Statistical Analysis

Care was taken that large cemeteries did not unduly skew the results by critically comparing patterns with those from the smaller burial grounds; it was not necessary to statistically test for these if they were clearly dominating the sample.

With regards to the male / female ratios, a one-way ANOVA test was performed to identify any significant differences according to region and settlement type. This test was chosen because it compares the means of several unrelated groups and reduces the risk of type 1 errors (Ruxton and Beauchamp 2008). It is also more appropriate than a chi-squared test because it considers individual cemetery data, rather than the sum of males and females. The Tukey post hoc test was used to establish where the significance occurred (Ruxton and Beauchamp, 2008).

In relation to age, and burial type, Pearson's chi-square tests were used to identify significant trends according to region and settlement type. This test is well-suited to categorical data that do not meet parametric assumptions (McHugh, 2013).

4.3.2 Primary Data

4.3.2.1 Cremation Classification

Excavation and skeletal reports from the site archives were used to create an extensive dataset that recorded the nature of the cremation deposits from all five cemeteries from Hertfordshire. The data were collected in order to examine cremation technology. Table 4.7 lists the information that was recorded and how it was catalogued following the classifications described in section 4.1. In relation to grave goods, the cremation deposits examined were assigned a group depending on the number of inclusions. These groups were based on the average number of items buried with the individuals examined. In order to assess the reliability of the osteological data (minimum number of individuals, sex, age), a pilot study was conducted to determine inter-observer reliability. A sub-sample of cremation deposits from each of the Hertfordshire cemeteries was re-assessed blind, using the same methods employed by the original examiner (see section 4.3.2.2 and Appendix 5 for results).

Table 4.7 Cremation properties recorded for primary data.

Cremation Property	Categories
Burial Date	Late Iron Age; Early Roman; Middle Roman; Late Roman; Roman
Settlement Type	Rural; Minor Urban; Major Urban
Burial Type	Urned; Unurned; Bustum; Pyre Site; Redeposited Pyre Debris; Unknown
Minimum Number of Individuals (MNI)	Numeric
Double Burial	YES; No
Sex of Individual(s)	Female; Male
Age of Individual(s)	Less than 13 years; 14 – 18 years of age; over 18 years; Unknown
Number of Grave Goods	1 – 2 grave goods; 3 – 4 grave goods; 5 – 6 grave goods

In order to explore cremation technology within the region of Hertfordshire in more detail, a sub-sample of 102 individuals were selected for further analysis. Every single cremation deposit from Folly Lane (N = 15), Cross Farm (N = 31), M1 Junction (N = 6) and Spencer Park (N = 4) was re-examined for this investigation, while 46 individuals that varied in age and sex were selected at random from Wallington Road; double burials were excluded from this analysis. Even though a minimum of 167 cremated individuals were recovered from this cemetery, not every cremation deposit was available for sampling.

The following sections (4.3.2.3 – 4.3.2.8) describe the further methods applied to this sub-sample from Hertfordshire. The combined use of several methods to examine the thermal alteration of burned bone teamed with charcoal analysis is recommended by contemporary research (Squires, et al., 2011; Cerezo-Román, et al., 2017) to obtain a holistic interpretation of ancient cremation technology.

4.3.2.2 Pilot Study: Inter-Observer Reliability

A pilot study was conducted to assess the inter-observer reliability of the osteological data from Wallington Road, Baldock (McKinley, 1991; 2006), Folly Lane, St Albans (Mays, 1999), Cross Farm, Harpenden (Roberts, 1996), and M1 Junction, Hemel Hempstead (Marquez-Grant, 2012) (see section 4.3.1). The osteological assessment of the individuals from Spencer Park was conducted by the author.

A sub-sample of 36 cremation deposits (Wallington Road: N = 10. Folly Lane: N = 10. Cross Farm: N = 10. M1 Junction: N = 6) were re-examined by the author to determine the minimum number of individuals, sex and age using the same methods employed by the original examiner; as these methods are all broadly similar, if not the same, it is likely that if the same approach was applied to all four cemeteries similar results would be ascertained. The re-examination was entirely blind, where the author had no previous knowledge of the results.

The outcome of this pilot study is presented in Appendix 5. The percentage agreement between the author's re-examination and the original assessment ranged from 80% to 100%. Due to this high level of inter-observer reliability, it was assumed that the osteological data from these 4 cemeteries could be re-used in this primary investigation.

4.3.2.3 Charcoal Analysis

Soil samples were taken from all five cemeteries for charcoal analysis in order to examine fuel selection. The samples were derived from the fills of both urned and unurned cremation deposits, presuming that the charcoal represented pyre debris that was collected alongside the burned bone following cremation. Due to the conditions of the museum archives, as well as the retention bias of the material following excavation (i.e. the Wallington Road excavations did not conduct environmental sampling, and retrieved few charcoal fragments), only a small number of samples could be assembled. However, the results are valuable in relation to the presence and/or absence of taxa, as well as ubiquity, which in this context refers to the number of samples in which one taxa is recorded.

For Wallington Road, Folly Lane and Cross Farm, samples were floated to extract the microfossils from the soil matrix, using a 0.25mm mesh; this process had already been done for the cremation deposits from Spencer Park and M1 Junction following the excavation. The material extracted was dried and sieved using 4mm and 2mm fractions. Ideally, charcoal fragments from both fractions would be subject to visual assessment. However, if the charred wood was poorly preserved fragments were often <2mm in size. A representative sample of charcoal was examined for each context. Usually, this included 100 fragments of charred wood. However, this depended on the quantity and quality of the material recovered during flotation.

Identification was determined by visually analysing the microscopic morphology of the charred wood fragments. This was achieved by slicing each sample with a razor blade along the transverse, radial longitudinal and tangential longitudinal planes. Each section was then examined using a bi-focal epi-illuminated Olympus BHM microscope at magnifications of x50, x100 and x400 (Campbell, 2004). The morphology of each plane was compared to the anatomical criteria specified by Schweingruber (1990) in order to determine identity to the lowest possible taxa. The identifications made were checked Dr Catherine Barnett, an archaobotanist that specialises in charcoal analysis based in the University of Reading's archaeology department.

All taxa identifications were recorded according to presence, absence and species ubiquity (the number of contexts each species appeared in). Latin binomials were used. If only the species could be determined, the acronym sp. was employed, and if the species could not be determined due to poor preservation, the convention cf. was used.

4.3.2.4 Oxidisation of Burned Bone

Macroscopic colour change indicative of oxidisation was analysed using a 7 point scoring system, based on the sequential spectrum of colour provided by Thompson et al. (2016), and developed by Munro, et al. (2007), comprising of: normal (Score = 1) (burning until the soft tissue was removed); brown (Score = 2); black (Score = 3) (carbonisation); taupe (Score = 4); grey (Score = 5); blue (Score = 6); white (Score = 7) (partial to full oxidisation) (Figure 4.8). A ranked score was given to each individual that represented the colour(s) observed. It was often found that individual elements would consist of more than one colour, which is to be expected as the varied distribution of soft tissue causes a difference in thermal combustion (Carroll and Smith, 2018; Thompson, et al., 2016). When this happened, each pigmentation was scored and the median was calculated.

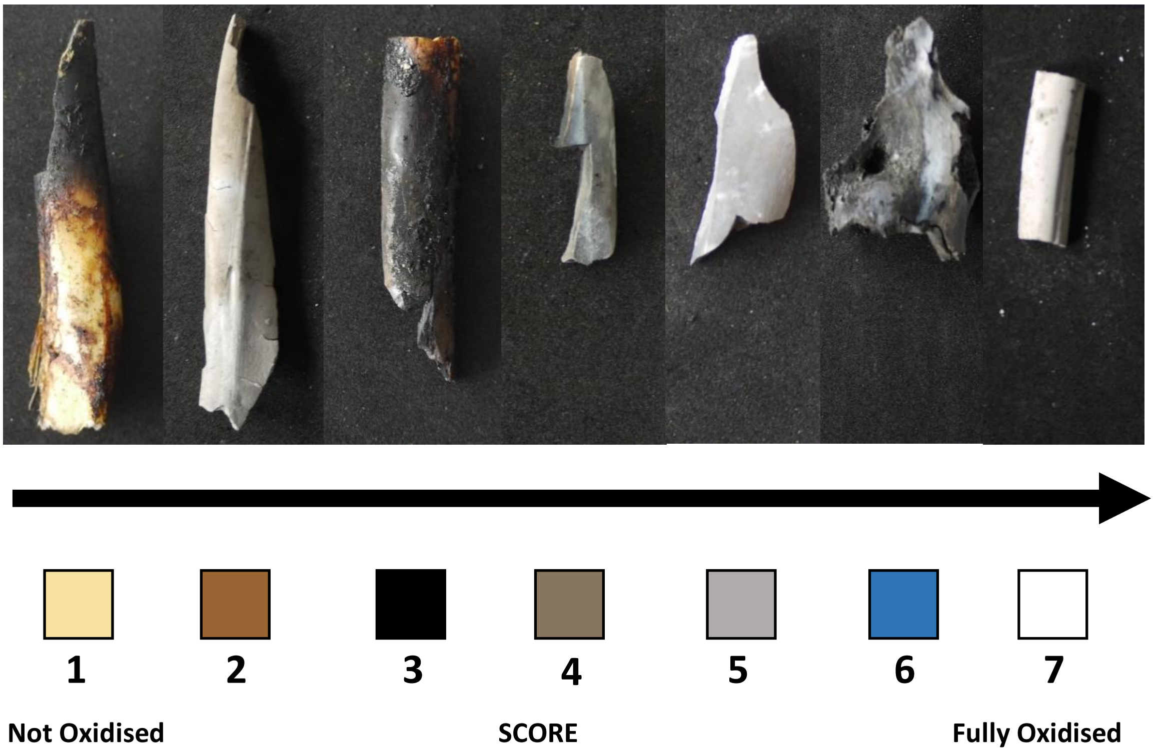


Figure 4.8 Schematic diagram of colour spectrum.

4.3.2.5 Burned Animal Bone Standards

In order to produce burned bone standards of known temperatures and durations, eleven sections of modern pig long bone were burned in an industrial furnace for 45 minutes at intervals of 100˚C, ranging from 100˚C to 1100˚C. These were created to produce standards for temperature used in the analysis of crystallinity, histology and quantitative petrography. The modern animal bone was sourced from Graig Farm Organics, Monchdre, and comprised freshly butchered pig long bones that were partially defleshed (soft tissue removed). The samples were stored in freezers and then thawed prior to incineration to prevent decomposition. Pigs are often used in forensic research as human proxies as their body size, fat distribution, and bone microstructure are, to some extent, similar to that of humans (Schotsmans, et al., 2014); however, it is important to acknowledge that the results achieved may not be fully representative of human bone (Thompson, 2002). Studies have found that the distribution of fatty tissue on a body can impact the resultant H-I changes (Dehaan, 2015). For example, Dehann (2015, p.9-10) explains that fat is the best fuel in the body for burning, but the effects of heating on this material depends on how thick it is, the thermal properties of the material, as well as the duration of the fire. He points out that its takes roughly 30-60 minutes for the core temperature of a human torso to rise in temperature when exposed to a normal room fire, which is longer than other areas of the body. In this study, the fact that the animal bone samples were partially defleshed (soft tissue removed) before firing would have had an impact on the resultant microscopic heat-induced alterations. However, as the FTIR-ATR, histological and quantitative petrographic results ascertained from these standards are consistent with data from published studies (Squires, et al., 2011; Castillo, et al., 2013; Thompson, et al., 2013), it was concluded that they are reliable and can be used in the primary analysis.

4.3.2.6 Crystallinity of Burned Bone

Burned bone crystallinity as a reflection of burning intensity was determined utilising the FTIR-ATR method pioneered by Thompson et al., (2013). A single fragment of burned long bone, preferably from the lower limbs, was sampled. With regards to the archaeological data, only single burials were sampled for this analysis. 0.5g of bone was removed from the periosteal layer of each fragment using a scalpel; the burned bone sample was then stored in a sealed glass vessel (Squires, et al., 2011). A Perkin-Elmer Spectrum 100 FTIR spectrometer, which was set to measure spectra between 200cm^{-1} - 2000cm^{-1} at a resolution of 4cm^{-1}, was used in this analysis. Six scans were taken for each sample and the average of these was used in the proceeding analysis. The CI and C/P indexes were calculated to establish burning intensity; a K-means cluster analysis was used to identify the groups of burning intensity from the modern animal bone standards, and a discriminant function was employed using the QP results to independently classify the archaeological data into one of the identified burning categories (see section 6.8.1 for the burning categories). A ranked score was then given to each individual that represented the assigned burning category. These included: 1 = Low (100°C - 300°C). 2 = Middle (400°C - 700°C). 3 = High (800°C - 1100°C).

4.3.2.7 Histological Changes of Burned Bone

Histological examinations of burned bone thin-sections were conducted to infer burning temperature (Squires, et al., 2011). The quantitative petrographic method developed here was compared to Squires, et al.'s (2011) qualitative technique. This was to assess the reliability of the results obtained from this new approach.

4.3.2.7.1 Thin-Section Production

Creating thin-sections of modern and archaeologically burned bone is challenging. In the past, researchers have struggled to produce consistently flat thin-sections that are the same thickness, without breaking the sample or grinding it by hand (Hanson and Cain, 2007; Squires, et al., 2011; Simmons, et al., 2016). In Squires et al.'s (2011, p.2404) examination of burned bone microstructure, thin-sections were cut to 60µ, 75µ and 100µ due to the fragile nature of the bone. For comparison, Castillo et al., (2013) examined samples that were 3mm thick, while Hanson and Cain (2007) prepared samples that were approximately 50µ thick. This variation hinders the consistency of the results and makes comparative analysis difficult. A new method for making thin-sections presented below helps to overcome this issue and encourages a standardised approach that will facilitate collaborative research in the future. The work was conducted in the thin-sectioning laboratory in the School of Archaeology, Geography and Environmental Science at the Univeristy of Reading.

As bone is a porous material, the process of impregnating a fragment in resin often leads to air pockets or bubbles that can obscure the appearance of the sample area when examined under a microscope (Glauert and Glauert, 1958; Feldman, 1962). The method presented in this thesis takes account of this by evacuating the resin mixture before it is poured over the bone fragment as well as afterwards, which helps to remove all the oxygen before the resin sets. To date, this approach has not been applied in other studies examining thin-sections of burned bone (Cattaneo, et al., 1999; Hanson and Cain, 2007; Squires, et al., 2011; Simmons, et al., 2016); however, it has been successfully used on other porous materials, including soils, metals and ceramics (Granger, 1967; Jongerius and Heintzberger, 1975; Machin, 2017; Sutton, 2017).

Some studies have used microtomes to prepare thin-sections, which is a tool used to cut extremely thin slices of material (Holden, et al., 1995a; Squires, et al., 2011; Castillo, et al., 2013; Schotmans, et al., 2014). This technique can be problematic when used to slice sections of burned bone. This is because the friable nature of the material often results in the sample breaking (Squires, et al., 2011). An alternative method involves grinding or polishing the resin block mounted to the glass slide (Cattaneo, et al., 1999; Simmons, et al., 2016). This can be a time-consuming process when conducted by hand (Simmons, et al., 2016). To make this method more efficient, this study employed a LOGITECH, which is a lapping machine that reduces a sample to a pre-programmed thickness. This not only guarantees the same thickness across the entire sample area, but also reduces the risk of breakage. Similar studies have also used this lapping technique and have found it particularly useful to process large numbers of samples (Holden, et al., 1995a; Cattaneo, et al., 1999). Despite the clear benefits of this new method, it is time consuming. On average, a batch of twelve samples takes a minimum of five days to produce. In addition, the numerous machines used in this procedure are specialist pieces of equipment that require expert training.

Figure 4.9 shows the steps involved in burned bone thin-section production. Single fragments of burned long bone, preferably from the lower limbs were sampled; with regards to the archaeological data, only single burials were used in this analysis. After being cleaned of any residue, each fragment was placed within an ice cube tray and impregnated with a solution of Epoxy Resin RX771C/NC and Aradur Hardener HY951, at a ratio of 10:1. The samples were then left to harden overnight in an industrial oven set at 60˚C. Next, the blocks were cut in half to expose the cross section of the element using a Wolfgang Gonzad diamond cut saw. The surface of the exposed cross section was then polished on a Buehler Metaserv Grinder-Polisher using 800 grinder paper to flatten the sample area. The blocks of resin were mounted to glass slides measuring 76mm x 26mm x 1.2 – 1.4mm using a solution of RT151-BU-256 Resin and RT151-BU-250G hardener, at a ratio of 4:1. These were left to set over night on a pressure plate. The samples were then cut using a CS10 Logitech to remove the excess resin. Once cut the slides were ground to 40µ using a LP30 Logitech LTD.

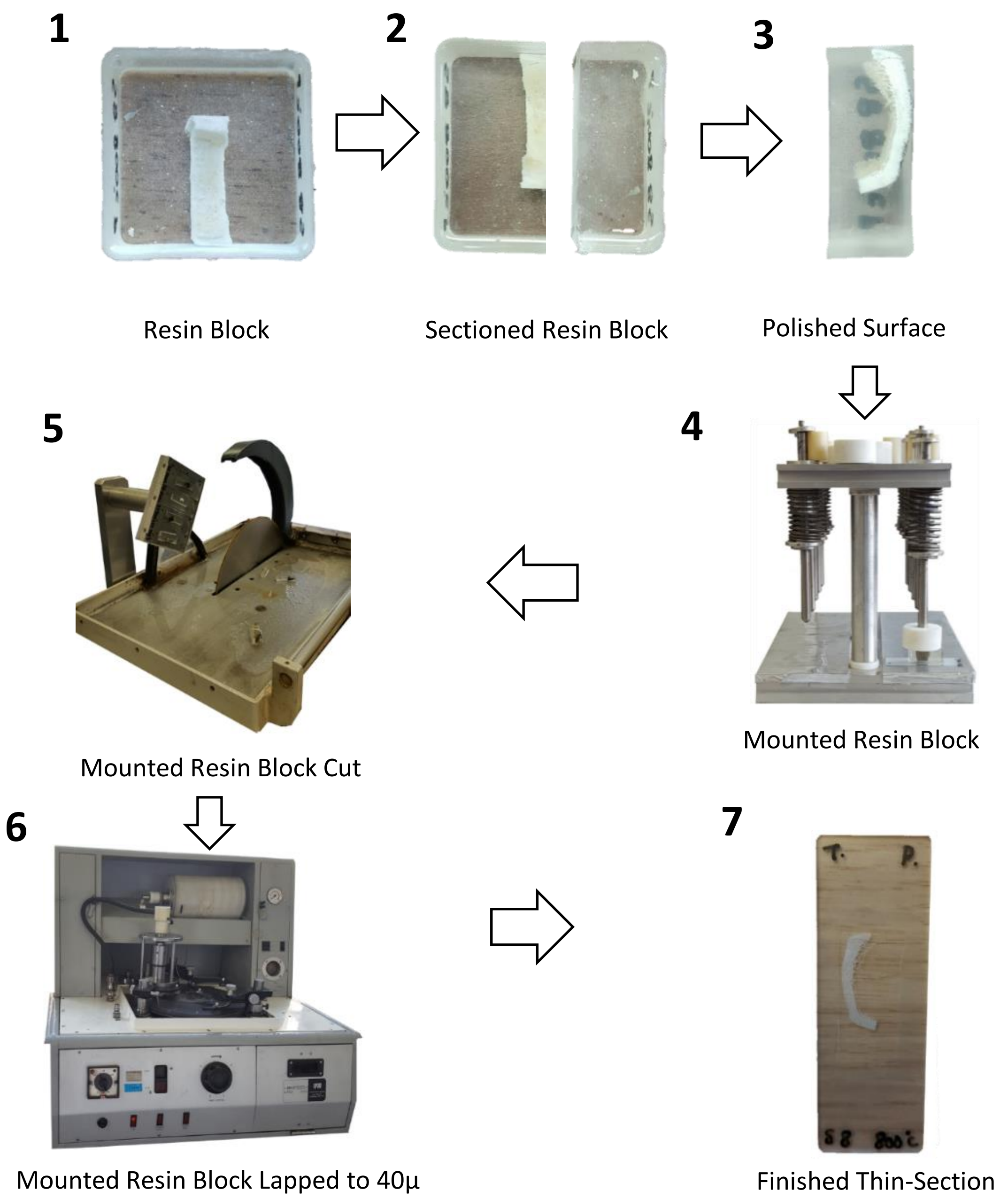


Figure 4.9 Flow diagram of burned bone thin-section production.

4.3.2.7.2 Quantitative Petrography of Burned Bone

See Appendix 8 for manuscript of Quantitative Petrography research paper (current status: Submitted). Quantitative Petrography is used to count the microscopic inclusions within thin-sections in order to examine the composition of the sample. The quantitative PETROG software and equipment used in this study was provided by Conwy Valley Systems Limited. The software's design is flexible and has been successfully applied to other artefacts including ceramics, and building materials (Machin, 2017; Sutton, 2017). It is therefore an invaluable addition to any multi-disciplinary department or laboratory. It is also compatible with Windows operating systems and can be used on most desktops. The programme exports the collected data into a Microsoft Excel or CSV spreadsheet file. The automated stepping stage is also compatible with most microscopes and can be assembled easily. However, this set-up is another example of specialist equipment that is not widely available at present.

The stepping stage (i.e. a metal framework that holds the glass slide in place) was first mounted to the platform of a Leica DM EP microscope with a Leica DF 295 camera. A spring-loaded arm attached to the stepping stage securely held the thin-section in place, while the motor systematically moved the sample for viewing; a live video stream was provided by the PETROG software so the operator could observe the image from the microscope. The sample specifications required by the PETROG software had to be programmed prior to analysis. This included setting the area of interest and the step count. The area of interest refers to the sample area the operator views via the live video stream, while the step count is the number of times the thin section is moved. In this study, a step count of 300 was employed to ensure that the entire sample area was covered. After each step, the cross-hairs on the live video stream landed on a heat-induced alteration, which is recorded using the software dictionary (Table 4.8); this was designed specifically for this project, based on Squires et al. (2011). Once complete, the data were exported into SPSS. A K-means cluster analysis was used to identify the groups of burning intensity from the modern animal bone standards, and a discriminant function was employed using the QP results to independently classify the archaeological data into one of the identified burning categories. A ranked score was assigned to each individual that represented the category of burning intensity assigned. These included: 1 = Category I (100°C - 400°C). 2 = Category II (500°C - 600°C). 3 = Category III (700°C - 600°C). 4 = Category IV (1000 - 1100°C).

Table 4.8 Dictionary of heat-induced alterations used for quantitative petrography.

Heat-Induced Alteration	Description
Hydroxyapatite Crystal Fusion	The hydroxyapatite crystals that form within the bone matrix fuse
Organic Material	The preservation of bones organic component
Haversian System – Well Defined	The preservation of Haversian systems that are not deformed or misshaped
Haversian System – Poorly Defined	The preservation of Haversian systems that are no longer clearly defined and are misshaped
Volkmann's Canal – Well Defined	The preservation of Volkmann's Canals that are not deformed or misshapen
Volkmann's Canal – Poorly Defined	The preservation of Volkmann's Canals that are no longer clearly defined and are misshaped
Osteon – Well Defined	The preservation of osteons that are not deformed or misshaped
Osteon – Poorly Defined	The preservation of Volkmann's canals that are no longer clearly defined and are misshaped
Canaliculi – Well Defined	The preservation of canaliculi that are not deformed or misshaped
Canaliculi – Poorly Defined	The preservation of canaliculi that are no longer clearly defined and are misshaped

4.3.2.7.3 Histology of Burned Bone

The burned bone thin-sections were examined using a Leica DM EP microscope. The microstructure of each sample was compared to the morphological criterion provided by Squires and colleagues (2011, p.2401), and burning intensity was based on the visual appearance of the samples microscopic organisation. A ranked score was assigned to each individual that represented the category of burning intensity assigned. These included: 1 = Less Intensely Cremated (300°C – 600°C). 2 = Intensely Cremated (600°C – 900°C). 3 = Completely Cremated (900°C+). These ranked categories were taken from Squires et al. (2011).

4.3.2.8 Weight, Fraction Size, and Skeletal Representation

All measurements were recorded in grams to one decimal place using TANITA digital scales. The total weight of each cremation deposit from Hertfordshire was first recorded before the burned bone was poured through a tower of 10mm, 5mm and 2mm metal mesh sieves, following the removal of any extraneous material, such as molten Fe objects, stones, and pottery fragments. The content of each sieve was also recorded. The burned bone was then identified to skeletal zone (skull, axial, upper limb, lower limb). Where possible elements were separated by skeletal element but were recorded as 'Unidentifiable' when identification could not be determined. The total weight of each skeletal zone was also recorded. This approach follows the standard procedure for recording burned human remains according to McKinley (2004; 2017).

Burned bone fragmentation can provide insight into pyre technology, such as the stirring or tending of the pyre debris to yield a more efficient cremation (Thompson, et al., 2016), while the selection of skeletal elements can provide insight into funerary practices and establish if the collection of burned bone was ritually or practically motivated (Brück, 2014). The total weight of burned bone in this study will be used to infer the level of burned bone preservation, but has also been used in other studies to examine age, sex, minimum number of individuals (MNI), and the size of the deceased before death (McKinley, 1993a; Ubelacker, 2009; May, 2011; Ward and Tayles, 2015, p.388). It is important to remember that these aspects are subject to multiple external factors including post-deposition damage and level of sexual dimorphism in a population. Again, the identification of skeletal elements is subject to the expertise of the examiner, as well as the degree of fragmentation that can hinder morphological identification.

4.3.2.9 Statistical Analysis

All statistical analyses were performed in IBM SPSS Statistics 24. In order to test for patterns in fragmentation and skeletal representation linear mixed models were run. These tests were used in place of a One-Way ANOVA because they are more robust and they take random effects into consideration (Chan and Walmsley, 1997; Baayen, et al., 2008). For each model enforced variance components were used, whereby the individuals from Hertfordshire were incorporated as the random intercepts, fragmentation or skeletal representation were the dependent variables, and the fixed measures were the categorical independent variables examined. These included: burial type, settlement type, cemetery, sex, age and number of grave goods.

The categories of burning intensity used to classify measures of crystallinity and quantitative petrography were statistically determined using a K-means cluster analysis on the eleven modern animal bone standards burned at set temperatures and durations (see section 4.3.1.5). This test was used because it is an unsupervised way of grouping unlabelled data (Kaur and Kaur, 2013). Previous studies examining burned bone crystallinity have used Principal Component Analysis (PCA) and Linear Discriminant Analysis (LCD) to identify heat-induced changes in burned bone and independently classify datasets (Thompson, et al., 2013). These models are better suited for large, complex datasets and dimension reduction. However, due to the smaller size of this study sample these tests could not be performed here. Instead, a discriminate function analysis was employed using the QP results produced by the K-means cluster analysis to statically assign the archaeological data to a burning category. This test was chosen because it is effective in predicting category membership according to a set of variables (Ramos and Rickard Liow, 2012).

With regards to burned bone weight, oxidisation (macroscopic colour), histology, crystallinity and quantitative petrography, Mann-Whitney U tests and Kruskal-Wallis H tests were performed to identify any differences according to the categorical variables, namely: burial type, settlement type, cemetery, sex, age and number of grave goods. Both of these tests are suited for examining ranked or ordinal datasets that are not normally distributed (McKnight and Najab, 2010).

In order to remove any bias induced by post-depositional damage by the burial environment, burned bone weight, fragmentation and skeletal representation were tested to identify any significant differences according to burial type (the manner of deposition: urned; unurned; unknown), before the data were pooled together. In addition, because the major and minor urban samples derive from Folly Lane and Wallington Road respectively, the two samples were pooled together unless any significant difference between the two was identified.

With regards to charcoal analysis, one-way ANOVA tests were performed to identify significant differences in the total number of fragments for each taxon identified from different contexts (Deforce and Haneca, 2012). If a significant difference was identified, the Tukey post-hoc test was applied to establish where the difference lied. Similar studies have also applied Principal Component Analysis (PCA) to identify whether certain contexts are associated with specific taxa (Deforce and Haneca, 2012). However, this was not appropriate here as the sample size is too small. Instead, the one-way ANOVA was performed as it has been applied in similar studies to examine differences in total fragment counts (Deforce and Haneca, 2012).

Chapter 5: Results - Survey of Cremation Practices (100 BC to AD 410)

5.1 Introduction

Secondary data including 2851 cremation deposits (2921 individuals, 150 cemeteries) was collected by the author. Of these, 2375 (2445 individuals, 131 cemeteries) date from the 1st century BC to the 4th century AD; the remaining 476 cremation deposits (476 individuals, 19 cemeteries) were undated (Tables 5.1 - 5.2) (Appendix 2 for list of cemeteries, key references and catalogue of secondary data).

Table 5.1 Summary of data according to region and time period. Undated data not included.

Late Iron Age				
Region	**N Cemeteries**	**N Individuals**	**N Cremation Deposits**	**% Cremation Deposits**
North-West	0	0	0	0
North-East	0	0	0	0
Midlands	7	19	19	3.1
South-East	9	606	592	96.9
South-West	0	0	0	0
TOTAL	**16**	**625**	**611**	**100**
Early Roman				
North-West	0	0	0	0
North-East	3	8	8	1.3
Midlands	31	221	218	35.2
South-East	36	366	359	58
South-West	5	34	34	5.5
TOTAL	**75**	**629**	**619**	**100**
Middle Roman				
North-West	4	27	27	3.1
North-East	1	53	53	6.1
Midlands	6	21	21	2.4
South-East	14	782	739	85.5
South-West	5	25	25	2.9
TOTAL	**30**	**908**	**865**	**100**
Late Roman				
North-West	1	207	205	73.2
North-East	1	1	1	0.4
Midlands	1	2	2	0.7
South-East	5	70	69	24.6
South-West	2	3	3	1.1
TOTAL	**10**	**283**	**280**	**100**
TOTAL	**131**	**2445**	**2375**	**-**

Table 5.2 Summary of data according to settlement type and time period. Undated data not included.

Settlement Type	N Cemeteries	N Individuals	N Cremation Deposits	% Cremation Deposits
Late Iron Age				
Rural	11	195	191	31.3
Minor Urban	2	14	14	2.3
Major Urban	3	416	406	66.4
TOTAL	**16**	**625**	**611**	**100**
Early Roman				
Rural	55	258	254	41
Minor Urban	17	311	308	49.8
Major Urban	3	60	57	9.2
TOTAL	**75**	**629**	**619**	**100**
Middle Roman				
Rural	18	139	128	14.8
Minor Urban	6	445	425	49.1
Major Urban	6	324	312	36.1
TOTAL	**30**	**908**	**865**	**100**
Late Roman				
Rural	6	15	15	5.4
Minor Urban	1	207	205	73.2
Major Urban	3	61	60	21.4
TOTAL	**10**	**283**	**280**	**100**
TOTAL	**131**	**2445**	**2375**	**-**

5.1.1 Distribution of Study Sample

The cremation deposits are unevenly distributed in time, and space. Despite the inclusion of 131 burial grounds dating from the Late Iron Age to the Late Roman period, the data are dominated by eleven large cemeteries that contribute 66.1% (N = 1569 of 2375) of the cremation deposits examined here (Figure 5.1) (see Appendix 3 for breakdown of large cemeteries); these cemeteries are characterised as sites that contribute more than 10% of the study sample. Their impact is even more pronounced when the data are divided into region, time period, or settlement type, and may therefore skew the results. To ensure that this survey does not just replicate patterns in the large cemeteries, the distribution of the dataset will need to be considered throughout the analysis and evidence from the smaller cemeteries critically compared to the larger ones, despite the differences in sample size.

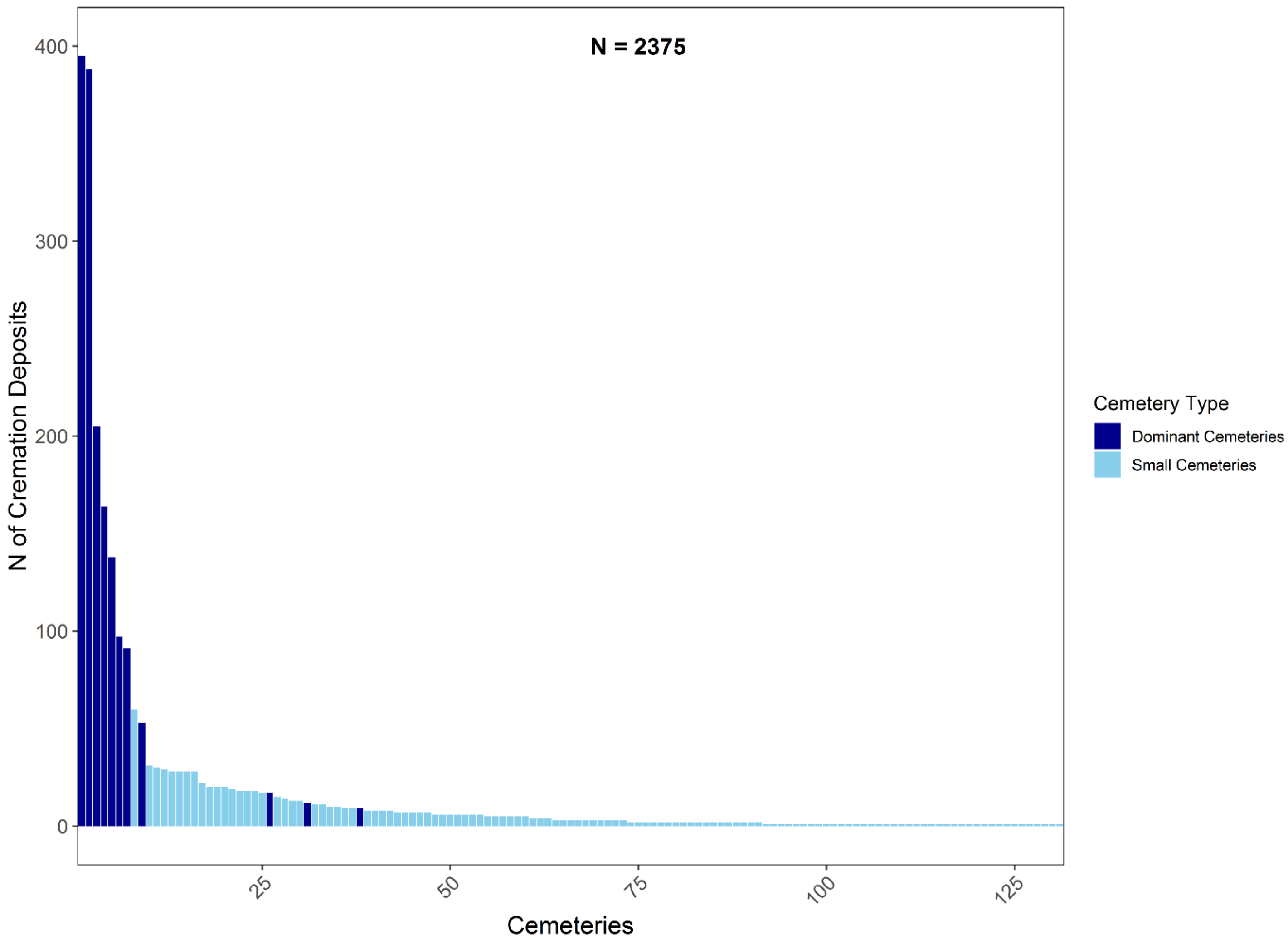


Figure 5.1 Number of cremation deposits according to the cemeteries examined here. The large cemeteries are highlighted in dark blue, while the smaller cemeteries are highlighted in light blue. Large cemeteries: 1) Yeomanry Drive North: N = 395. 2) King Harry Lane (LIA): N = 388. 3) Brougham: N = 205. 4) Westhampnett (LIA): N = 164. 5) London, Eastern Cemetery: N = 138. 6) Skeleton Green: N = 97. 7) Derby Racecourse: N = 91. 9) Trentholme Drive: N = 53. 26) Gill Mill: N = 17. 31) Radley Barrow Hills: N = 34. 38) Worton Rectory Farm: N = 9.

The majority of cremation deposits come from the South-East of the country (74.1%, N = 1759 of 2375) (Table 5.1 and Figure 5.2). The data are strongly dominated by two main cemeteries that contribute 44.5% (N = 783) of the total number of cremation deposits from this region. These are Yeomanry Drive North (N = 395) and King Harry Lane (LIA) (N = 388). With regards to time period, no Late Iron Age data are recorded for the North-East, North-West and South-West of the country (Table 5.1 and Figure 5.2). Most cremation deposits date to the Middle Roman period (36.4%, N = 865); however, 61.6% of these data come from the South-Eastern cemeteries of Yeomanry Drive North (N = 395) and London, Eastern Cemetery (N = 138). The Late Roman period is only represented by 280 cremation deposits (11.8% of 2375), most of which (73.2%, N = 205) come from the cemetery of Brougham found in the North-West (Table 5.1 and Figure 5.2). With regards to settlement type, the largest proportion of data come from Minor Urban settlements (40.1%, N = 952) (Table 5.2 and Figure 5.3). This sample is skewed towards two large cemeteries that contribute 63% (N = 600) of the cremation deposits, including Yeomanry Drive North (N = 395), (South-East), and Brougham (N = 205) (North-West).

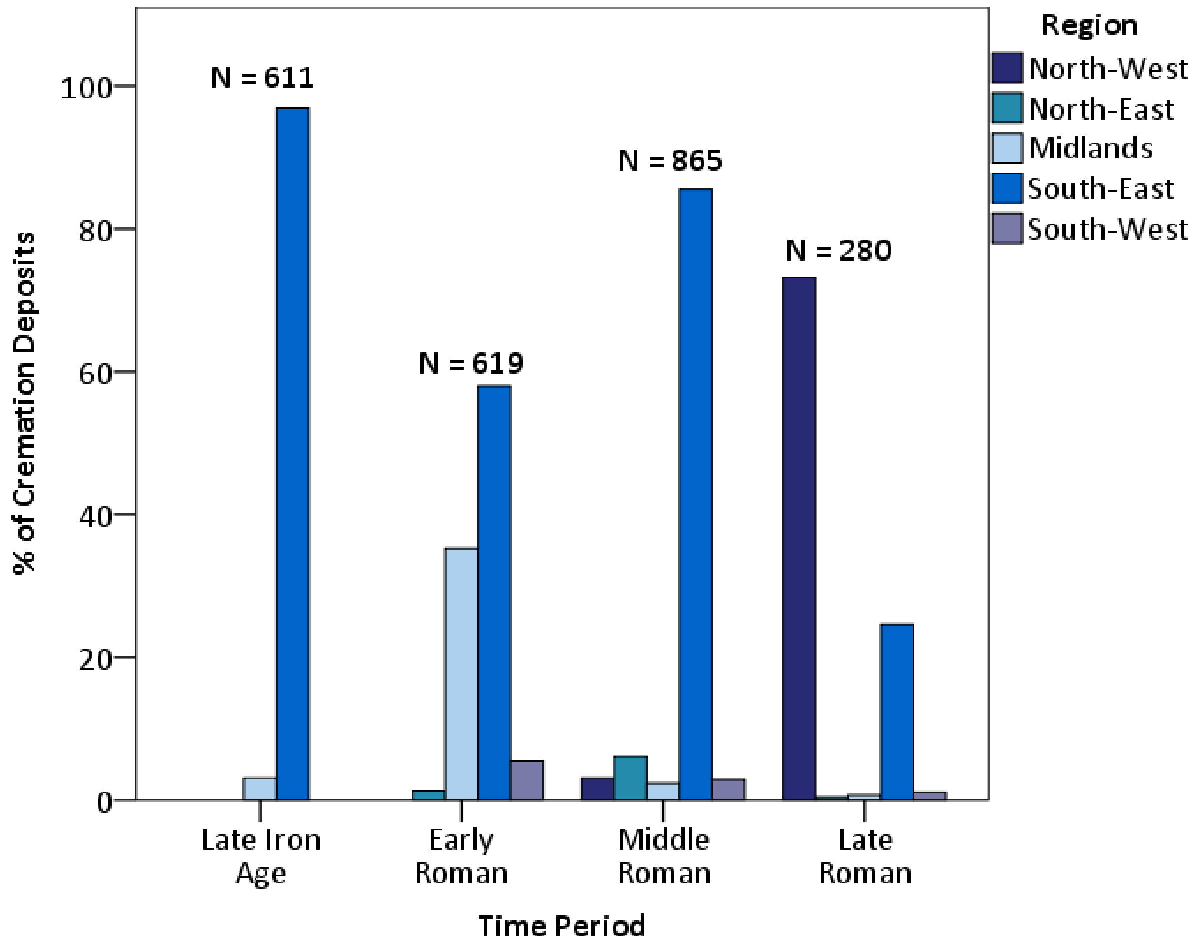


Figure 5.2 Percentage of cremation deposits according to region and time period.

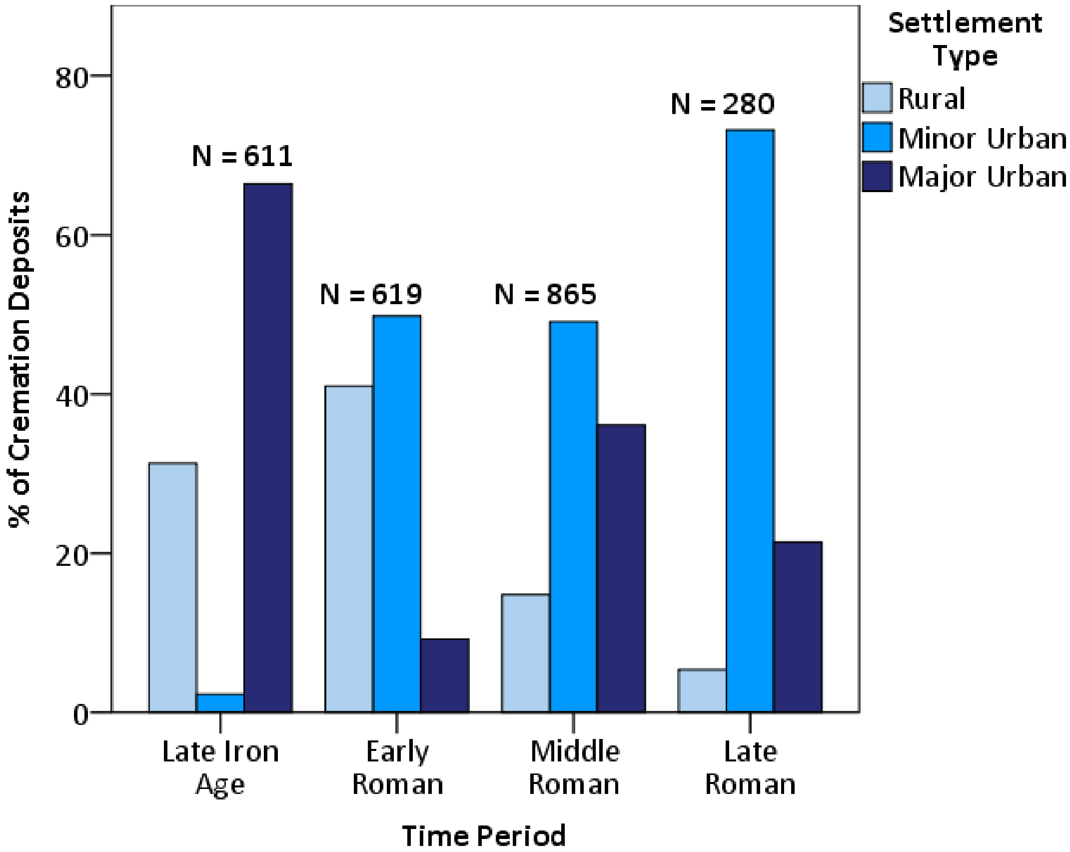


Figure 5.3 Percentage of cremation deposits according to settlement type and time period.

5.2 Sex

Of the 2445 individuals from 131 cemeteries dating from the Late Iron Age to the Late Roman period, a total of 736 (30.1% of 2445) from 50 burial grounds are sexed (Tables 5.3 – 5.4, Figures 5.4 – 5.5). These data are dominated by eight large cemeteries, where 78% (N = 574) of the sample derives from (see Appendix 3 for breakdown of large cemeteries). Again, most sexed individuals come from the South-East which makes up 82.5% (N = 607) of the sample. Chronologically, the data are evenly distributed with most dating to the Middle Roman period (39.5%, N = 291). In relation to settlement type, the largest proportion of sexed individuals (47.1%, N = 347) come from Minor Urban cemeteries.

Table 5.3 Summary of sexed individuals according to region and time period. Undated data not included.

Late Iron Age			
Region	**N Cemeteries**	**N Sexed Individuals**	**% Sexed Individuals**
North-West	0	0	0
North-East	0	0	0
Midlands	1	2	1.1
South-East	5	172	98.9
South-West	0	0	0
TOTAL	**6**	**174**	**100**
Early Roman			
North-West	0	0	0
North-East	1	1	0.7
Midlands	6	8	5.3
South-East	12	137	90.7
South-West	3	5	3.3
TOTAL	**22**	**151**	**100**
Middle Roman			
North-West	0	0	0
North-East	0	0	0
Midlands	2	4	1.3
South-East	12	283	97.4
South-West	3	4	1.3
TOTAL	**17**	**291**	**100**
Late Roman			
North-West	1	104	86.7
North-East	0	0	0
Midlands	0	0	0
South-East	3	15	12.5
South-West	1	1	0.8
TOTAL	**5**	**120**	**100**
TOTAL	**50**	**736**	**-**

Table 5.4 Summary of sexed individuals according to settlement type and time period. Undated data not included.

Late Iron Age			
Region	**N Cemeteries**	**N Sexed Individuals**	**% Sexed Individuals**
Rural	3	37	21.3
Minor Urban	1	1	0.5
Major Urban	2	136	78.2
TOTAL	**6**	**174**	**100**
Early Roman			
Rural	14	46	30.5
Minor Urban	6	92	60.9
Major Urban	2	13	8.6
TOTAL	**22**	**151**	**100**
Middle Roman			
Rural	10	40	13.7
Minor Urban	2	150	51.6
Major Urban	5	101	34.7
TOTAL	**17**	**291**	**100**
Late Roman			
Rural	1	1	0.8
Minor Urban	1	104	86.7
Major Urban	3	15	12.5
TOTAL	**5**	**120**	**100**
TOTAL	**50**	**736**	**-**

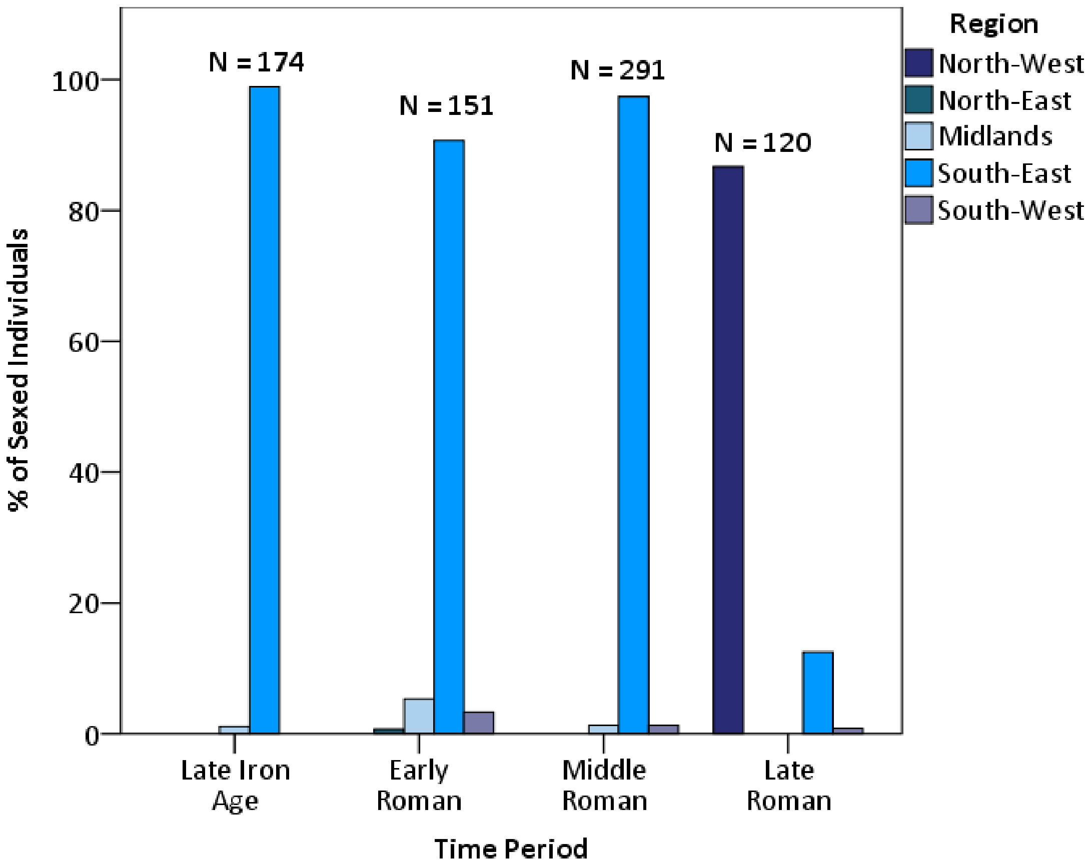


Figure 5.4 Percentage of sexed individuals according to region and time period.

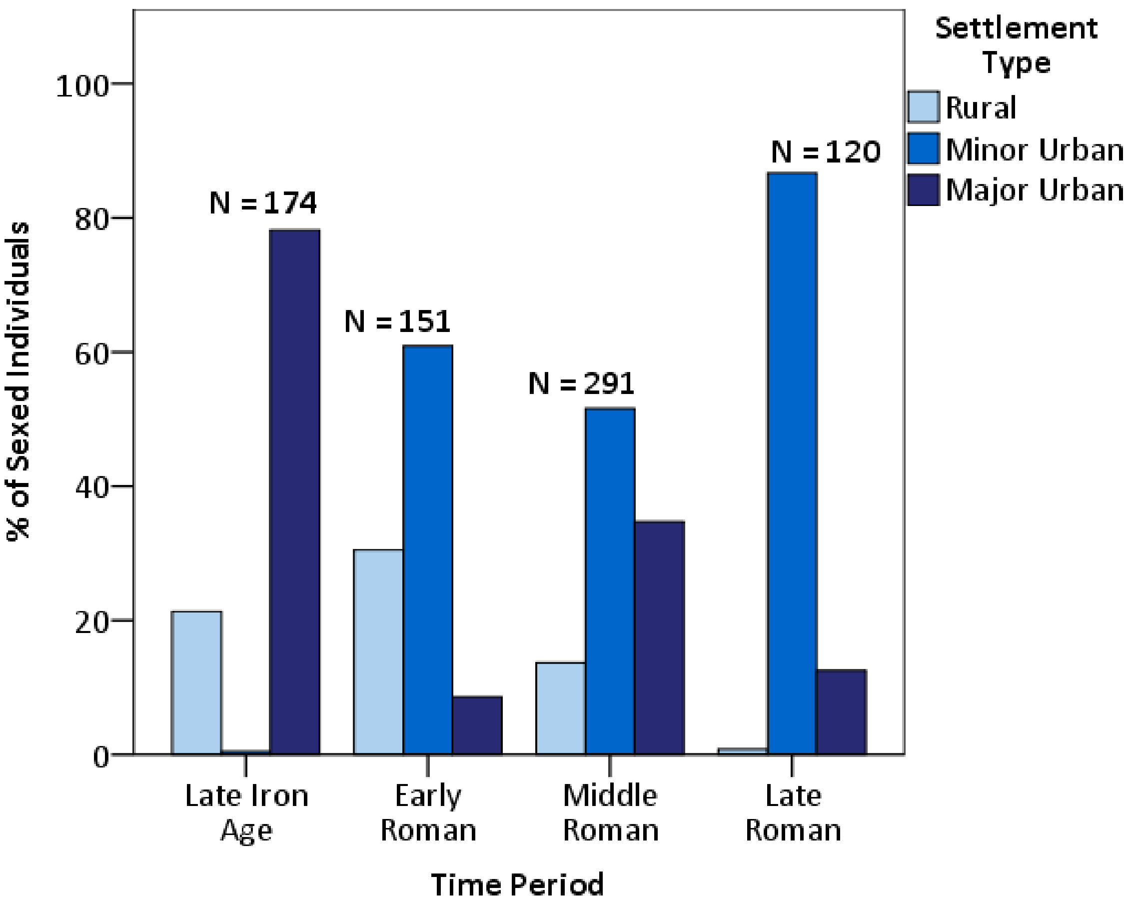


Figure 5.5 Percentage of sexed individuals according to settlement type and time period.

5.2.1 Male / Female Ratio According to Region

Figure 5.7 shows the distrubion of the male / female ratio according to region. It was necessary to normalise the data due to the lack of sexed individuals. Plotting a ratio where one of the values is 0 results in a misrepresentation of the data. To overcome this issue, the percentage difference between the number of males and females were converted to fractions and plotted against the minimum number of individuals.

Overall, males are more commonly associated with cremation (Table 5.5 and Figure 5.6 – 5.7). However, in the South-East and Midlands during the Early Roman period, 57.2% of the 145 sexed individuals are female (62/83), while all of the individuals from the South-West are male. A one-way ANOVA Tukey post hoc test found this to be significant ($p = 0.006$) (see Appendix 4 for statistic results). By the Middle Roman period in the South-East the male / female ratio (48/32) is skewed toward males, excluding Yeomanry Drive North (47/101) and London, Eastern Cemetery (16/39). This prevalence of females is also found at the Late Roman North-Western cemetery of Brougham (44/60).

Table 5.5 Summary of males and females according to region and time period. Undated data not included.

Late Iron Age						
Region	**N Males**	**%**	**N Females**	**%**	**TOTAL**	**%**
North-West	0	0	0	0	**0**	0
North-East	0	0	0	0	**0**	0
Midlands	2	1.8	0	0	**2**	1.1
South-East	109	98.2	63	100	**172**	98.9
South-West	0	0	0	0	**0**	0
TOTAL	**111**	**100**	**63**	**100**	**174**	**100**
Early Roman						
North-West	0	0	0	0	**0**	0
North-East	0	0	1	1.2	**1**	0.7
Midlands	3	4.5	5	5.9	**8**	5.3
South-East	59	88.1	78	92.9	**137**	90.7
South-West	5	7.4	0	0	**5**	3.3
TOTAL	**67**	**100**	**84**	**100**	**151**	**100**
Middle Roman						
North-West	0	0	0	0	**0**	0
North-East	0	0	0	0	**0**	0
Midlands	4	3.4	0	0	**4**	1.3
South-East	111	94.9	172	98.9	**283**	97.3
South-West	2	1.7	2	1.1	**4**	1.4
TOTAL	**117**	**100**	**174**	**100**	**291**	**100**
Late Roman						
North-West	44	84.6	60	88.2	**104**	86.7
North-East	0	0	0	0	**0**	0
Midlands	0	0	0	0	**0**	0
South-East	8	15.4	7	10.3	**15**	12.5
South-West	0	0	1	1.5	**1**	0.8
TOTAL	52	100	68	100	**120**	100
TOTAL	**347**	**-**	**389**	**-**	**736**	**-**

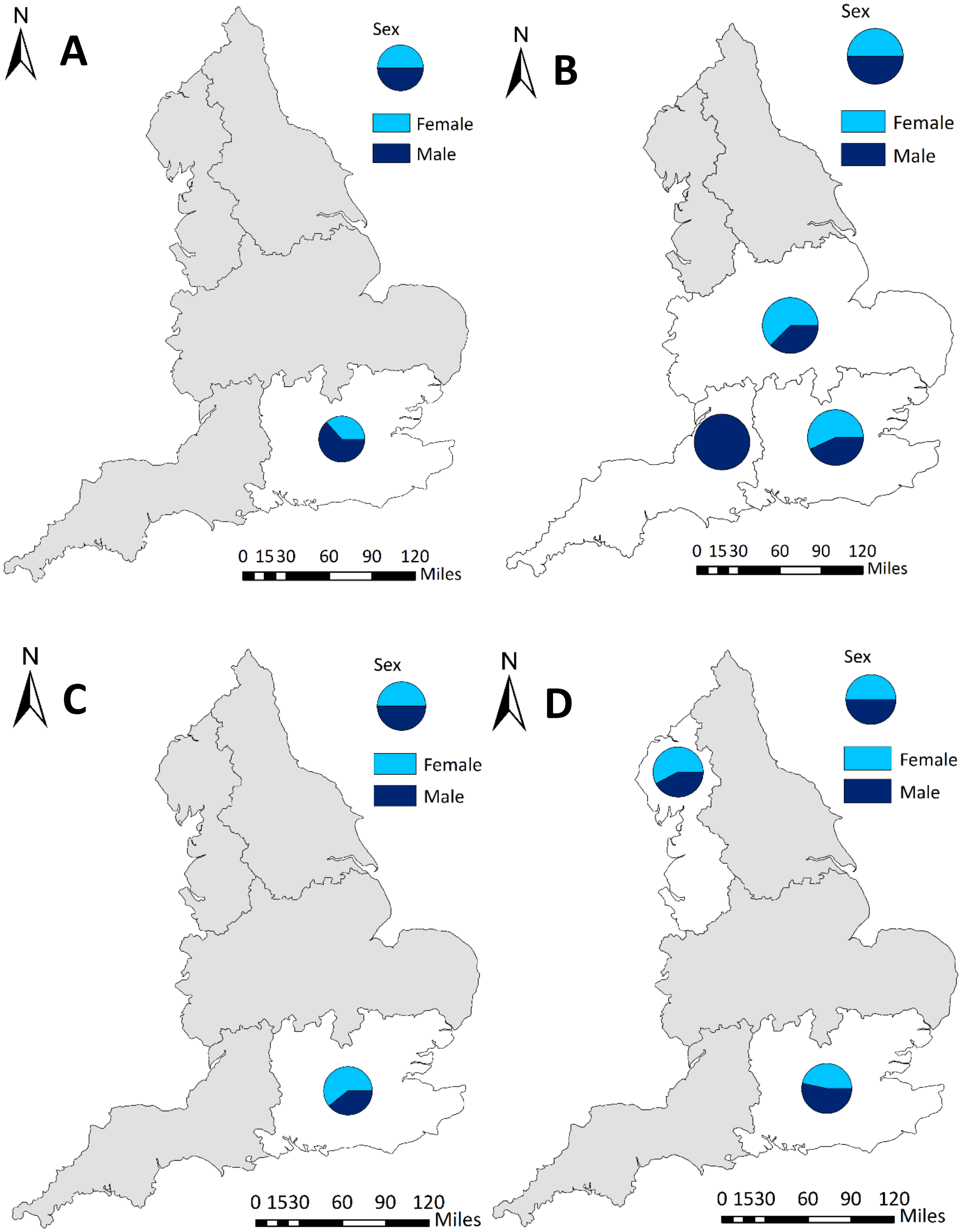


Figure 5.6 Distribution of males and females according to region. Only regions with 5 or more sexed individuals are shown here. * NE = North-East. NW = North-West. ML = Midlands. SE = South-East. SW = South-West. A) Late Iron Age period. SE: N = 172. B) Early Roman period. ML: N = 8. SE: N = 137. SW: N = 5. C) Middle Roman period. SE: N = 283. D) Late Roman period. NW: N = 104. SE: N = 15.

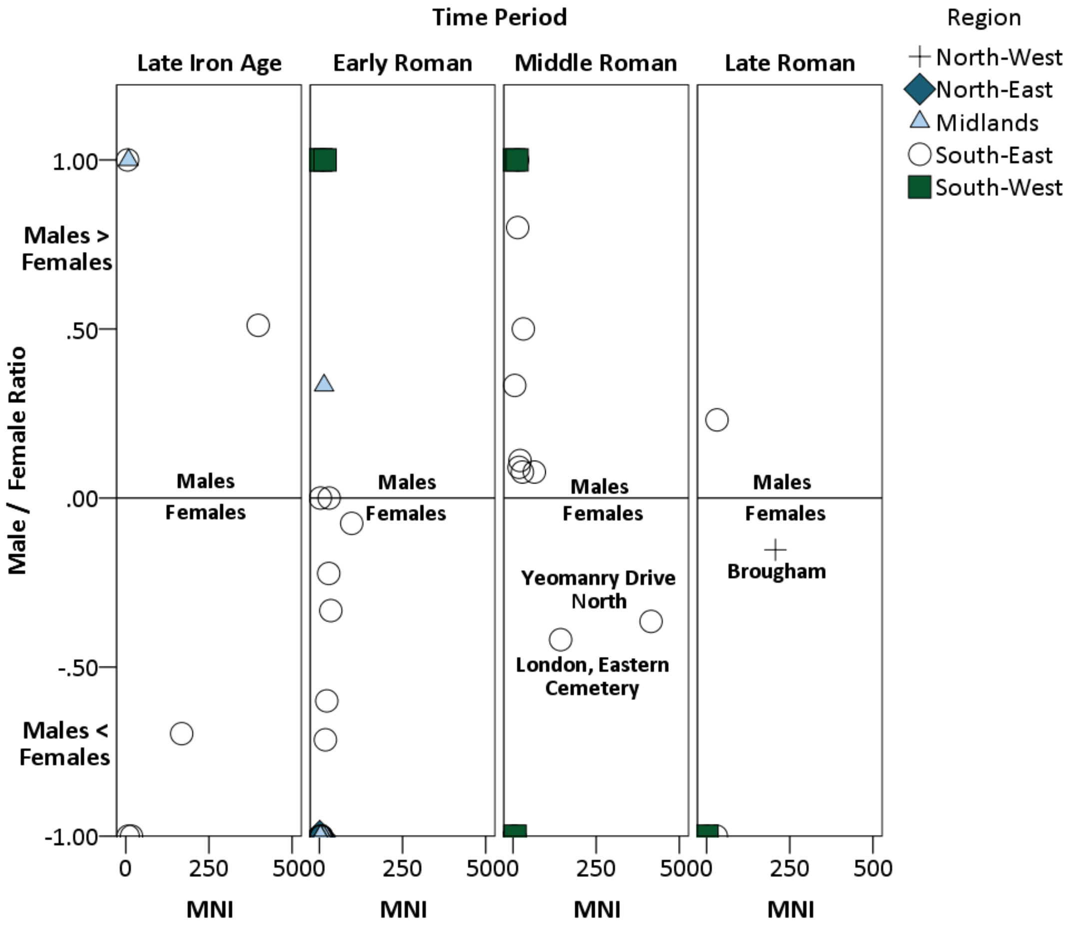


Figure 5.7 Normalised Males / Female ratio according to region and time period. The percentage difference between the number of males and females were converted to fractions and plotted against the minimum number of individuals. Large cemeteries labelled: Yeomanry Drive North: N Sexed = 148. London, Eastern Cemetery: N Sexed = 55. Brougham: N Sexed = 104).

5.2.2 Male / Female Ratio According to Settlement Type

Figure 5.8 shows the distrubion of the male / female ratio according to region. It was necessary to normalise the data due to the lack of sexed individuals. Plotting a ratio where one of the values is 0 results in a misrepresentation of the data. To overcome this issue, the percentage difference between the number of males and females were converted to fractions and plotted against the minimum number of individuals.

Sexed individuals are recorded for all settlement types during the Late Iron Age to Early Roman transition (Table 5.6). However, 77.6% of the pre-Roman data come from the Major Urban cemetery of King Harry Lane (LIA) (N = 135). A one-way ANOVA found no difference in the male / female ratio according to settlement type during the Early Roman period (p = 0.559) (Figure 5.8) (see Appendix 4 for statistic results). The prevalence of female cremation deposits during this period is found at both Rural and Urban settlements. In the Middle Roman period the Minor (47/103) and Major Urban

(42/59) samples are skewed towards females, which is caused by the large cemeteries of Yeomanry Drive North (47/101) and London, Eastern Cemetery (16/39) respectively. Similarly, the prevalence of females in the Late Roman Minor Urban sample (44/60) comes from Brougham. It is worth mentioning that the osteological analysis of these cemeteries that display a higher prevalence of females (Yeomanry Drive North; London, Eastern Cemetery; Brougham) was conducted by the same specialist.

Table 5.6 Summary of males and females according to settlement and time period. Undated data not included.

Late Iron Age						
Region	**N Males**	**%**	**N Females**	**%**	**TOTAL**	**%**
Rural	9	8.1	28	44.4	**37**	21.3
Minor Urban	0	0	1	1.6	**1**	0.5
Major Urban	102	91.9	34	54	**136**	78.2
TOTAL	**111**	**100**	**63**	**100**	**174**	**100**
Early Roman						
Rural	22	32.8	24	28.6	**46**	30.5
Minor Urban	41	61.2	51	60.7	**92**	60.9
Major Urban	4	6	9	10.7	**13**	8.6
TOTAL	**67**	**100**	**84**	**100**	**151**	**100**
Middle Roman						
Rural	28	23.9	12	6.9	**40**	13.7
Minor Urban	47	40.2	103	59.2	**150**	51.6
Major Urban	42	35.9	59	33.9	**101**	34.7
TOTAL	**117**	**100**	**174**	**100**	**291**	**100**
Late Roman						
Rural	0	0	1	1.5	**1**	0.8
Minor Urban	44	84.6	60	88.2	**104**	86.7
Major Urban	8	15.4	7	10.3	**15**	12.5
TOTAL	**52**	**100**	**68**	**100**	**120**	**100**
TOTAL	**347**	**-**	**389**	**-**	**736**	**-**

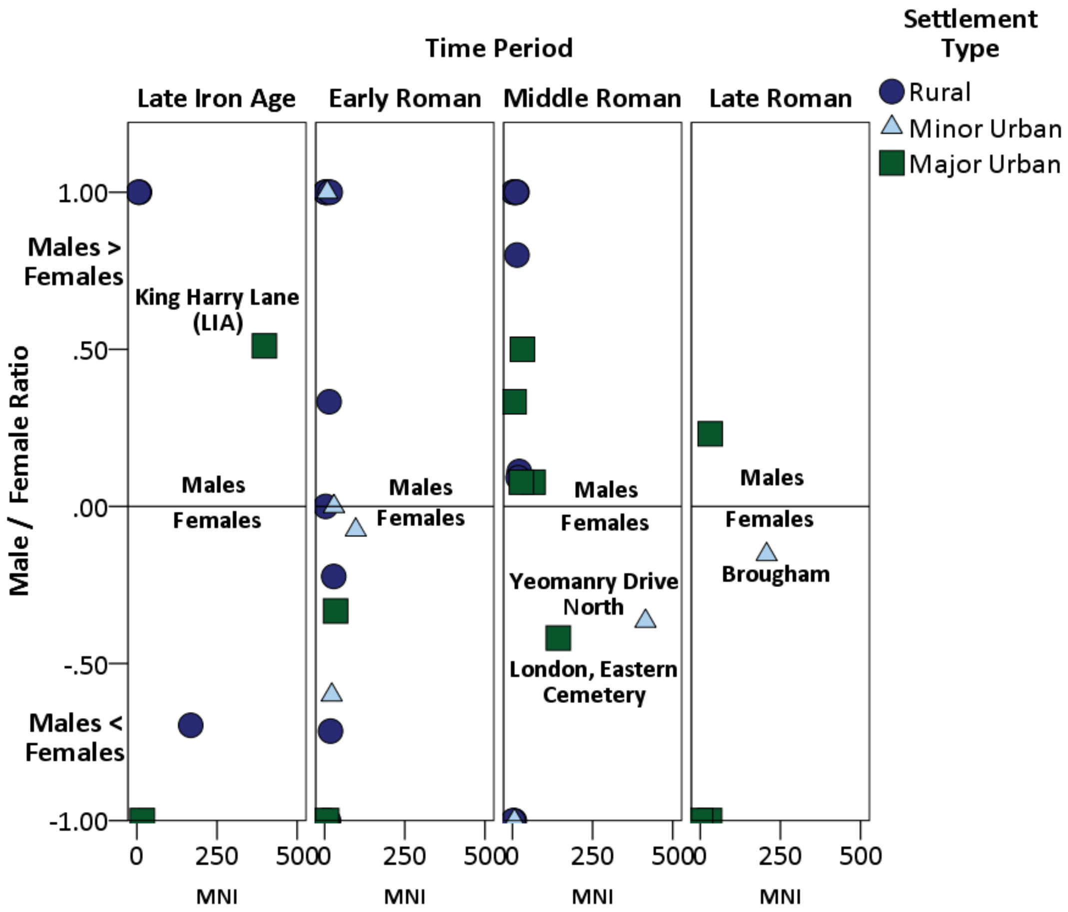


Figure 5.8 Normalised Males / Female ratio according to settlement type and time period. The percentage difference between the number of males and females as fractions were calculated and plotted against the minimum number of individuals. Prominent cemeteries labelled. King Harry Lane (LIA): N Sexed = 135. Yeomanry Drive North: N Sexed = 148. London, Eastern Cemetery: N Sexed = 55. Brougham: N Sexed = 104.

5.3 Age

Age assessments were available for 1815 (74.2% of 2445) individuals from the Late Iron Age to the Late Roman period representing 67 cemeteries (Tables 5.7 – 5.8, Figures 5.9 – 5.10). The data are dominated by eleven large cemeteries, where 76.9% (N = 1396) of the individuals are recorded (see Appendix 3 for breakdown of large cemeteries). Again, the majority of aged individuals come from the South-East (79.3%, N = 1439). The distribution of data according to time period are relatively even with most aged individuals (38.3%, N = 696) dating to the Middle Roman period. In relation to settlement type, most of the data recorded (44.4%, N = 805) comes from Minor Urban settlements.

Table 5.7 Summary of aged individuals according to region and time period. Undated data not included.

Late Iron Age			
Region	**N Cemeteries**	**N Aged Individuals**	**% Aged Individuals**
North-West	0	0	0
North-East	0	0	0
Midlands	4	5	1
South-East	8	481	99
South-West	0	0	0
TOTAL	**12**	**486**	**100**
Early Roman			
North-West	0	0	0
North-East	2	2	0.5
Midlands	10	113	29.4
South-East	16	251	65.4
South-West	3	18	4.7
TOTAL	**31**	**384**	**100**
Middle Roman			
North-West	1	2	0.3
North-East	0	0	0
Midlands	2	12	1.7
South-East	12	665	95.6
South-West	3	17	2.4
TOTAL	**18**	**696**	**100**
Late Roman			
North-West	1	205	82.3
North-East	1	1	0.4
Midlands	0	0	0
South-East	3	42	16.9
South-West	1	1	0.4
TOTAL	**6**	**249**	**100**
TOTAL	**67**	**1815**	**-**

Table 5.8 Summary of aged individuals according to region and time period. Undated data not included.

Late Iron Age			
Region	**N Cemeteries**	**N Aged Individuals**	**% Aged Individuals**
Rural	8	146	30
Minor Urban	2	5	1.1
Major Urban	2	335	68.9
TOTAL	**12**	**486**	**100**
Early Roman			
Rural	22	127	33.1
Minor Urban	7	224	58.3
Major Urban	2	33	8.6
TOTAL	**31**	**384**	**100**
Middle Roman			
Rural	10	108	15.5
Minor Urban	3	371	53.3
Major Urban	5	217	31.2
TOTAL	**18**	**696**	**100**
Late Roman			
Rural	2	2	0.8
Minor Urban	1	205	82.3
Major Urban	3	42	16.9
TOTAL	**6**	**249**	**100**
TOTAL	**67**	**1815**	**-**

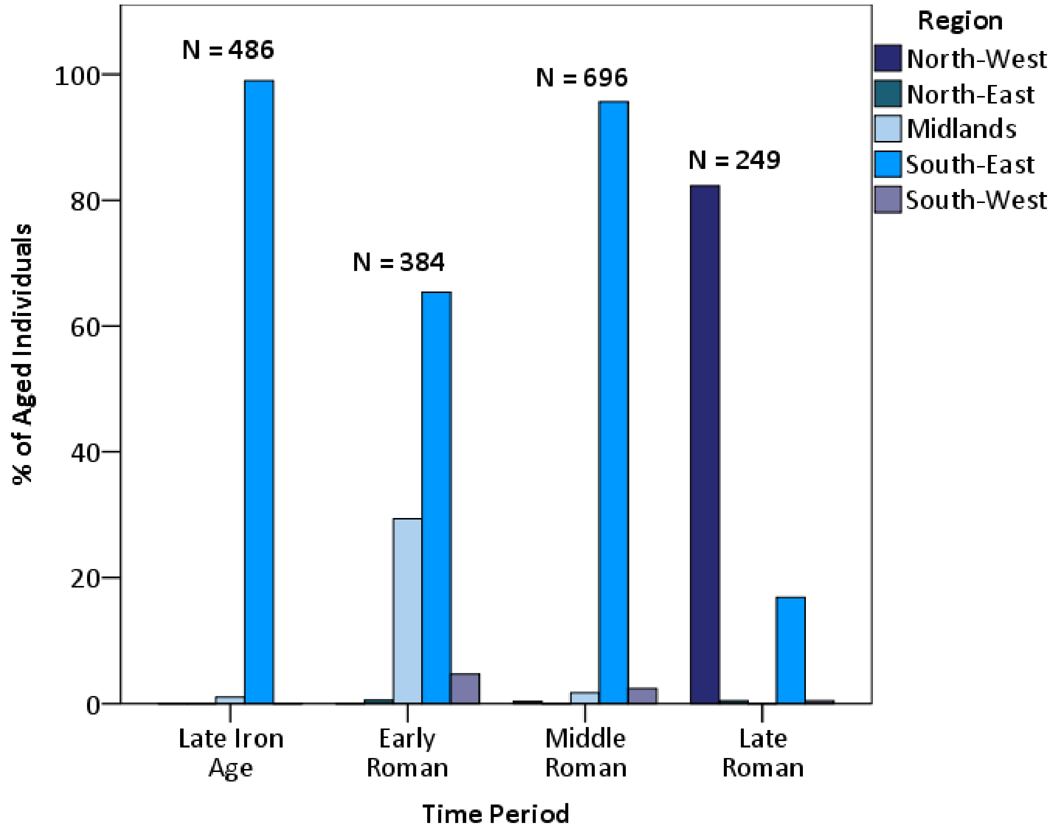


Figure 5.9 Percentage of aged individuals according to region and time period.

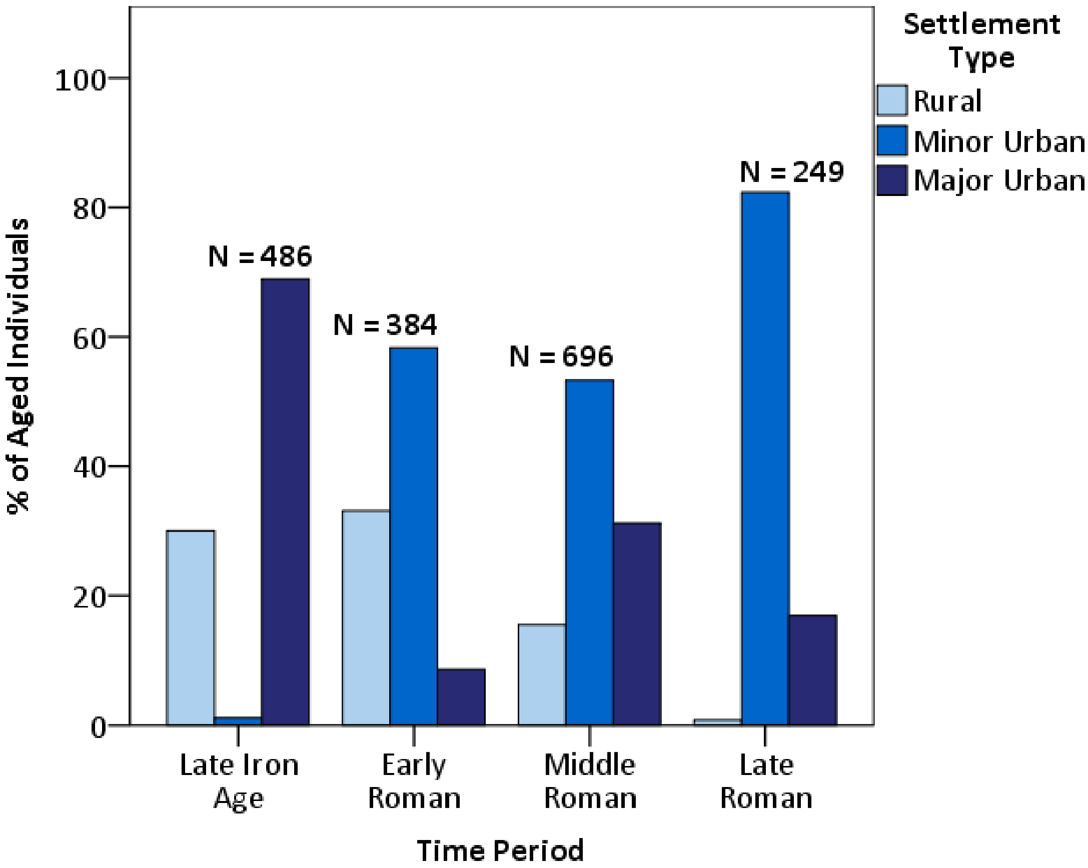


Figure 5.10 Percentage of aged individuals according to settlement type and time period.

5.3.1 Age According to Region

Most cremated individuals are over 18 years of age (Table 5.9 and Figure 5.11). In the Late Iron Age, more 14 – 18 year olds (N = 47) than < 13 year olds (N = 37) are found in the South-East, caused by Westhampnett (LIA) (Figure 5.12). This is also evident in the Midlands during the Early Roman period, the South-East in the Middle Roman period, and the North-West in the Late Roman period. This is caused by the cemeteries of Derby Racecourse (N = 85), Yeomanry Drive North (N = 365) London, Eastern cemetery (N = 129), and Brougham (N = 205) (Figures 5.13 – 5.14). A chi-squared test did not find these regional differences between 14 – 18 year olds and < 13 year olds significant (Table 5.10).

Table 5.9 Summary of aged individuals according to region and time period. Undated data not included.

Region	N < 13	%	N 14 - 18	%	N 18+	%	TOTAL	%
Late Iron Age								
North-West	0	0	0	0	0	0	**0**	0
North-East	0	0	0	0	0	0	**0**	0
Midlands	1	2.6	0	0	4	1	**5**	1
South-East	37	97.4	47	100	397	99	**481**	99
South-West	0	0	0	0	0	0	**0**	0
TOTAL	**38**	**100**	**47**	**100**	**401**	**100**	**486**	**100**
Early Roman								
North-West	0	0	0	0	0	0	**0**	0
North-East	0	0	0	0	2	0.7	**2**	0.5
Midlands	11	34.4	40	81.6	62	20.4	**113**	29.4
South-East	20	62.5	9	18.4	222	73.3	**251**	65.4
South-West	1	3.1	0	0	17	5.6	**18**	4.7
TOTAL	**32**	**100**	**49**	**100**	**303**	**100**	**384**	**100**
Middle Roman								
North-West	2	2.5	0	0	0	0	**2**	0.3
North-East	0	0	0	0	0	0	**0**	0
Midlands	0	0	0	0	12	2.5	**12**	1.7
South-East	78	96.3	124	98.4	463	94.7	**665**	95.6
South-West	1	1.2	2	1.6	14	2.8	**17**	2.4
TOTAL	**81**	**100**	**126**	**100**	**489**	**100**	**696**	**100**
Late Roman								
North-West	38	92.7	49	100	118	74.3	**205**	82.3
North-East	0	0	0	0	1	0.6	**1**	0.4
Midlands	0	0	0	0	0	0	**0**	0
South-East	3	7.3	0	0	39	24.5	**42**	16.9
South-West	0	0	0	0	1	0.6	**1**	0.4
TOTAL	**41**	**100**	**49**	**100**	**159**	**100**	**249**	**100**
TOTAL	**192**	**-**	**271**	**-**	**1352**	**-**	**1815**	**-**

Table 5.10 Summary of chi-squared results. Significant values of 14 – 18 year olds and < 13 year olds according to time period and region. *d.f = degrees of freedom.

Time Period	Age	Statistic Value	d.f	Sig.
Late Iron Age	< 13	4.000	3	0.261
	14 - 18	4.000	3	0.261
Early Roman	< 13	6.638	10	0.759
	14 - 18	7.833	10	0.645
Middle Roman	< 13	7.800	12	0.801
	14 - 18	7.429	12	0.828
Late Roman	<1 3	3.000	2	0.223
	14 - 18	3.000	1	0.083

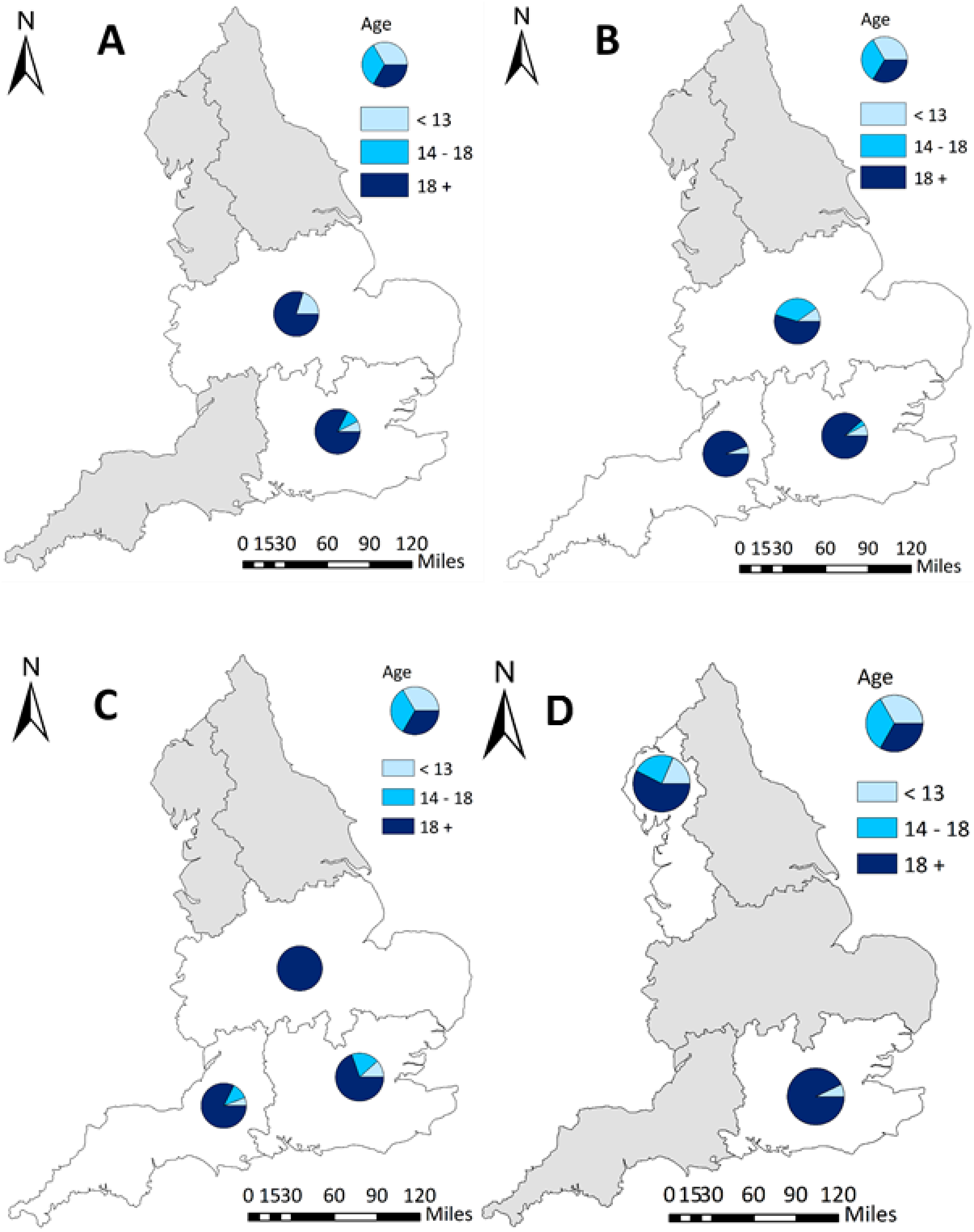


Figure 5.11 Distribution of aged individuals according to region. Only regions with 5 or more aged individuals are shown here. * NE = North-East. NW = North-West. ML = Midlands. SE = South-East. SW = South-West. A) Late Iron Age period. ML: N = 5. SE: N = 481. B) Early Roman period. ML: N = 113. SE: N = 251. SW: N = 18. C) Middle Roman period. ML: N = 12. SE: N = 665. SW: N = 17. D) Late Roman period: NW: N = 205. SE: N = 42.

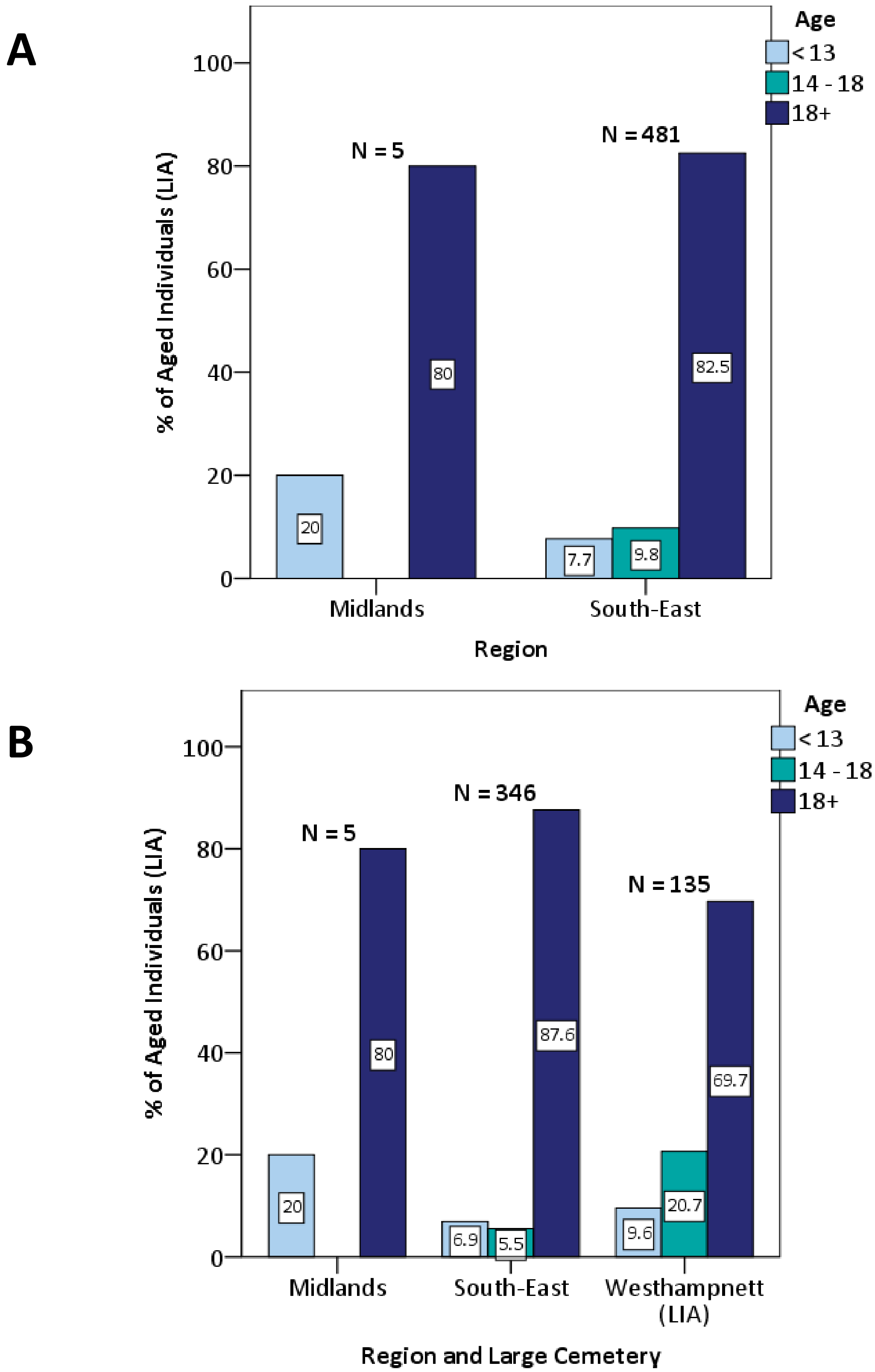


Figure 5.12 Percentage of aged individuals from the Midlands and South-East dating to the Late Iron Age period. *LIA = Late Iron Age. A) Pooled data from the Midlands and South-East. B) Comparison of pooled data with the large cemetery of Westhampnett (LIA) removed from the South-East sample.

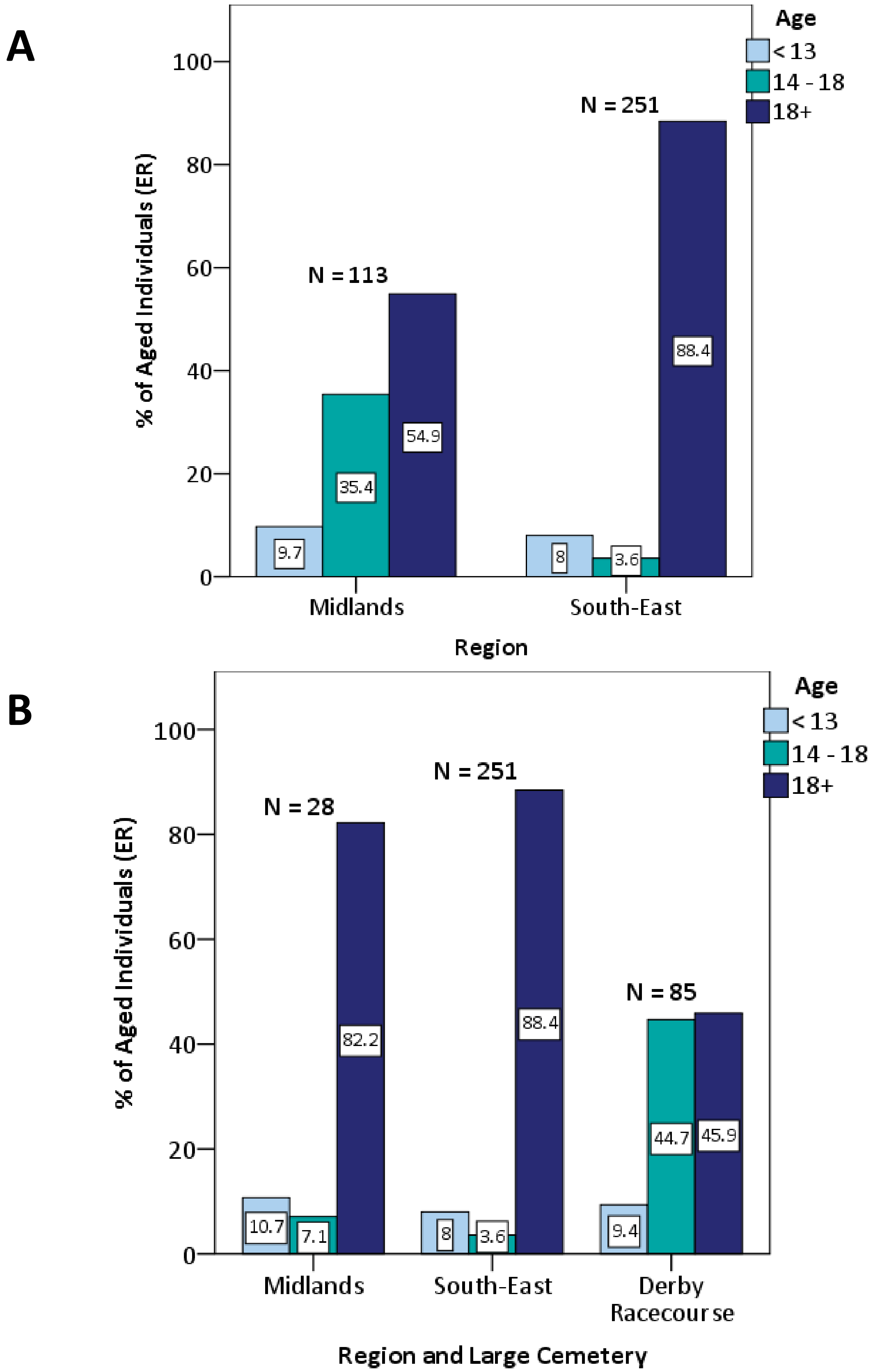
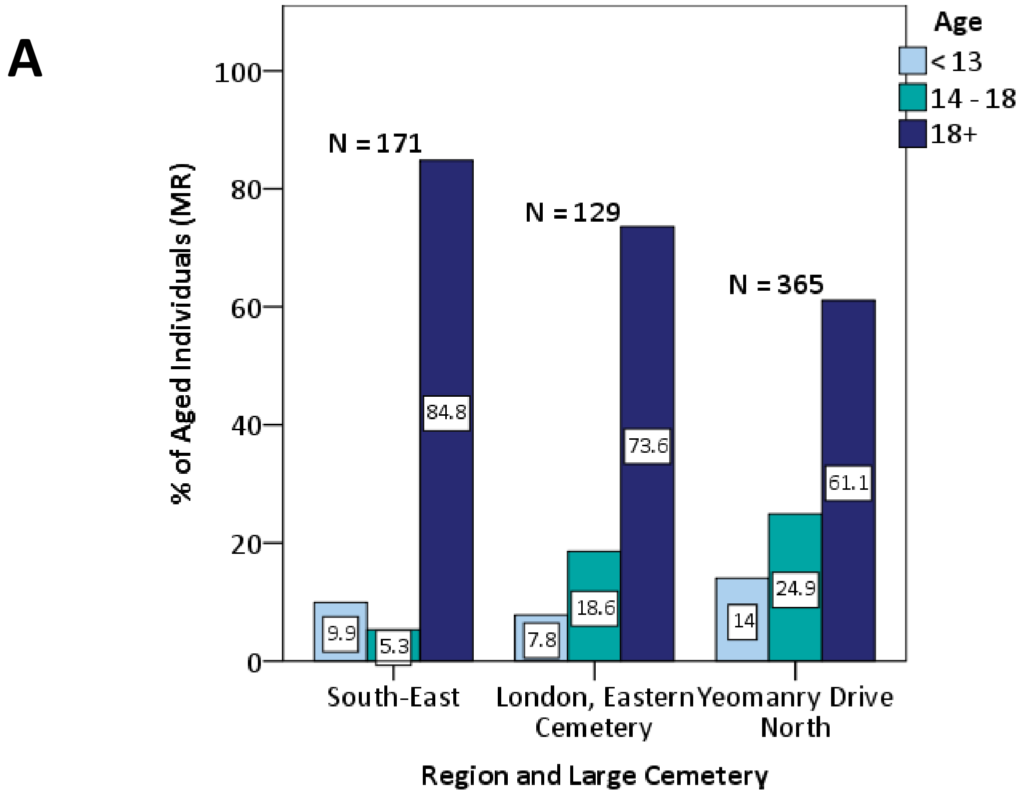


Figure 5.13 Percentage of aged individuals from the Midlands and South-East dating to the Early Roman period. *ER = Early Roman. A) Pooled data from the Midlands and South-East. B) Comparison of pooled data with the large cemetery of Derby Racecourse removed from the Midlands sample.



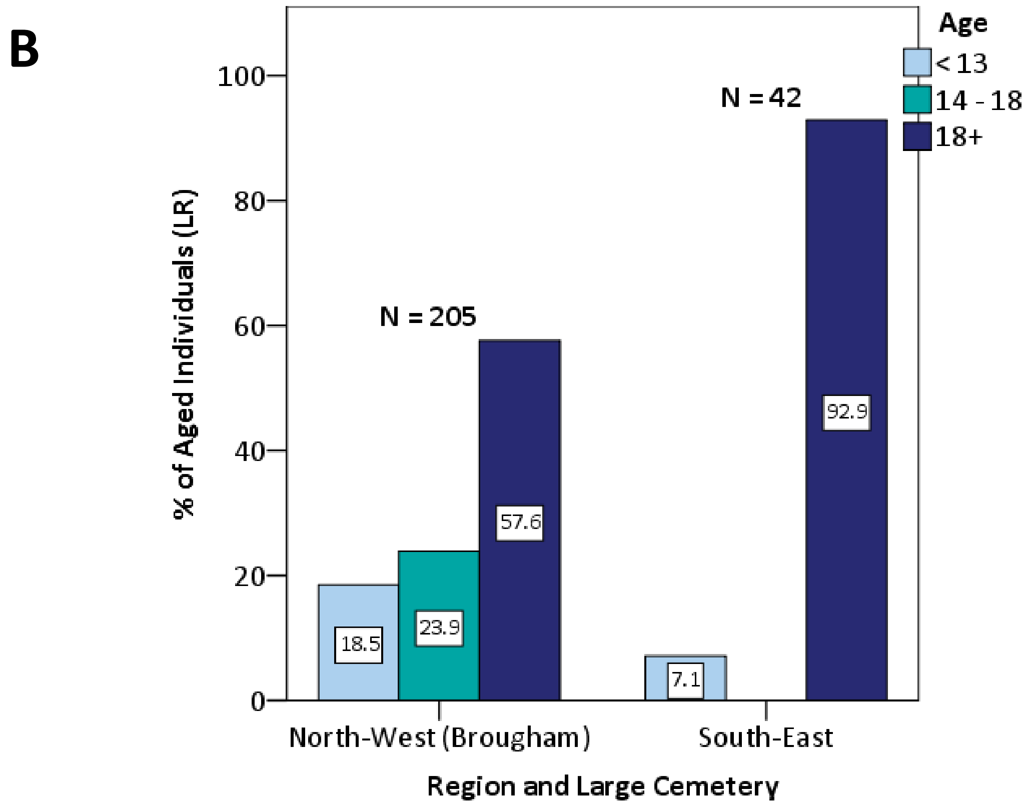


Figure 5.14 Percentage of aged individuals dating to the Middle Roman and Late Roman periods. *MR = Middle Roman. LR = Late Roman. A) Comparison of data from the South-East dating to the Middle Roman period with London, Eastern Cemetery and Yeomanry Drive North removed from study sample. B) Comparison of pooled data from the South-East and North-West dating to the Late Roman period. The data from Brougham makes up 100% of the North-West Late Roman sample.

5.3.2 Age According to Settlement Type

From the Late Iron Age to the Early Roman period, aged individuals are recorded for all settlement types (Table 5.11). The majority of cremated individuals at each settlement type were over 18 years of age. The higher prevalence of 14 – 18 year olds compared to < 13 year olds is found across Rural, Major and Minor Urban cemeteries from the Late Iron Age to the Late Roman period. A chi-squared test found no significant difference between these age groups according to settlement type (Table 5.12). Clearly, this difference is not subject to regional or settlement type variation. Interestingly, the osteological analysis of the cemeteries that displayed this higher prevalence of 14 – 18 years (Westhampnett LIA; Derby Racecourse; Yeomanry Drive North; London, Eastern Cemetery; Brougham) was conducted by the same specialist.

Table 5.11 Summary of aged individuals according to settlement type and time period. Undated data not included.

Late Iron Age								
Region	**N <13**	**%**	**N 14 - 18**	**%**	**N 18+**	**%**	**TOTAL**	**%**
Rural	14	36.8	29	61.7	103	25.7	**146**	30.1
Minor Urban	0	0	0	0	5	1.2	**5**	1
Major Urban	24	63.2	18	38.3	293	73.1	**335**	68.9
TOTAL	**38**	**100**	**47**	**100**	**401**	**100**	**486**	**100**
Early Roman								
Rural	11	34.4	7	14.2	109	36	**127**	33.1
Minor Urban	17	53.1	38	77.6	169	55.7	**224**	58.3
Major Urban	4	12.5	4	8.2	25	8.3	**33**	8.6
TOTAL	**32**	**100**	**49**	**100**	**303**	**100**	**384**	**100**
Middle Roman								
Rural	6	7.4	3	2.4	99	20.2	**108**	15.5
Minor Urban	54	66.7	91	72.2	226	46.3	**371**	53.3
Major Urban	21	25.9	32	25.4	164	33.5	**217**	31.2
TOTAL	**81**	**100**	**126**	**100**	**489**	**100**	**696**	**100**
Late Roman								
Rural	0	0	0	0	2	1.3	**2**	0.8
Minor Urban	38	92.7	49	100	118	74.2	**205**	82.3
Major Urban	3	7.3	0	0	39	24.5	**42**	16.9
TOTAL	41	100	49	100	159	100	**249**	100
TOTAL	**192**	**-**	**271**	**-**	**1352**	**-**	**1815**	**-**

Table 5.12 Summary of chi-squared results. Significant values of 14 –18 year olds and < 13 year olds according to time period and settlement type. *d.f = degrees of freedom.

Time Period	Age	Statistic Value	d.f	Sig.
Late Iron Age	< 13	8.000	6	0.238
	14 – 18	8.000	6	0.238
Early Roman	< 13	9.839	8	0.277
	14 – 18	11.278	8	0.186
Middle Roman	< 13	13.722	12	0.319
	14 – 18	13.310	12	0.347
Late Roman	< 13	3.000	2	0.223
	14 – 18	3.000	1	0.083

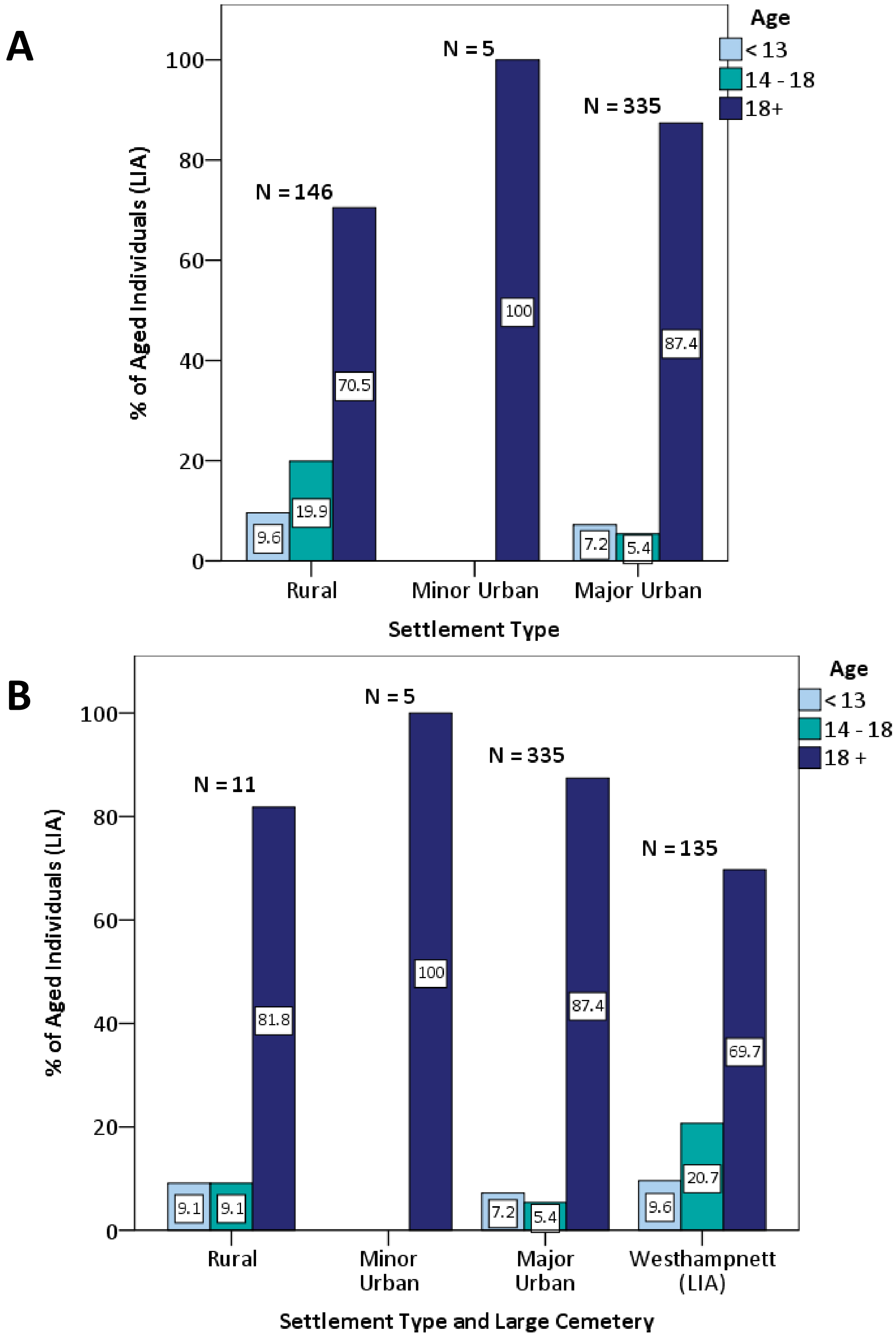


Figure 5.15 Percentage of aged individuals from the Rural, Minor and Major Urban cemeteries dating to the Late Iron Age period. A) Pooled data from Rural, Minor and Major Urban cemeteries. B) Comparison of pooled data from all settlement types dating to the Late Iron Age period with the large cemetery of Westhampnett (LIA) removed from the Rural sample.

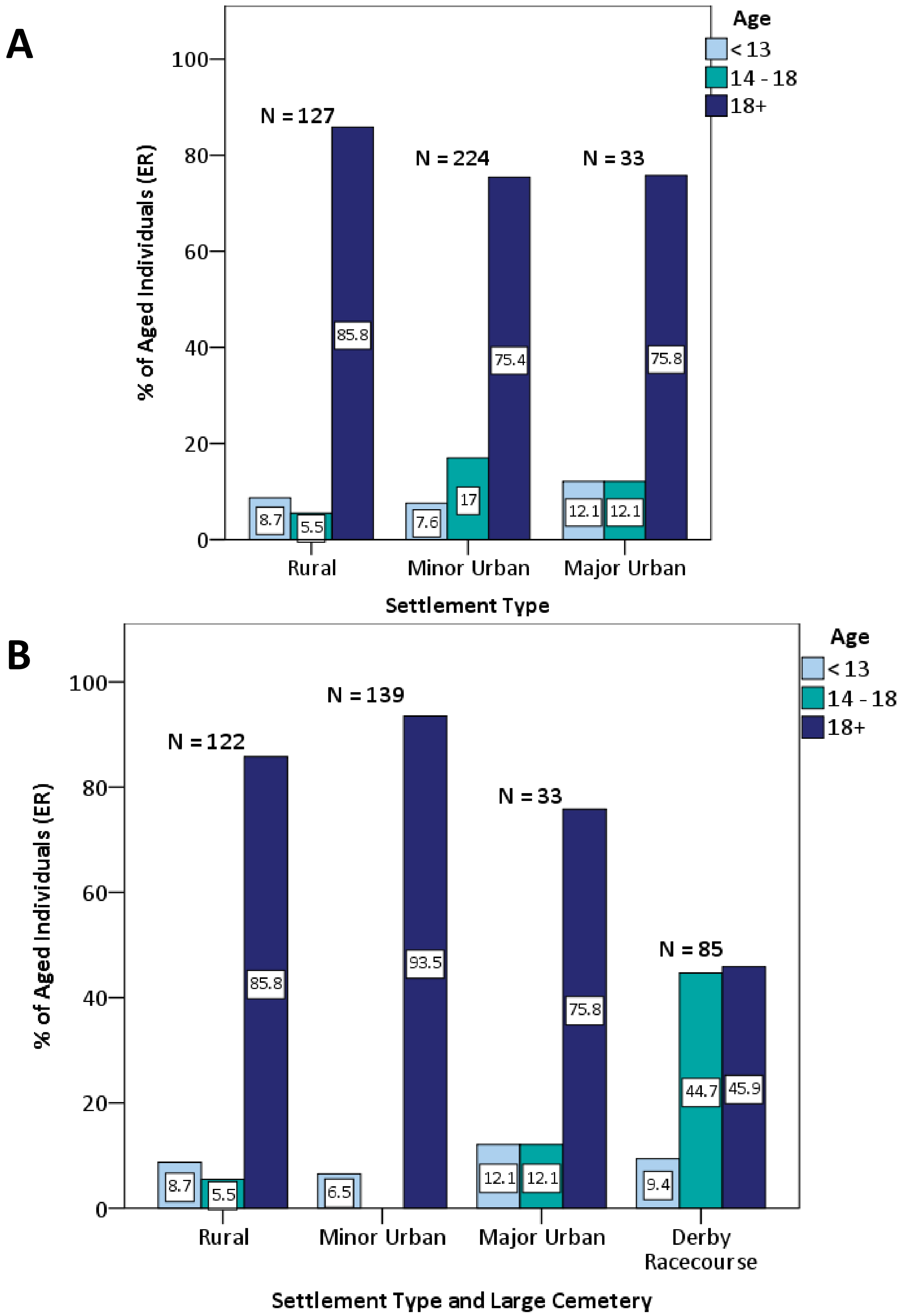
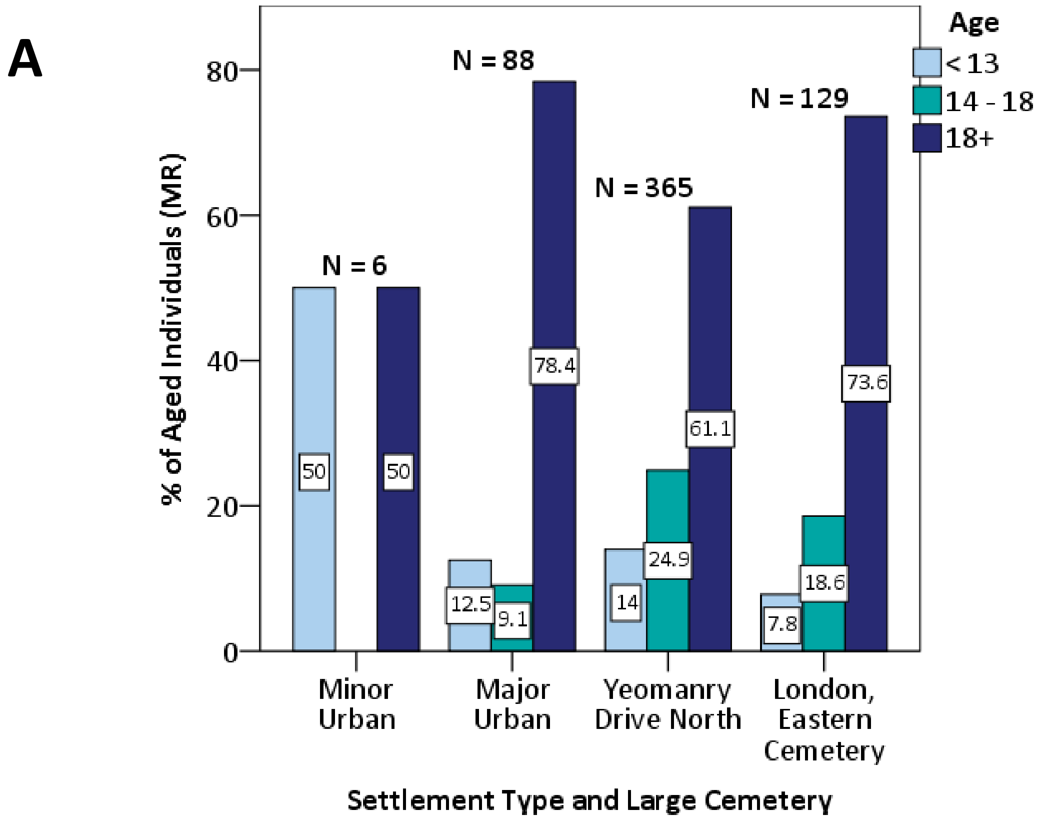


Figure 5.16 Percentage of aged individuals from the Rural, Minor and Major Urban cemeteries dating to the Early Roman period. *ER = Early Roman. A) Pooled data from Rural, Minor and Major Urban cemeteries. B) Comparison of pooled data from all settlement types dating to the Early Roman period with the large cemetery of Derby Racecourse removed from the Minor Urban sample.



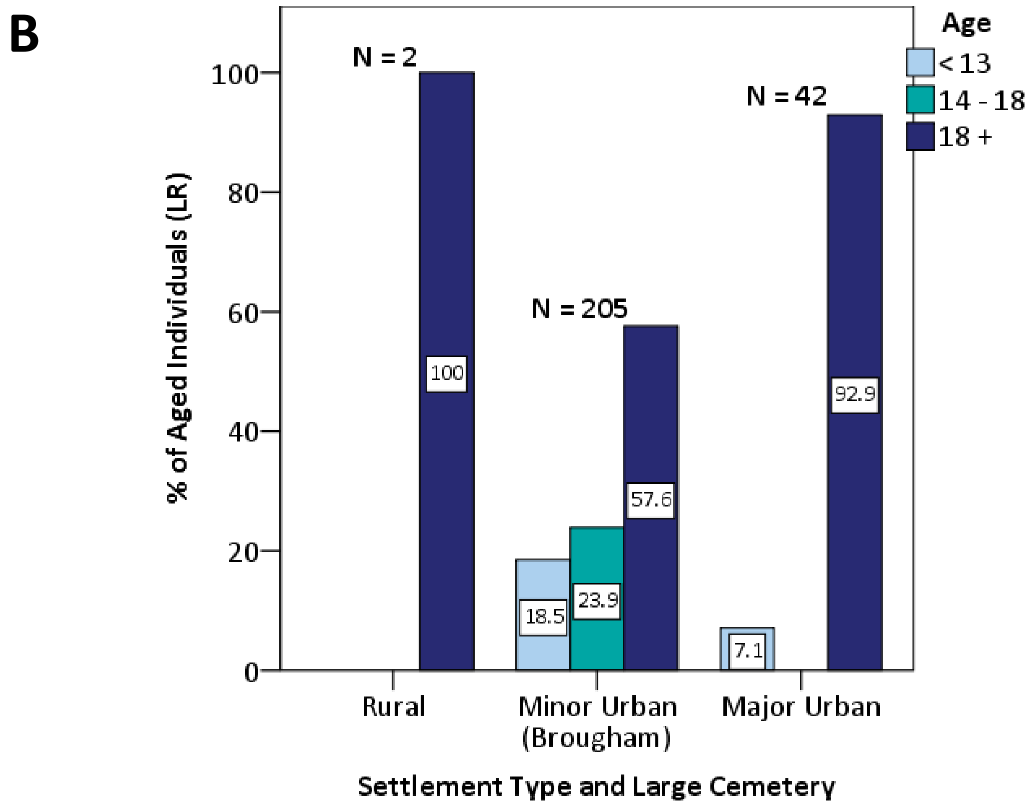


Figure 5.17 Percentage of aged individuals dating to the Middle and Late Roman periods. *MR = Middle Roman. LR = Late Roman. A) Comparison of pooled data from Minor and Major Urban cemeteries dating to the Middle Roman period with the large cemeteries of Yeomanry Drive North and London, Eastern Cemetery. B) Comparison of pooled data from all settlement types dating to the Late Roman period. The data from Brougham makes up 100% of the Minor Urban sample.

5.4 Burial Type

Burial type was recorded for 2046 (86.1% of 2375) cremation deposits from 118 cemeteries dating from the Late Iron Age to the Late Roman period (Tables 5.13 – 5.14 and Figures 5.18 – 5.19). The data are dominated by twelve burial grounds where 69.1% (N = 1414) of these cremation deposits are recorded (see Appendix 3 for breakdown of large cemeteries). The South-East makes up the largest proportion of the sample and contributes 78.8% (N = 1613) of identifications. Chronologically, most cremation deposits date to the Middle Roman period (39.9%, N = 816). With regards to settlement type, the data are evenly distribution with 38.7% (N = 791) deriving from Minor Urban cemeteries.

Table 5.13 Summary of identified burials according to region and time period. Undated data not included.

Late Iron Age			
Region	**N of Cemeteries**	**N Cremation Deposits**	**% Cremation Deposits**
North-West	0	0	0
North-East	0	0	0
Midlands	5	12	2.1
South-East	9	560	97.9
South-West	0	0	0
TOTAL	**14**	**572**	**100**
Early Roman			
North-West	0	0	0
North-East	3	8	1.8
Midlands	27	118	27.3
South-East	31	282	65.1
South-West	4	25	5.8
TOTAL	**65**	**433**	**100**
Middle Roman			
North-West	4	22	2.7
North-East	1	38	4.7
Midlands	5	19	2.3
South-East	14	713	87.4
South-West	5	24	2.9
TOTAL	**29**	**816**	**100**
Late Roman			
North-West	1	161	71.5
North-East	1	1	0.5
Midlands	1	2	0.9
South-East	5	58	25.8
South-West	2	3	1.3
TOTAL	**10**	**225**	**100**
TOTAL	**118**	**2046**	**-**

Table 5.14 Summary of identified burials according to settlement type and time period. Undated data not included.

Late Iron Age			
Region	**N of Cemeteries**	**N Cremation Deposits**	**% Cremation Deposits**
Rural	9	176	30.8
Minor Urban	2	11	1.9
Major Urban	3	385	67.3
TOTAL	**14**	**572**	**100**
Early Roman			
Rural	46	182	42
Minor Urban	16	195	45.1
Major Urban	3	56	12.9
TOTAL	**65**	**433**	**100**
Middle Roman			
Rural	17	118	14.5
Minor Urban	6	424	52
Major Urban	6	274	33.5
TOTAL	**29**	**816**	**100**
Late Roman			
Rural	6	15	6.7
Minor Urban	1	161	71.5
Major Urban	3	49	21.8
TOTAL	**10**	**225**	**100**
TOTAL	**118**	**2046**	**-**

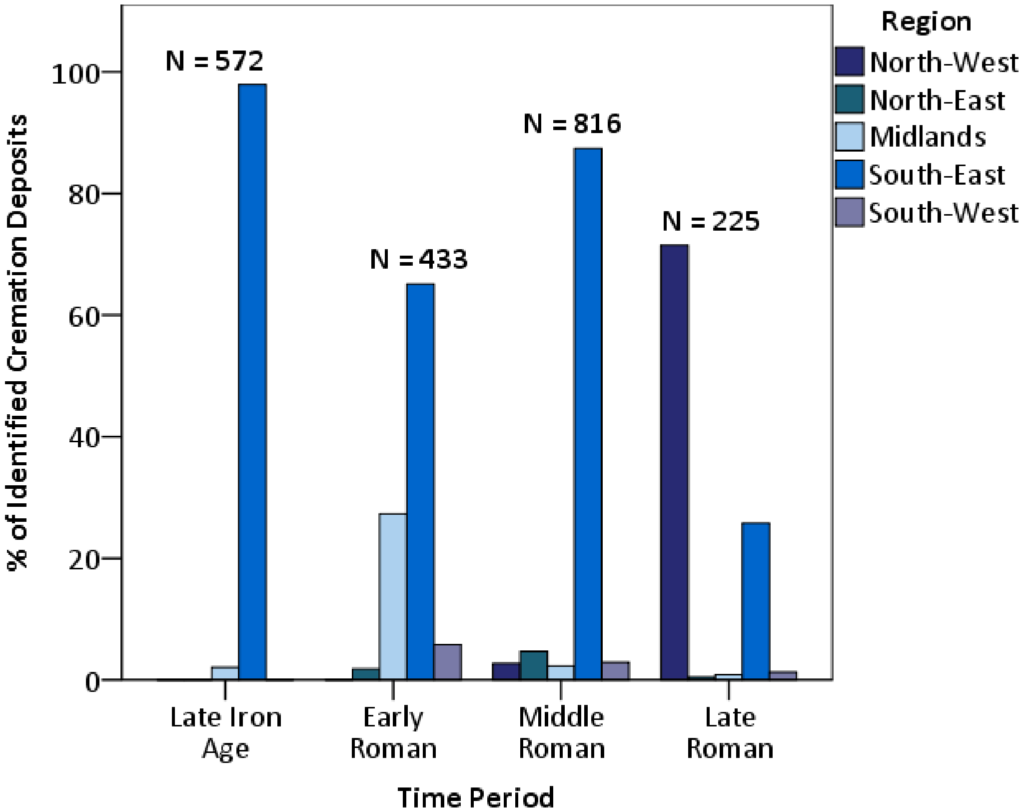


Figure 5.18 Percentage of identified cremation deposits according to region and time period.

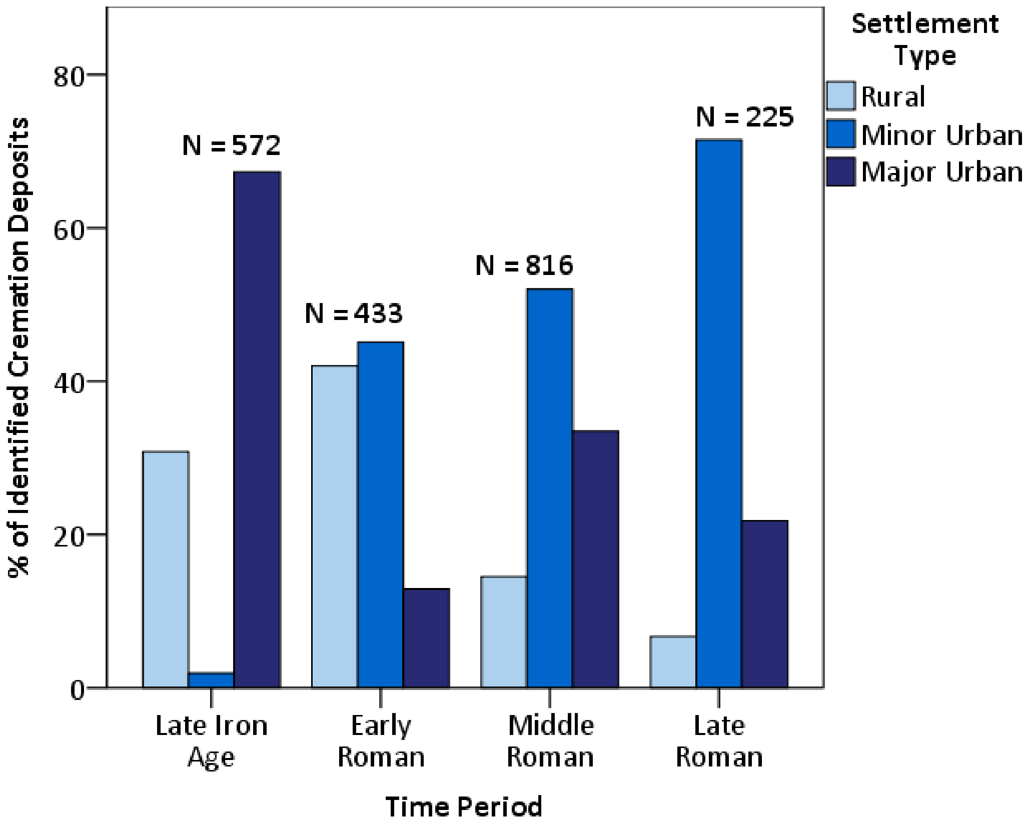


Figure 5.19 Percentage of identified cremation deposits according to settlement type and time period.

5.4.1 Burial Type According to Region

In the Late Iron Age, the South-East has more urned (N = 311, 55.5%) burials (Table 5.15), due to King Harry Lane (LIA) (Figure 5.21). In the Early Roman period, the Midlands has equal numbers of unurned (N = 59) and urned burials (N = 59), which is a result of Derby Racecourse contributing unusually high numbers of unurned cremation deposits (Figure 5.22). When these two cemeteries are removed, these regions shift from unurned to urned practices by the Early Roman period; however, more unurned burials are found in the South-West. A chi-squared test did not find this difference between regions significant (Urned: $p = 0.966$. d.f. = 26; Unurned: $p = 0.239$. d.f. = 22). Pyres are exclusive to the South until the Middle Roman period, and bustum burials are found in the Middle Roman period in the South-East, and then also in the North-West in the Later Roman period (Figure 5.20).

Table 5.15a Summary of identified deposits according to region and time period. Undated data not included.

Late Iron Age								
Region	**N Pyre**	**%**	**N Urned**	**%**	**N Unurned**	**%**	**TOTAL**	**%**
North-West	0	0	0	0	0	0	**0**	0
North-East	0	0	0	0	0	0	**0**	0
Midlands	0	0	6	1.9	6	2.8	**12**	2.2
South-East	12	100	311	98.1	209	97.2	**532**	97.8
South-West	0	0	0	0	0	0	**0**	0
TOTAL	**12**	**100**	**317**	**100**	**215**	**100**	**544**	**100**
Early Roman								
North-West	0	0	0	0	0	0	**0**	0
North-East	0	0	5	1.9	3	1.9	**8**	1.9
Midlands	0	0	59	22.9	59	36.9	**118**	28.1
South-East	2	100	190	73.6	79	49.4	**271**	64.5
South-West	0	0	4	1.6	19	11.8	**23**	5.5
TOTAL	**2**	**100**	**258**	**100**	**160**	**100**	**420**	**100**
Middle Roman								
North-West	0	0	13	2.9	9	2.7	**22**	2.8
North-East	0	0	38	8.4	0	0	**38**	4.8
Midlands	0	0	18	3.9	1	0.3	**19**	2.4
South-East	2	50	373	81.9	313	94.3	**688**	87
South-West	2	50	13	2.9	9	2.7	**24**	3
TOTAL	**4**	**100**	**455**	**100**	**332**	**100**	**791**	**100**
Late Roman								
North-West	0	0	117	79.5	6	25	**123**	71.9
North-East	0	0	0	0	1	4.2	**1**	0.6
Midlands	0	0	2	1.4	0	0	**2**	1.2
South-East	0	0	27	18.4	16	66.6	**43**	25.1
South-West	0	0	1	0.7	1	4.2	**2**	1.2
TOTAL	**0**	**0**	**147**	**100**	**24**	**100**	**171**	**100**
TOTAL	**18**	**-**	**1177**	**-**	**731**	**-**	**1926**	**-**

Table 5.15b Summary of identified burials continued according to region and time period. Undated data not included.

Late Iron Age						
Region	**N Bustum**	**%**	**N Redeposited Pyre Debris**	**%**	**TOTAL**	**%**
North-West	0	0	0	0	**0**	0
North-East	0	0	0	0	**0**	0
Midlands	0	0	0	0	**0**	0
South-East	0	0	28	100	**28**	100
South-West	0	0	0	0	**0**	0
TOTAL	**0**	**0**	**28**	**100**	**28**	**100**
Early Roman						
North-West	0	0	0	0	**0**	0
North-East	0	0	0	0	**0**	0
Midlands	0	0	0	0	**0**	0
South-East	0	0	11	84.6	**11**	84.6
South-West	0	0	2	15.4	**2**	15.4
TOTAL	**0**	**0**	**13**	**100**	**13**	**100**
Middle Roman						
North-West	0	0	0	0	**0**	0
North-East	0	0	0	0	**0**	0
Midlands	0	0	0	0	**0**	0
South-East	3	100	22	100	**25**	100
South-West	0	0	0	0	**0**	0
TOTAL	**3**	**100**	**22**	**100**	**25**	**100**
Late Roman						
North-West	3	16.7	35	97.2	**38**	70.4
North-East	0	0	0	0	**0**	0
Midlands	0	0	0	0	**0**	0
South-East	15	83.3	0	0	**15**	27.8
South-West	0	0	1	2.8	**1**	1.8
TOTAL	**18**	**100**	**36**	**100**	**54**	**100**
TOTAL	**21**	**-**	**99**	**-**	**120**	**-**

Figure 5.20 Distribution of identified burials according to region. Only regions with 5 or more identified burials are shown here. *R.P.D = Redeposited Pyre Debris. NE = North-East. NW = North-West. ML = Midlands. SE = South-East. SW = South-West. A) Late Iron Age period. ML: N = 12. SE: N = 560. B) Early Roman period. NE: N = 8. ML: N = 118. SE: N = 282. SW: N = 25. C) Middle Roman period. NW: N = 22. NE: N = 38. ML: N = 19. SE: N = 713. SW: N = 24. D) NW: N = 161. SE: N = 58.

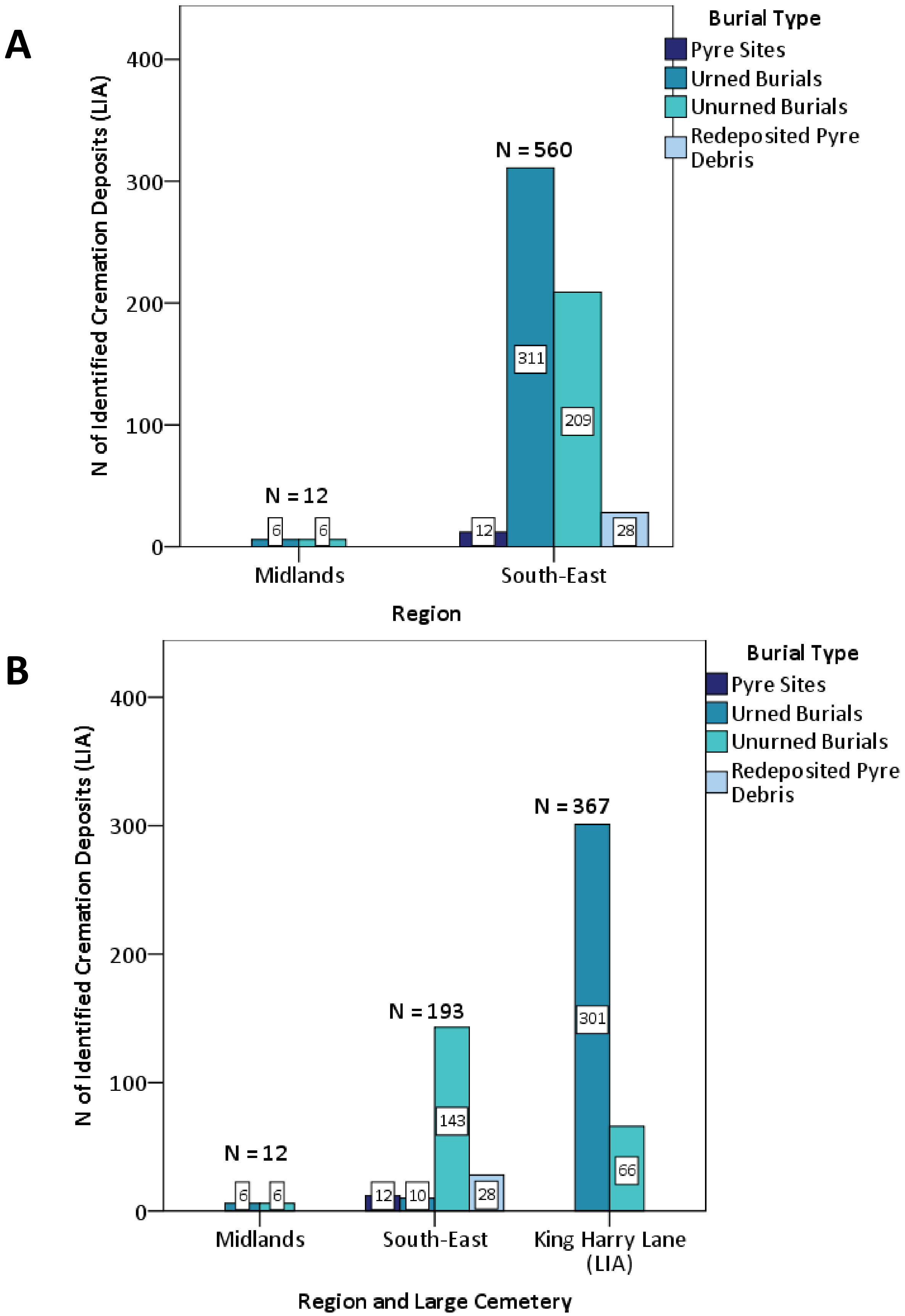


Figure 5.21 Number of identified burials from the Midlands and South-East dating to the Late Iron Age period. *LIA = Late Iron Age. A) Pooled data from Midlands and South-East cemeteries. B) Comparison of pooled data with the large cemetery of King Harry Lane (LIA) removed from the South-East sample.

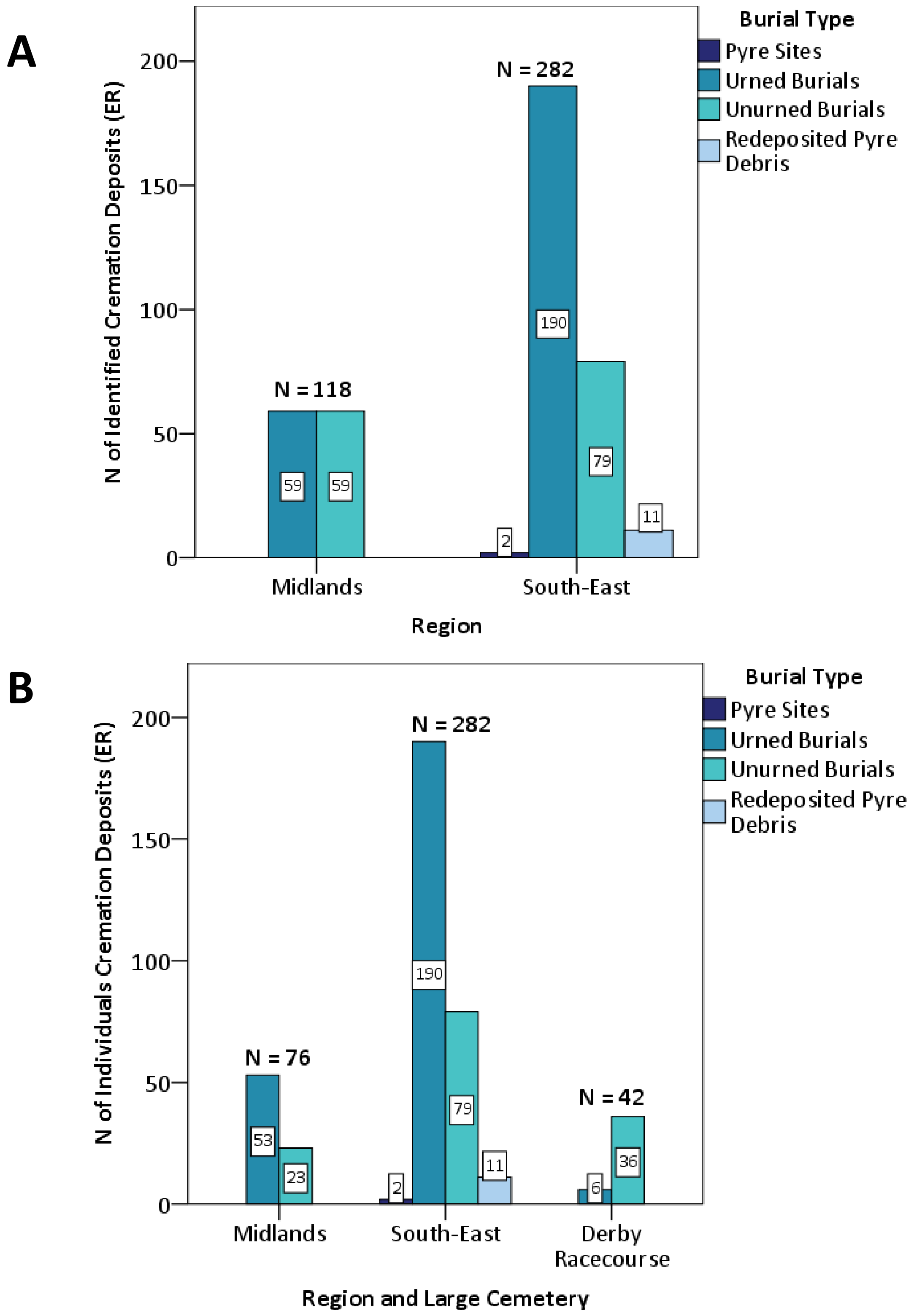


Figure 5.22 Number of identified burials from the Midlands and South-East dating to the Early Roman period. *ER = Early Roman. A) Pooled data from Midlands and South-East cemeteries. B) Comparison of pooled data with the large cemetery of Derby Racecourse removed from the Midlands sample.

5.4.2 Burial Type According to Settlement Type

Burial data were recorded for all settlement types during the Late Iron Age (Table 5.16). However, 88.6% of the Rural cremation deposits come from Westhampentt (LIA) (N = 156), and 95.3% of the Major Urban sample is from King Harry Lane (LIA) (N = 367). King Harry Lane (LIA) has an unusually high prevalence of urned burials compared to other contemporary Major Urban cemeteries (Figure 5.23). By the Early Roman period the majority of cremation deposits from Rural (N = 111) and Major Urban (N = 45) cemeteries are urned. However, unurned burials are more prevalent at Minor Urban sites, once Skeleton Green (N = 68) is removed (Figure 5.24). A chi-squared test found this difference in settlement type to be significant (p = 0.001. d.f. = 24). The Minor Urban sample is skewed towards unurned practices in the Middle Roman period, caused by Yeomanry Drive North (N = 395) that makes up 93.2% of the data (Figure 5.25). Both Pyre sites and bustum burials are found at all settlement types.

Table 5.16a Summary of identified burials according to settlement type and time period. Undated data not included.

Late Iron Age								
Region	**N Pyre**	**%**	**N Urned**	**%**	**N Unurned**	**%**	**TOTAL**	**%**
Rural	9	75	13	4.1	134	62.3	**156**	28.7
Minor Urban	1	8.3	2	0.6	8	3.8	**11**	2
Major Urban	2	16.7	302	95.3	73	33.9	**377**	69.3
TOTAL	**12**	**100**	**317**	**100**	**215**	**100**	**544**	**100**
Early Roman								
Rural	0	0	111	43	64	40	**175**	41.7
Minor Urban	0	0	102	39.6	91	56.9	**193**	46
Major Urban	2	100	45	17.4	5	3.1	**52**	12.3
TOTAL	**2**	**100**	**258**	**100**	**160**	**100**	**420**	**100**
Middle Roman								
Rural	0	0	83	18.2	30	9	**113**	14.3
Minor Urban	2	50	184	40.4	238	71.7	**424**	53.6
Major Urban	2	50	188	41.4	64	19.3	**254**	32.1
TOTAL	**4**	**100**	**455**	**100**	**332**	**100**	**791**	**100**
Late Roman								
Rural	0	0	4	2.7	2	8.3	**6**	3.5
Minor Urban	0	0	117	79.6	6	25	**123**	71.9
Major Urban	0	0	26	17.7	16	66.7	**42**	24.6
TOTAL	**0**	**0**	**147**	**100**	**24**	**100**	**171**	**100**
TOTAL	**18**	**-**	**1177**	**-**	**731**	**-**	**1926**	**-**

Table 5.16b Summary of identified burials continued according to settlement type and time period. Undated data not included.

Late Iron Age							
Region	**%**	**N Bustum**	**%**	**N Redeposited Pyre Debris**	**%**	**TOTAL**	**%**
Rural	62.3	0	0	20	71.4	**20**	71.4
Minor Urban	3.8	0	0	0	0	**0**	0
Major Urban	33.9	0	0	8	28.6	**8**	28.6
TOTAL	**100**	**0**	**0**	**28**	**100**	**28**	**100**
Early Roman							
Rural	40	0	0	7	53.8	**7**	53.8
Minor Urban	56.9	0	0	2	15.4	**2**	15.4
Major Urban	3.1	0	0	4	30.8	**4**	30.8
TOTAL	**100**	**0**	**0**	**13**	**100**	**13**	**100**
Middle Roman							
Rural	9	0	0	5	22.7	**5**	20
Minor Urban	71.7	0	0	0	0	**0**	0
Major Urban	19.3	3	100	17	77.3	**20**	80
TOTAL	**100**	**3**	**100**	**22**	**100**	**25**	**100**
Late Roman							
Rural	8.3	8	44.4	1	2.8	**9**	16.7
Minor Urban	25	3	16.7	35	97.2	**38**	70.4
Major Urban	66.7	7	38.9	0	0	**7**	12.9
TOTAL	**100**	**18**	**100**	**36**	**100**	**54**	**100**
TOTAL	**-**	**21**	**-**	**99**	**-**	**120**	**-**

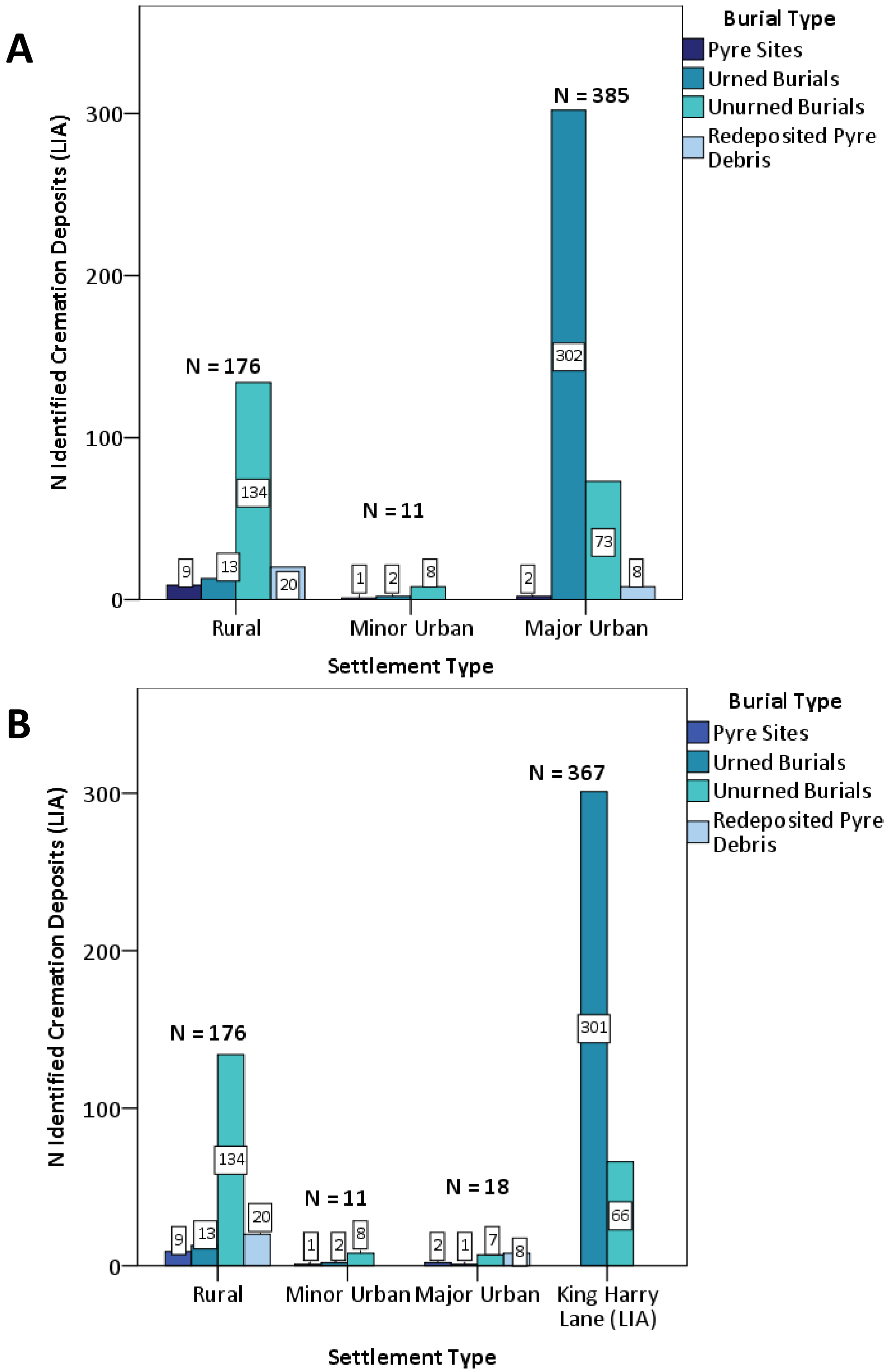


Figure 5.23 Number of identified burials for Rural, Minor and Major Urban cemeteries dating to the Late Iron Age period. *LIA = Late Iron Age. A) Pooled data from Rural, Minor and Major Urban cemeteries. B) Comparison of pooled data with the large cemetery of King Harry Lane (LIA) removed from Major Urban sample.

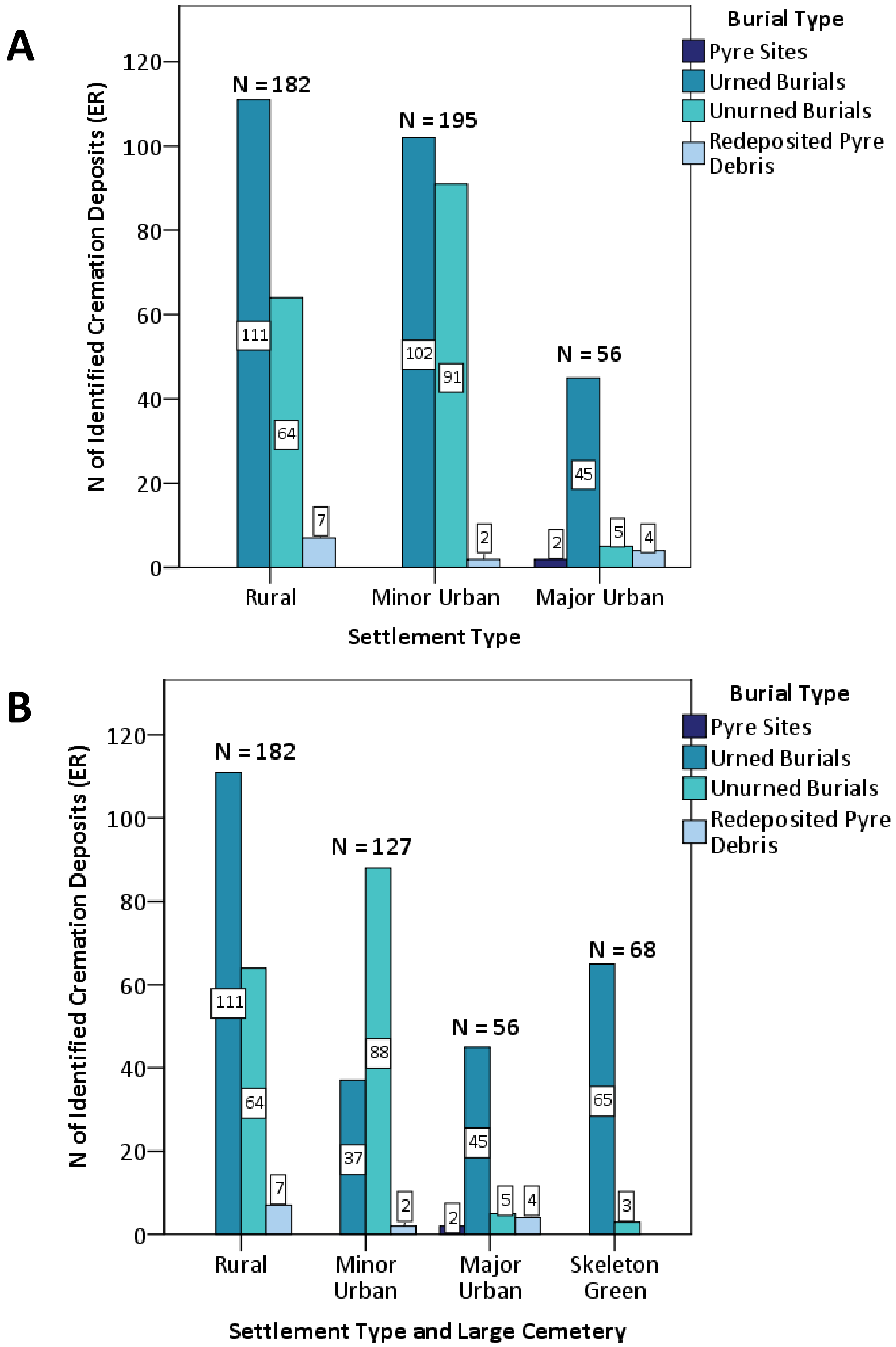


Figure 5.24 Number of identified burials for Rural, Minor and Major Urban cemeteries dating to the Early Roman period. *ER = Early Roman. A) Pooled data from Rural, Minor and Major Urban cemeteries. B) Comparison of pooled data with the large cemetery of Skeleton Green removed from the Minor Urban sample.

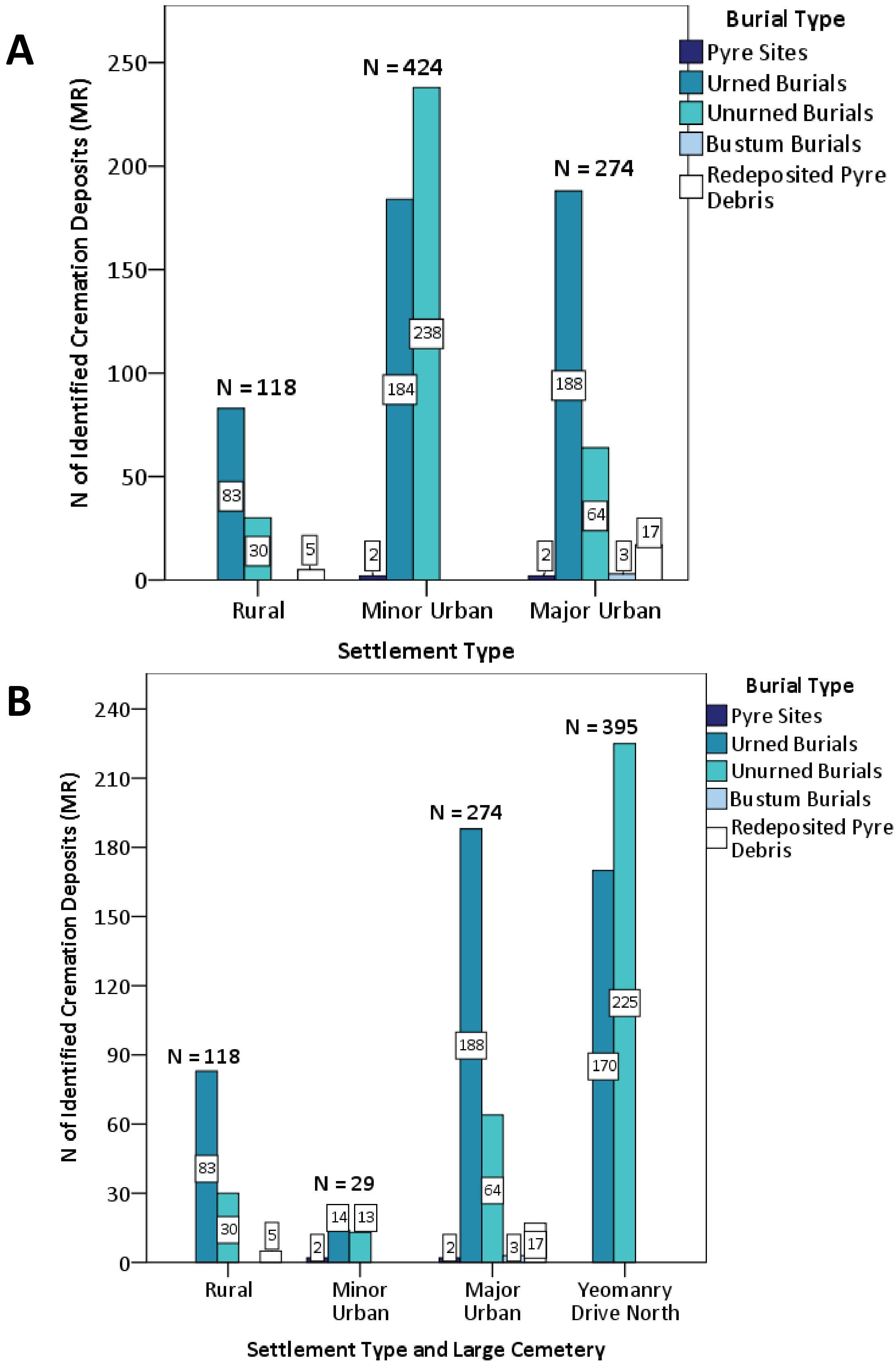


Figure 5.25 Number of identified burials for Rural, Minor and Major Urban cemeteries dating to the Middle Roman period. *MR = Middle Roman. A) Pooled data from Rural, Minor and Major Urban cemeteries. B) Comparison of pooled data with the large cemetery of Yeomanry Drive North removed from Minor Urban sample.

5.5 Grave and Pyre Goods

Grave goods were recorded for 1010 (42.5% of 2375) burials (89 cemeteries), compared to 356 (15% of 2375) burials with pyre goods (38 cemeteries) (Tables 5.17 – 5.18, Figures 5.26 - 5.29). Thirteen cemeteries contribute 74% (N = 747) of grave goods and 88.2% (N = 314) of pyre goods (see Appendix 3 for breakdown of large cemeteries). Most grave goods (81.1%, N = 819) derive from the South-East, and 57% (N = 203) of pyre goods are from the North-West. 48% (N = 485) of grave goods are Late Iron Age, and most pyre goods are Late Roman (58.7%, N = 209). Most grave goods (49.7%, N = 502) come from Major Urban sites, while 62.9% (N = 224) of pyre goods are from Minor Urban centres.

Table 5.17 Summary of grave and pyre goods according to region and time period. Undated data not included.

			Late Iron Age			
Region	**N Cemeteries**	**N Grave Goods**	**%**	**N Cemeteries**	**N Pyre Goods**	**%**
North-West	0	0	0	0	0	0
North-East	0	0	0	0	0	0
Midlands	5	7	1.4	0	0	0
South-East	7	478	98.6	3	27	100
South-West	0	0	0	0	0	0
TOTAL	**12**	**485**	**100**	**3**	**27**	**100**
			Early Roman			
North-West	0	0	0	0	0	0
North-East	0	0	0	0	0	0
Midlands	21	44	20.8	5	6	12
South-East	24	162	76.4	13	43	86
South-West	4	6	2.8	1	1	2
TOTAL	**49**	**212**	**100**	**19**	**50**	**100**
			Middle Roman			
North-West	3	6	3.2	2	2	2.9
North-East	1	18	9.7	1	7	10
Midlands	4	5	2.7	2	4	5.7
South-East	11	154	82.8	7	57	81.4
South-West	3	3	1.6	0	0	0
TOTAL	**22**	**186**	**100**	**12**	**70**	**100**
			Late Roman			
North-West	1	101	79.5	1	201	96.2
North-East	0	0	0	0	0	0
Midlands	1	1	0.8	0	0	0
South-East	4	25	19.7	2	7	3.3
South-West	0	0	0	1	1	0.5
TOTAL	**6**	**127**	**100**	**4**	**209**	**100**
TOTAL	**89**	**1010**	**-**	**38**	**356**	**-**

Table 5.18 Summary of grave and pyre goods according to settlement type and time period. Undated data not included.

Late Iron Age						
Region	**N Cemeteries**	**N Grave Goods**	**%**	**N Cemeteries**	**N Pyre Goods**	**%**
Rural	8	155	32	1	3	11.1
Minor Urban	1	4	0.8	1	1	3.7
Major Urban	3	326	67.2	1	23	85.2
TOTAL	**12**	**485**	**100**	**3**	**27**	**100**
Early Roman						
Rural	36	102	48.1	14	20	40
Minor Urban	11	81	38.2	3	20	40
Major Urban	2	29	13.7	2	10	20
TOTAL	**49**	**212**	**100**	**19**	**50**	**100**
Middle Roman						
Rural	13	58	31.2	5	13	18.6
Minor Urban	3	5	2.7	2	2	2.9
Major Urban	6	123	66.1	5	55	78.5
TOTAL	**22**	**186**	**100**	**12**	**70**	**100**
Late Roman						
Rural	2	2	1.6	2	2	1
Minor Urban	1	101	79.5	1	201	96.2
Major Urban	3	24	18.9	1	6	2.8
TOTAL	**6**	**127**	**100**	**4**	**209**	**100**
TOTAL	**89**	**1010**	**-**	**38**	**356**	**-**

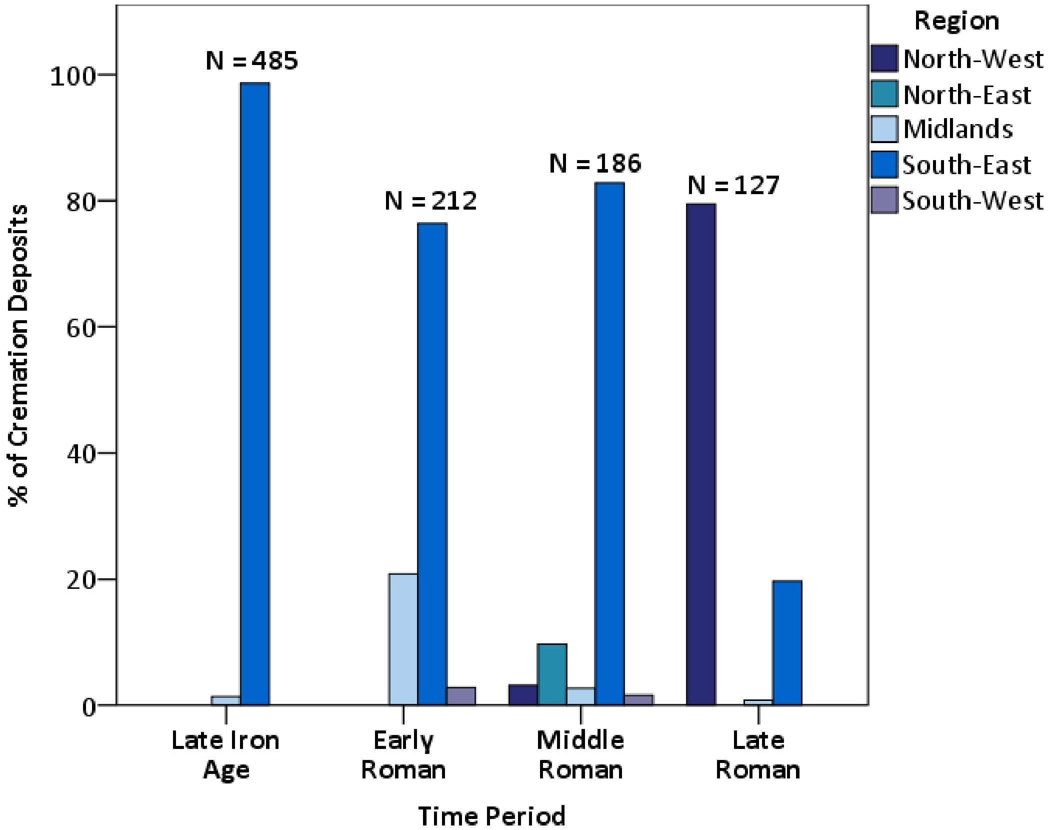


Figure 5.26 Percentage of burials with grave goods according to region and time period.

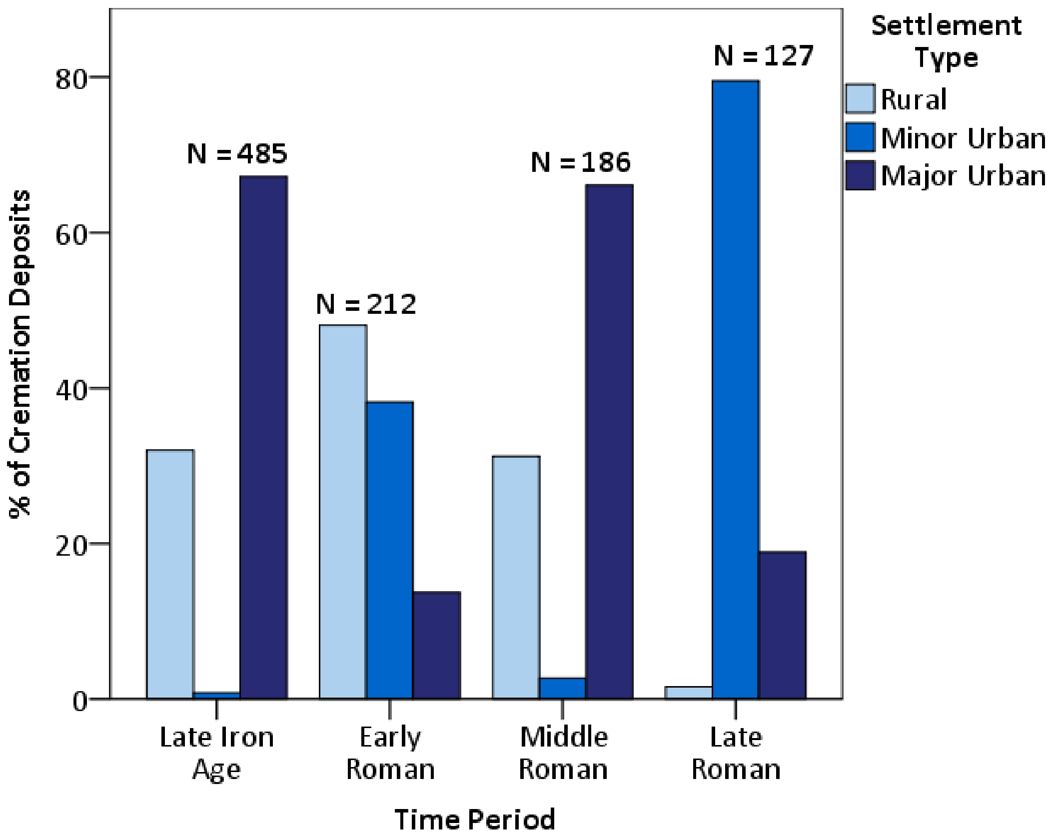


Figure 5.27 Percentage of burials with grave goods according to settlement type and time period.

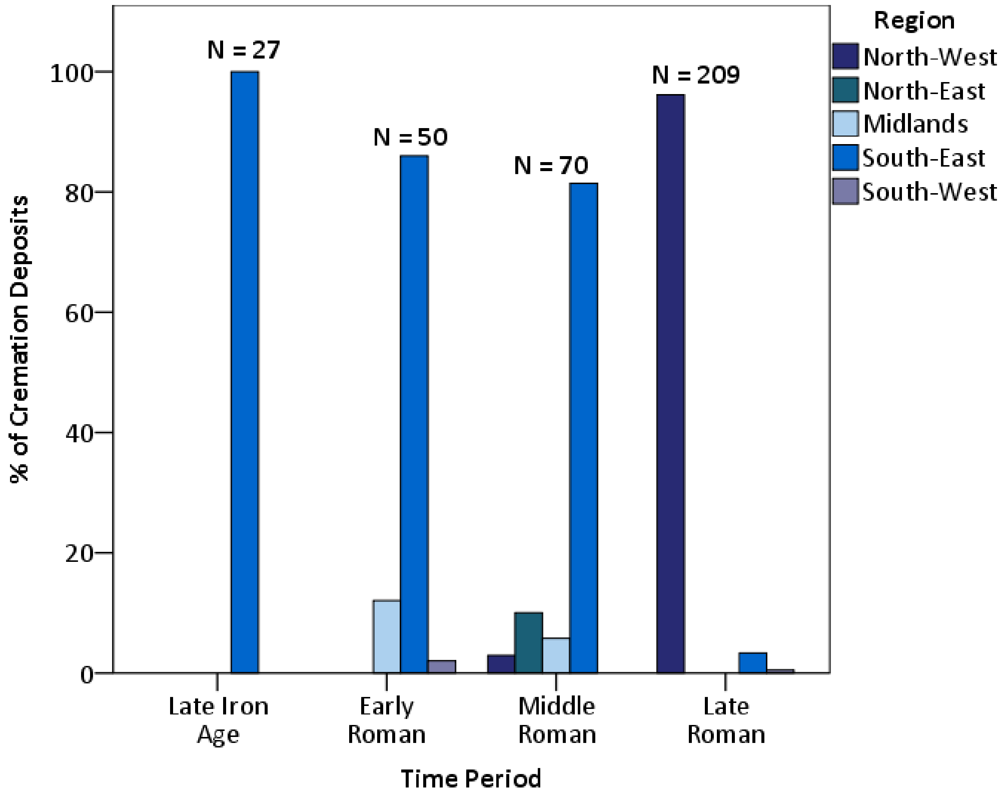


Figure 5.28 Percentage of burials with pyre goods according to region and time period.

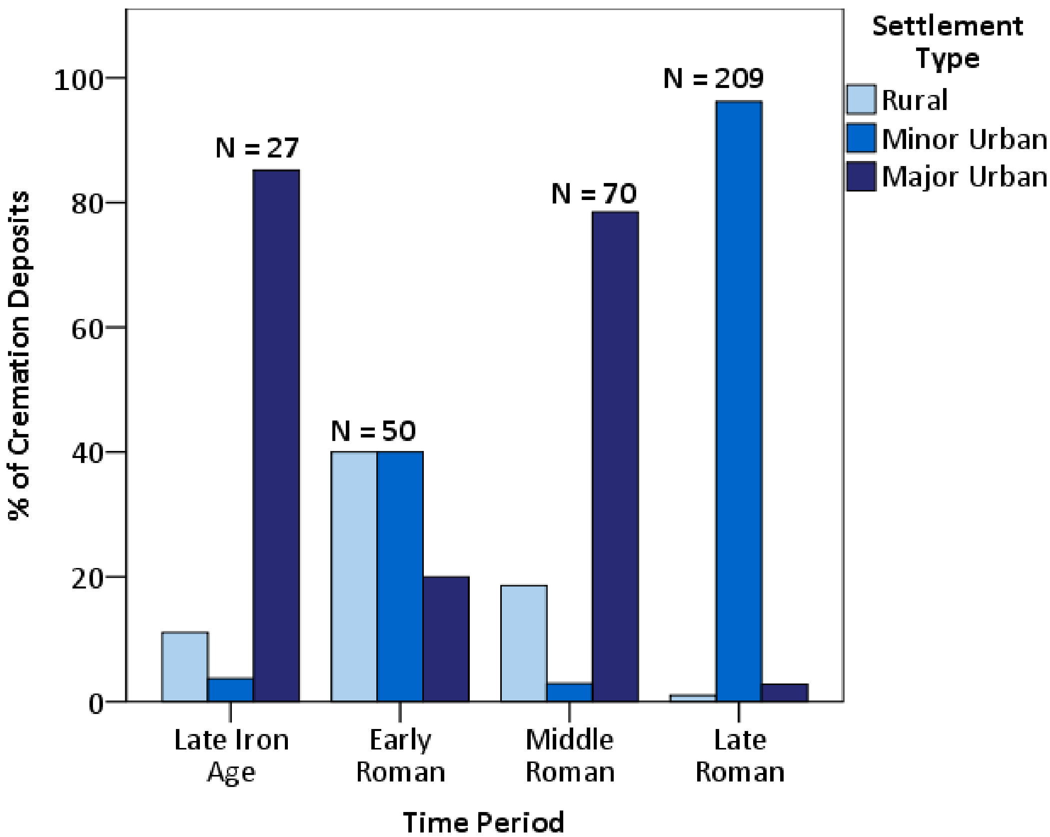


Figure 5.29 Percentage of burials with pyre goods according to settlement type and time period.

5.5.1 Grave and Pyre Goods According to Region

Overall, grave goods were more common than pyre goods across all regions from the Late Iron Age to the Middle Roman period (Table 5.19 and Figure 5.30). The only exception was found in the North-West in the Late Roman period. This is caused by the cemetery of Brougham (Grave Goods: N = 101. Pyre Goods: N = 201), which contributes 100% of the study sample in this region. Generally, from the Late Iron Age to Middle Roman period in the South-East and Midlands the percentage of grave goods drops, while the percentage of pyre goods increases (Figures 5.31 – 5.33).

Table 5.19 Summary of grave and pyre goods according to region and time period. Undated data not included.

Late Iron Age					
Region	**N Cremation Deposits**	**N Grave Goods**	**%**	**N Pyre Goods**	**%**
North-West	0	0	0	0	0
North-East	0	0	0	0	0
Midlands	19	7	36.8	0	0
South-East	592	478	80.7	27	4.6
South-West	0	0	0	0	0
TOTAL	**611**	**485**	**79.4**	**27**	**4.4**
	Early Roman				
North-West	0	0	0	0	0
North-East	8	0	0	0	0
Midlands	218	44	20.2	6	2.8
South-East	359	162	45.1	43	12
South-West	34	6	17.6	1	2.9
TOTAL	**619**	**212**	**34.2**	**50**	**8.1**
	Middle Roman				
North-West	27	6	22.2	2	7.4
North-East	53	18	34	7	13.2
Midlands	21	5	23.8	4	19
South-East	739	154	20.8	57	7.7
South-West	25	3	12	0	0
TOTAL	**865**	**186**	**21.5**	**70**	**8.1**
	Late Roman				
North-West	205	101	49.3	201	98
North-East	1	0	0	0	0
Midlands	2	1	50	0	0
South-East	69	25	36.2	7	10.1
South-West	3	0	0	1	33.3
TOTAL	**280**	**127**	**45.4**	**209**	**74.6**
TOTAL	**2375**	**1010**	**-**	**356**	**-**

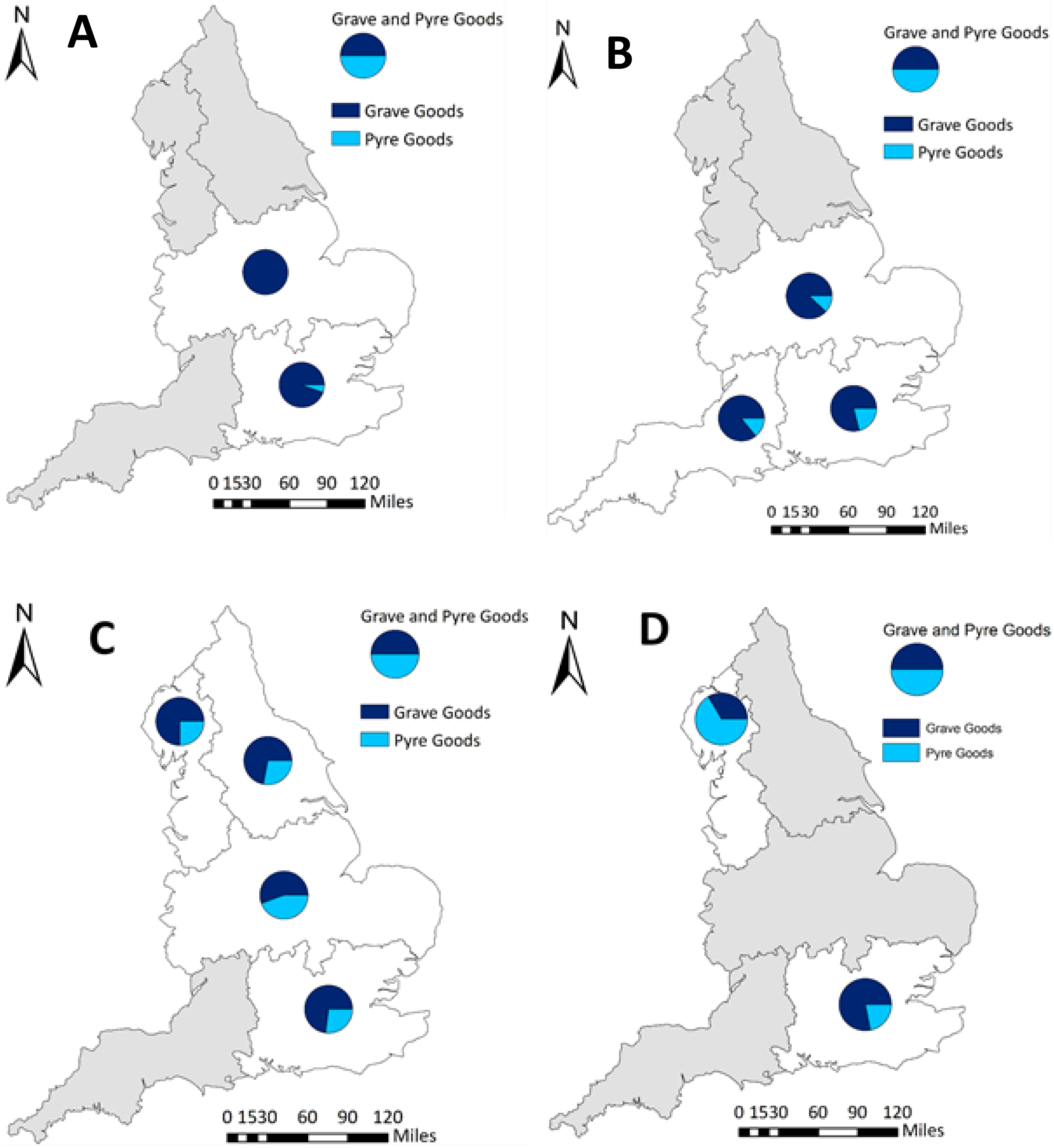


Figure 5.30 Distribution of grave and pyre goods according to region. Only regions with 5 or more inclusions are shown here. *NE = North-East. NW = North-West. ML = Midlands. SE = South-East. SW = South-West. A) Late Iron Age period. ML: N GG = 7. SE: N GG = 478. N PG = 27. B) Early Roman period. ML: N GG = 44. N PG = 6. SE: N GG = 162. N PG = 43. SW: N GG = 6. N PG = 1.C) Middle Roman period. NW: N GG = 6. N PG = 2. NE: N GG = 18. N PG = 7. ML: N GG = 5. N PG = 4. SE: N GG = 154. N PG = 57. D) Late Roman period. NW: N GG = 101. N PG = 201. SE: N GG = 25. N PG = 7.

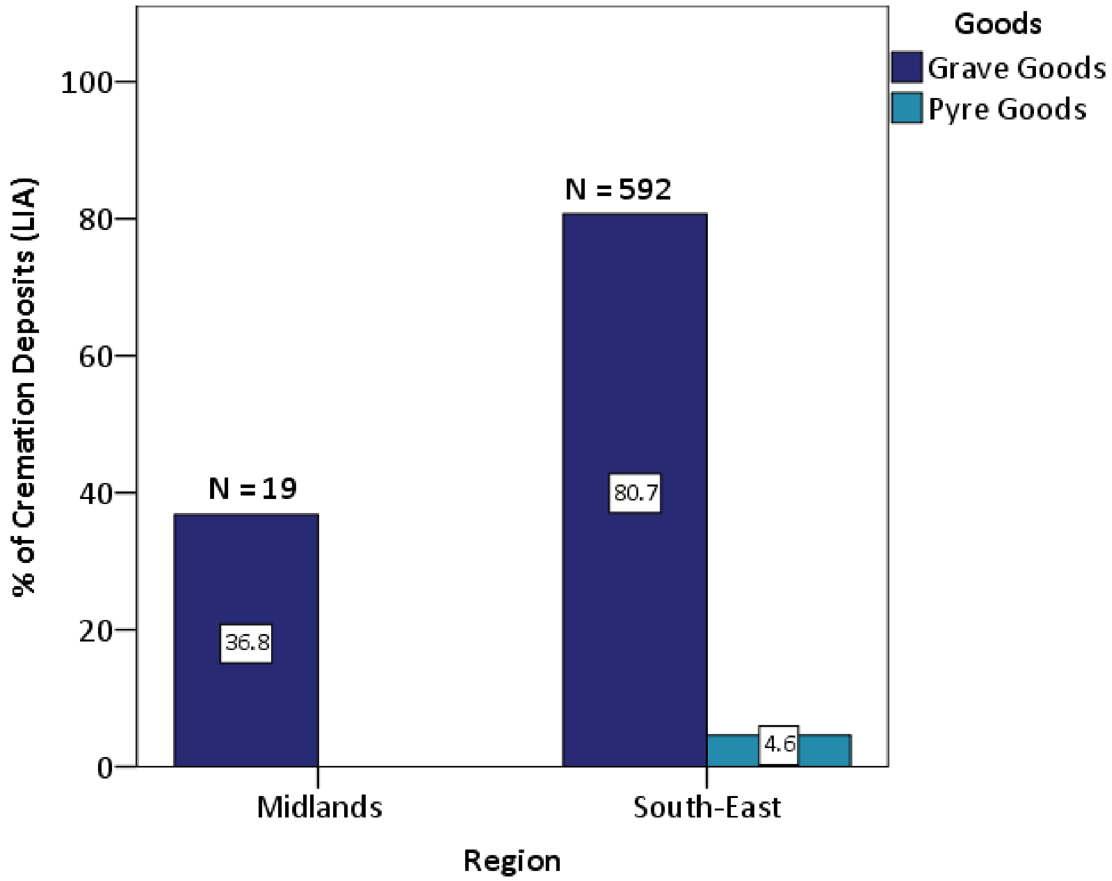


Figure 5.31 Percentage of grave and pyre goods for the Late Iron Age Midlands and South-East. *LIA = Late Iron Age.

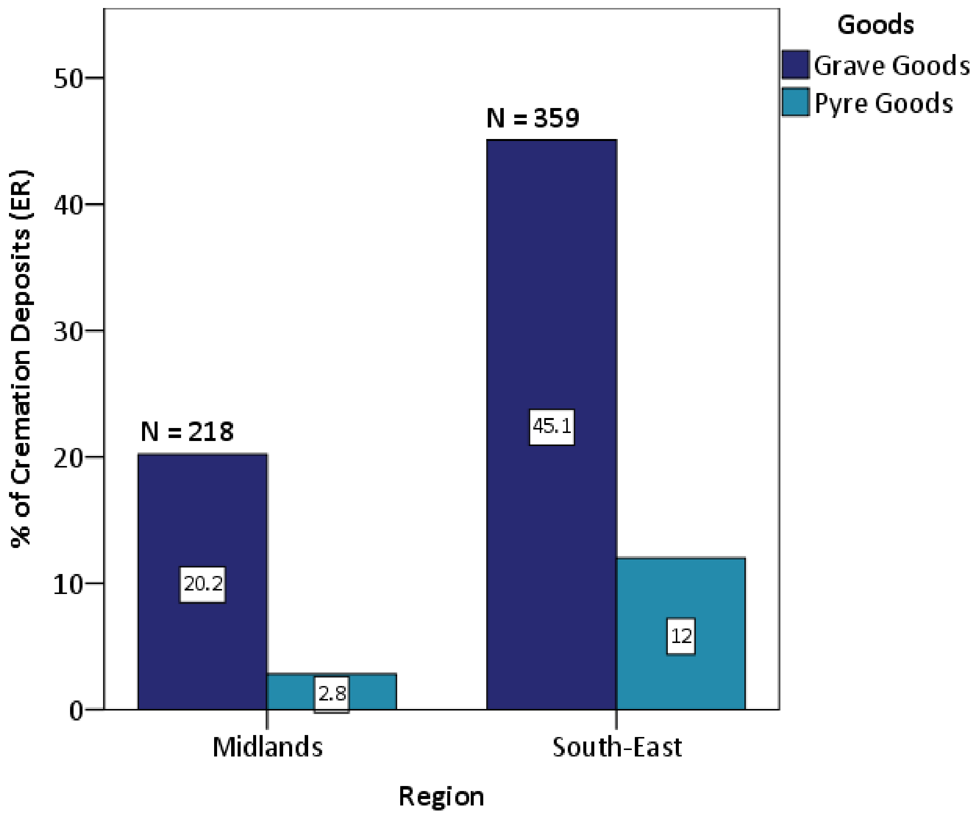


Figure 5.32 Percentage of grave and pyre goods for the Early Roman Midlands and South-East. * ER = Early Roman.

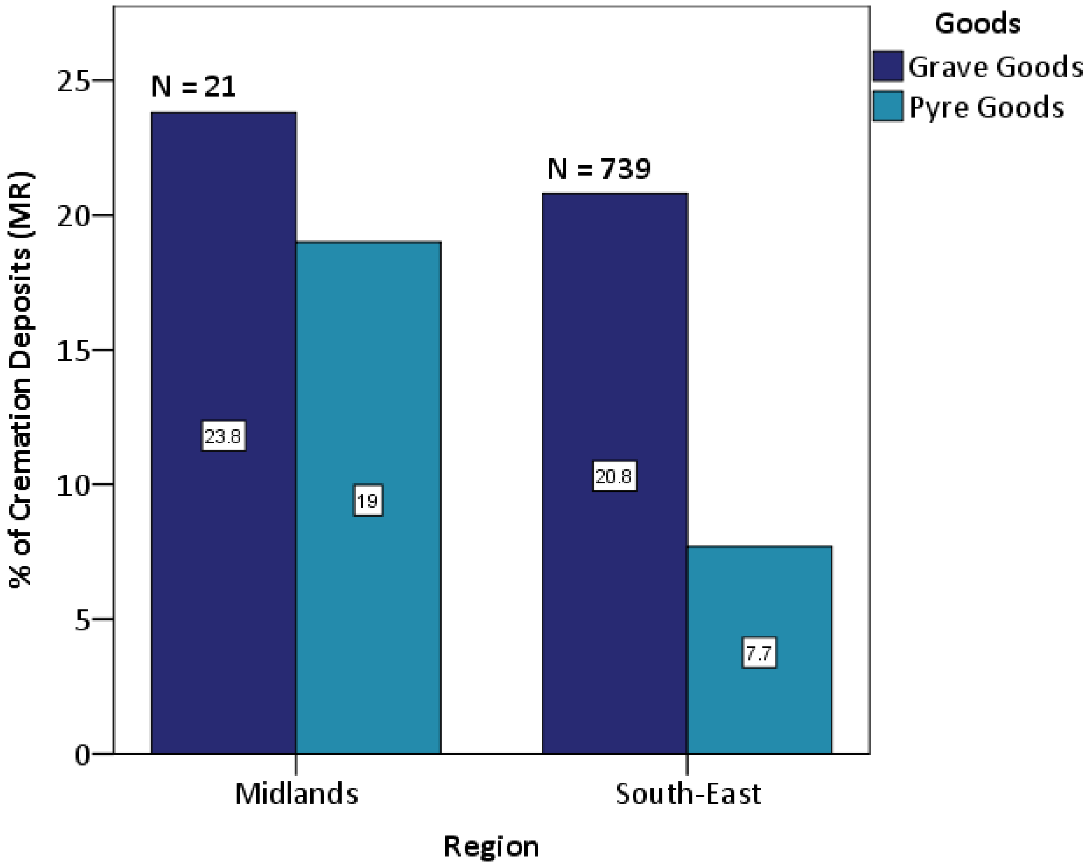


Figure 5.33 Percentage of grave and pyre goods for the Middle Roman Midlands and South-East. * MR = Middle Roman.

5.5.2 Grave and Pyre Goods According to Settlement Type

Grave and pyre goods were identified across all settlement types prior to the Roman conquest (Table 5.18). However, all of the pyre goods from the Rural and Major Urban samples come from the cemeteries of Westhampnett (N = 3) and King Harry Lane (LIA) (N = 23) respectively, while all of the Minor Urban data derive from the Late Iron Age phase of Stansted Airport (LIA) (GG: N = 4. PG: N = 1). Overall, grave goods were more common than pyre goods across all settlement types from the Late Iron Age to the Middle Roman period. The only difference was found in the Late Roman period at Minor Urban sites. This is caused by the cemetery of Brougham (GG: N = 101. PG: N = 201), which makes up the entire Late Roman study sample. Generally, the drop in the number of grave goods and rise in the number of pyre goods from the Late Iron Age to Middle Roman periods is evident at Rural and Major Urban settlements (Figures 5.34 - 5.36). The only exception was found at Minor Urban centres. This is again caused the by large Middle Roman cemetery of Yeomanry Drive North that makes up 92.9% (N = 395) of the sample; while the osteological data are available for this cemetery, the grave and pyre goods have not been published.

Table 5.20 Summary of grave and pyre goods according to settlement type and time period. Undated data not included.

Late Iron Age					
Region	**N Cremation Deposits**	**N Grave Goods**	**%**	**N Pyre Goods**	**%**
Rural	191	155	81.2	3	1.6
Minor Urban	14	4	28.6	1	7.1
Major Urban	406	326	80.3	23	5.7
TOTAL	**611**	**485**	**79.4**	**27**	**4.4**
Early Roman					
Rural	254	102	40.2	20	7.9
Minor Urban	308	81	26.3	20	6.5
Major Urban	57	29	50.9	10	17.5
TOTAL	**619**	**212**	**34.2**	**50**	**8.1**
Middle Roman					
Rural	128	58	45.3	13	10.2
Minor Urban	425	5	1.2	2	0.5
Major Urban	312	123	39.4	55	17.6
TOTAL	**865**	**186**	**21.5**	**70**	**8.1**
Late Roman					
Rural	15	2	13.3	2	13.3
Minor Urban	205	101	49.3	201	98
Major Urban	60	24	40	6	10
TOTAL	**280**	**127**	**45.4**	**209**	**74.6**
TOTAL	**2375**	**1010**	**-**	**356**	**-**

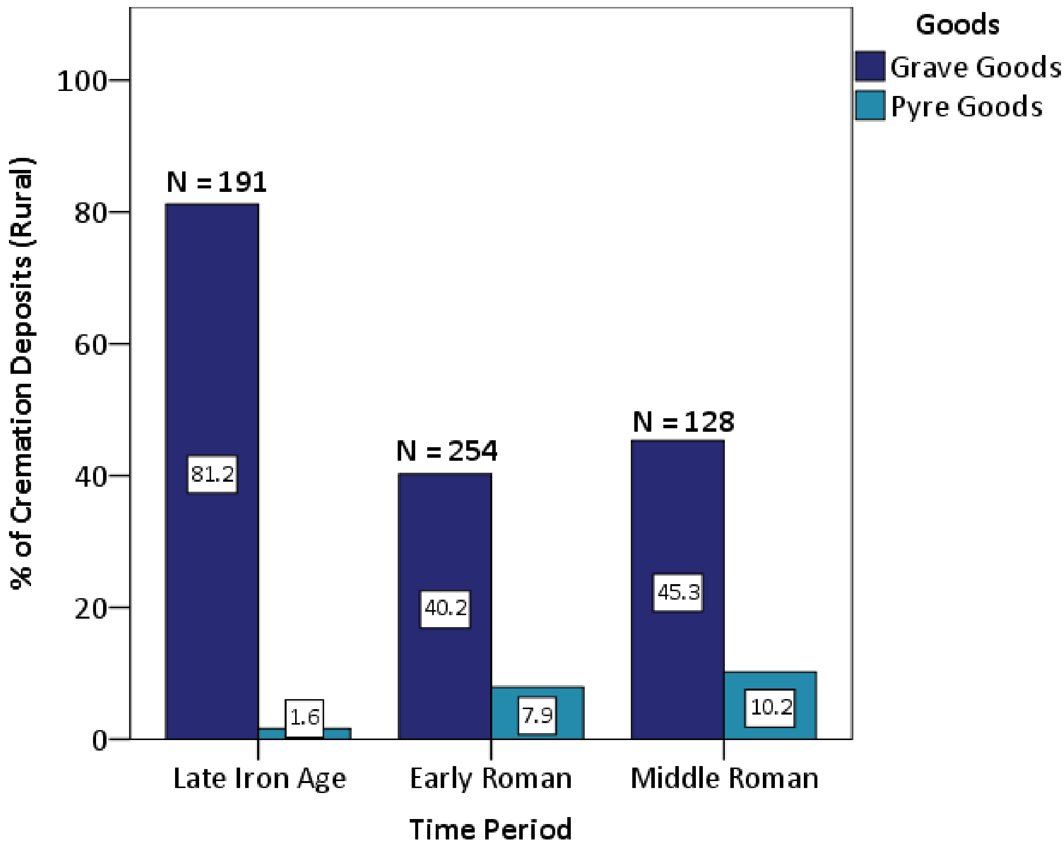


Figure 5.34 Percentage of grave and pyre goods from the Late Iron Age to the Middle Roman period. Pooled data from Rural cemeteries.

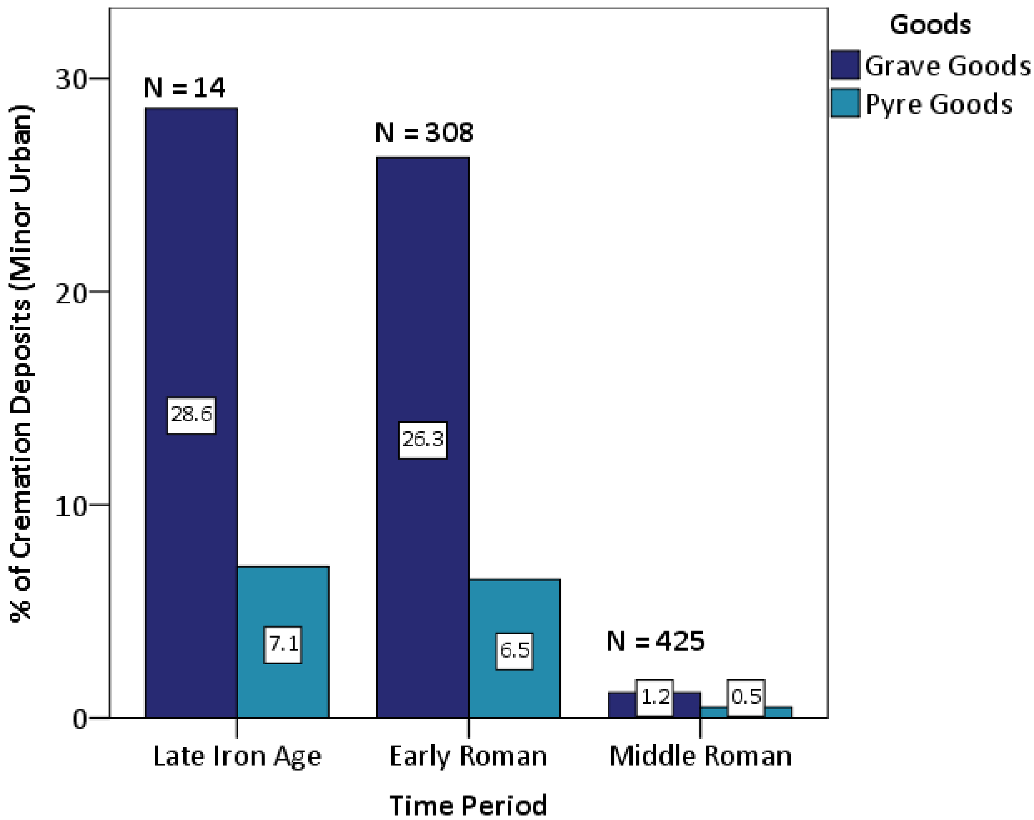


Figure 5.35 Percentage of grave and pyre goods from the Late Iron Age to the Middle Roman period. Pooled data from Minor Urban cemeteries.

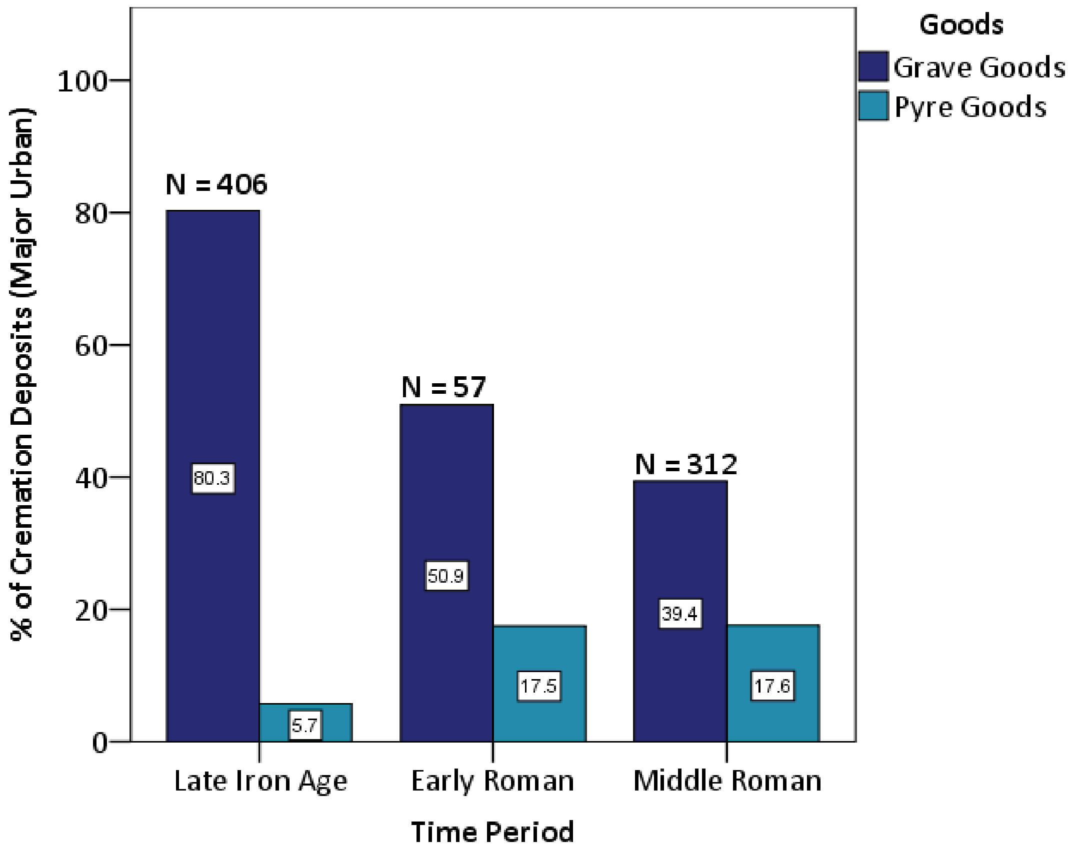


Figure 5.36 Percentage of grave and pyre goods from the Late Iron Age to the Early Roman period. Pooled data from Major Urban cemeteries.

5.6 Summary of Cremation Practices Survey 100BC – 410AD

No cremation deposits dating to the Late Iron Age were recorded for the North, and South-West of the country. Of the 131 cemeteries included in this analysis, the dataset is dominated by eleven large burials grounds that contribute 66.1% (N = 1569 of 2375) of the study sample; their impact is even more pronounced when the data are divided into region, time period, or settlement type, which has in some instances, skewed the results obtained. For every variable examined, the largest proportion of data comes from the South-East. The only exception was the distribution of pyre goods, where the vast majority came from the North-Western cemetery of Brougham. With regards to time period, most of the data collected date to the Middle Roman period. Again, the only exception concerned the distribution of grave and pyre goods that were more prevalent in the Late Iron Age and Late Roman periods, respectively.

Overall, males were more commonly cremated across all regions and settlement types. However, in the Early Roman period a prevalence of female cremation deposits was found in both the South-East and Midlands. In comparison, all sexed individuals from the contemporaneous cemeteries in the South-West were male. This regional difference was significant ($p = 0.006$), but it did not vary according to settlement type. Interestingly, the Middle Roman cemeteries of Yeomanry Drive North, and London, Eastern cemetery, as well as the Late Roman burial ground of Brougham also displayed a predominance of female cremation deposits, contrary to contemporary cemeteries. While these cemeteries vary in both time and space, it may be significant that the osteological analysis of these burial grounds was conducted by the same specialist.

From the Late Iron Age to the Late Roman period, individuals over 18 years of age were more visible across all regions and settlement types. This is to be expected as the survival rate of non-adults in cremation contexts is generally lower due to the fragile nature of their remains and the taphonimc destruction of fire. At the cemeteries of Westhampnett (LIA), Derby Racecourse, Yeomanry Drive North, London, Eastern Cemetery, and Brougham a higher prevalence of 14 – 18 year olds was identified. This result is not easily explained by temporal or spatial trends; however, the osteological analysis of these burial grounds was again conducted by the same specialist.

In both the South-East and Midlands, the primary cremation rite changed from unurned to urned practices in the Early Roman period. The large cemetery of King Harry Lane had an unusually high prevalence of urned burials compared to other Late Iron Age cemeteries. Similarly, the Early Roman cemetery of Derby Racecourse had more unurned burials than most contemporary cemeteries in the

Midlands. This change in burial rite happened across Rural and Major Urban cemeteries. However, unurned practices remained the predominant burial rite at Minor Urban burial grounds until the Middle Roman period; this difference according to settlement type was found to be significant ($p = 0.001$). The large Minor Urban cemeteries of Skeleton Green and Yeomanry Drive North were also found to deviate from 'normal' practices and were skewing the study sample. Interestingly, no pyre sites were recorded for the North and Midlands. These features were recorded from the Late Iron Age to the Middle Roman period at both Rural, Minor and Major Urban cemeteries. In addition, bustum burials were found in the Middle and Late Roman periods, specifically in the South-East and North-West of the country. Again, this burial type was found across all settlement types.

Grave goods were more prevalent than pyre goods from the Late Iron Age to the Middle Roman period. This was the trend for almost all settlement types and regions. The only exception was the Late Roman cemetery of Brougham found in the North-West, where 98% of the cremation deposits included items that were recovered from the funeral pyre. In both the South-East and Midlands from the Early to the Middle Roman period, the number of cremation deposits with grave goods dropped, while the percentage with pyre goods increased. This was generally consistent across most settlement types, excluding Minor Urban cemeteries where the lack of published data from the large burial ground of Yeomanry Drive North is skewing the sample.

Chapter 6: Results - Cremation Technology from Hertfordshire (100BC to AD 410)

6.1 Introduction

A total of 102 individuals from five cemeteries from Hertfordshire dating from the 1st century BC to the 4th century AD were examined for this part of the thesis (see Appendix 1 for list of cemeteries, key references and catalogue of primary data). This primary investigation examines individual cremation deposits that were analysed by the author.

This sample of individuals from Hertfordshire is unevenly distributed in space and time because of the poor quality of the cemetery archives (see section 4.2.1). During data collection it was often the case that burials were not sampled because they could not be found in the museum stores, or because museum stores were closed to researchers. In particular, cremation deposits from rural cemeteries were rarely subject to post-excavation processing; rather, cinerary urns had often been block lifted and not subsequently excavated. This created a bias toward urban individuals in the dataset. For instance, the cremation deposits from the urban cemetery of Wallington Road (Baldock) dominate this study sample (45.1%, N = 46 of 102) because it had the largest assemblage of cremation deposits available for sampling.

6.1.1 Distribution of Study Sample

With regards to settlement type, 46 (45.1%) individuals come from Minor Urban settlements, and 15 (14.7%) derive from Major Urban cemeteries (Table 6.1); all of these data come from Wallington Road, Baldock (N = 46) and Folly Lane, St Albans (N = 15) respectively. Where appropriate they will be pooled together to form a larger, Urban group (see section 4.3.1.9). Apart from Wallington Road and Folly Lane where 59.8% (N = 61) of the data are recorded, this cremation study also includes individuals from the Rural cemeteries of Cross Farm, Harpenden (N = 31), as well as M1 Junction (N = 6), and Spencer Park (N = 4) both near Hemel Hempstead, where 40.2% of the data were recorded (Table 6.1). Chronologically, most individuals date to the Early Roman period (66.7%, N = 68) (Table 6.1). However, only 2 (2%) cremation deposits predate the Roman conquest. Due to this temporal bias, it is not possible to examine chronological differences in cremation technology from Hertfordshire. Sections 6.2 to 6.9 will therefore only discuss the Roman data. Section 6.10 will then compare the general trends identified with the two Late Iron Age individuals from Hertfordshire analysed in this study. Alongside settlement type and cemetery, patterns in relation to sex, age and the number of grave goods will also be examined.

Table 6.1 Number and percentage of all individuals in the cremation technology study.

Time Period							
	Wallington Road	**Folly Lane**	**Cross Farm**	**M1 Junction**	**Spencer Park**	**TOTAL**	**%**
Late Iron Age	1	0	0	1	0	**2**	2
Early Roman	35	13	15	1	4	**68**	66.7
Middle Roman	9	0	16	4	0	**29**	28.4
Late Roman	1	2	0	0	0	**3**	2.9
TOTAL	**46**	**15**	**31**	**6**	**4**	**102**	100
Settlement Type							
Rural	0	0	31	6	4	**41**	40.2
Minor Urban	46	0	0	0	0	**46**	45.1
Major Urban	0	15	0	0	0	**15**	14.7
TOTAL	**46**	**15**	**31**	**6**	**4**	**102**	100
Sex							
Female	14	1	7	0	0	**22**	43.1
Male	15	4	9	0	1	**29**	56.9
TOTAL	**29**	**5**	**16**	**0**	**1**	**51**	100
Age							
< 13	0	0	1	0	0	**1**	1.1
14 – 18	3	0	2	0	0	**5**	5.6
18 +	33	14	28	5	4	**84**	93.3
TOTAL	**36**	**14**	**31**	**5**	**4**	**90**	100
Grave Goods							
1 – 2	29	5	16	2	1	**53**	70.7
3 – 4	4	3	11	0	0	**18**	24
5 – 6	1	2	1	0	0	**4**	5.3
TOTAL	**34**	**10**	**28**	**2**	**1**	**75**	100

6.2 Weight

Overall burned bone weight fluctuates substantially when all the individuals in the cremation technology study are pooled together; the distribution ranges from 1 – 2331.3g with a median weight of 404g (Table 6.2).

No significant difference in weight according to burial type (Kruskal-Wallis: p = 0.401) or between Major and Minor Urban settlements (Mann-Whitney U: p = 0.107) was found. When compared with the individuals from Rural settlements, the difference in weight was significant (Mann-Whitney U: p = 0.019), where the Urban samples had a greater range (1 – 2331.3g) and median weight (474.1g) (Figures 6.1 and 6.2).

With regards to cemetery, burned bone weight between Wallington Road and Spencer Park was significantly different (Kruskal-Wallis U test: p = 0.041) (Table 6.3). The burials from Wallington Road have the greatest range (1.9 – 2331.3g) and median weight (590g) of all the cemeteries examined here. This is most likely caused the Urban-Rural differences. The cremation deposits from Spencer Park however have the smallest distribution of burned bone weight (1.9 – 432.5g) and the lowest median (5.7g), which is partially because this cemetery has the fewest samples (N = 4) (Figure 6.3).

Unsurprisingly, the burned bone weight from male cremation deposits is statistically heavier than females (Mann-Whitney U test: p = 0.029) (Figure 6.4). The males range from 159.7g to 2331.1g with a median weight of 794.4g. The females have a similar distribution of bone weight (62.5 – 1649g), however they have a smaller median (448.1g).

No significant difference in burned bone weight was found according to age (Kruskal-Wallis: p = 0.09), or the number of grave goods (Kruskal-Wallis: p = 0.690) (Figures 6.5 – 6.6).

Table 6.2 Weight data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	515.6	433.3	1	2331.3	2330.3
Unurned	483.7	313.1	1.9	1649	1647.1
Unknown	170.5	170.5	11.4	329.5	318.1
Total	**504.2**	**404**	**1**	**2331.3**	**2330.3**
Settlement Type					
Rural	379.2	272.1	1.9	1276.7	1274.8
Urban	587.5	474.1	1	2331.3	2330.3
TOTAL	**504.2**	**404**	**1**	**2331.3**	**2330.3**
Cemetery					
Wallington Road	631.9	590	1.9	2331.3	2329.4
Folly Lane	454.4	311.6	1	1649	1648
Cross Farm	442.8	315.3	11.4	1276.7	1265.3
M1 Junction	198.9	15.7	9	755.5	746.5
Spencer Park	111.4	5.7	1.9	432.5	430.6
TOTAL	**504.2**	**404**	**1**	**2331.3**	**2330.3**
Sex					
Female	560.9	448.1	62.5	1649	1586.5
Male	825	794.4	159.7	2331.3	2171.6
TOTAL	**708.8**	**668.1**	**62.5**	**2331.3**	**2268.8**
Age					
< 13	72.9	72.9	72.9	72.9	0
14 – 18	798.9	776.9	590	1061.5	471.5
18 +	522.8	376.5	1.9	2331.3	2329.4
TOTAL	**533.2**	**432.5**	**1.9**	**2331.3**	**2329.4**
Grave Goods					
1 – 2	589.5	508.7	1	2331.3	2330.3
3 – 4	556.5	541.6	62.5	1649	1586.5
5 – 6	495.9	252.4	37.5	1441.2	1403.7
TOTAL	**576.4**	**494.6**	**1**	**2331.3**	**2330.3**

Table 6.3 Summary of Kruskal-Wallis pairwise comparison results. Significant values of cemeteries according to weight. * Statistically significant.

Cemetery	Test Statistic	Standard Error	Adjusted Sig.
Spencer Park – M1 Junction	10.475	19.461	1.000
Spencer – Folly Lane	29.408	16.326	0.716
Spencer Park – Cross Farm	31.940	15.413	0.382
Spencer Park – Wallington Road	43.419	15.137	0.041*
M1 Junction – Folly Lane	18.933	14.981	1.000
M1 Junction – Cross Farm	21.465	13.981	1.000
M1 Junction – Wallington Road	32.944	13.676	0.160
Folly Lane – Cross Farm	-2.531	9.125	1.000
Folly Lane – Wallington Road	14.011	8.650	1.000
Cross Farm – Wallington Road	11.480	6.772	0.900

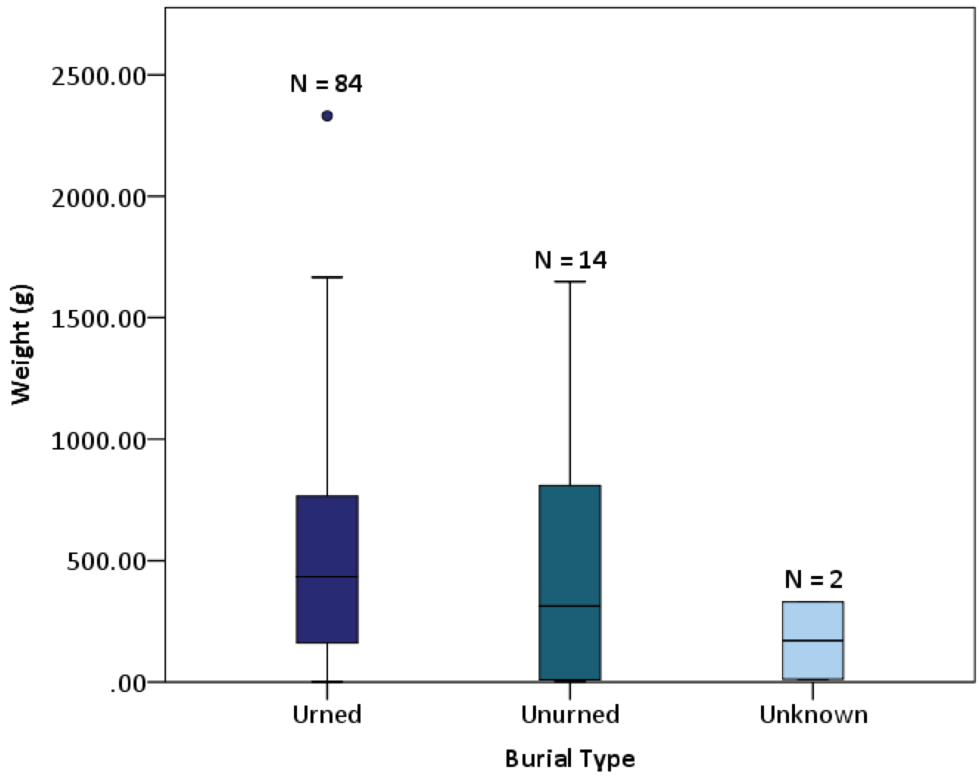


Figure 6.1 Distribution of weight according to burial type. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.2.

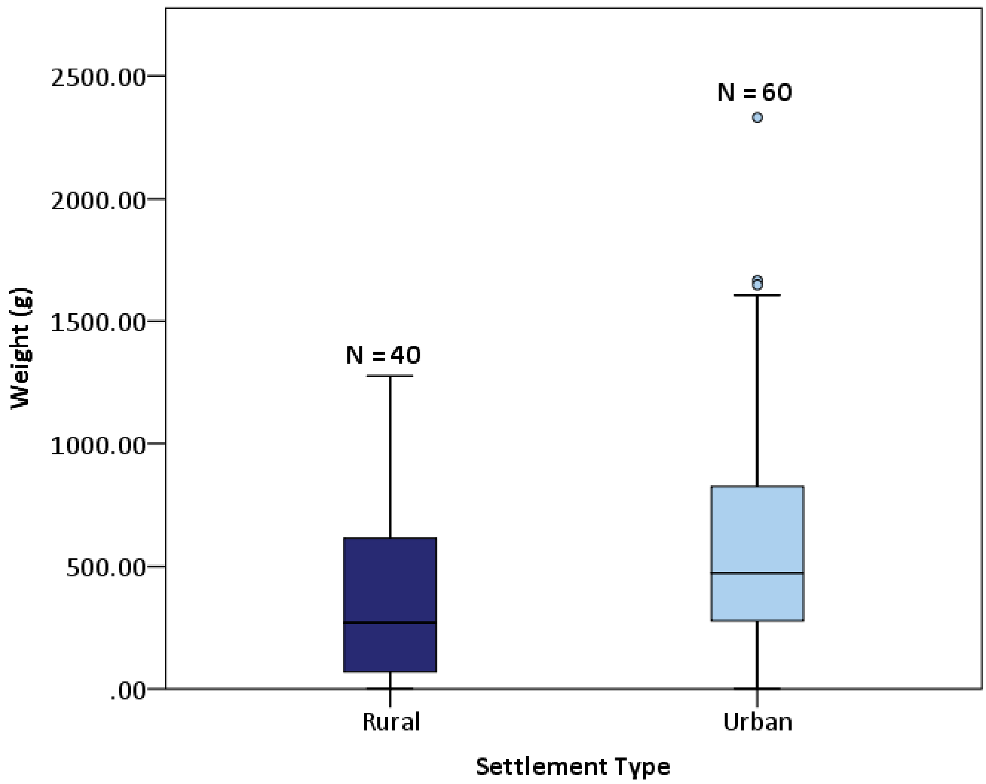


Figure 6.2 Distribution of weight according to settlement type. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.2.

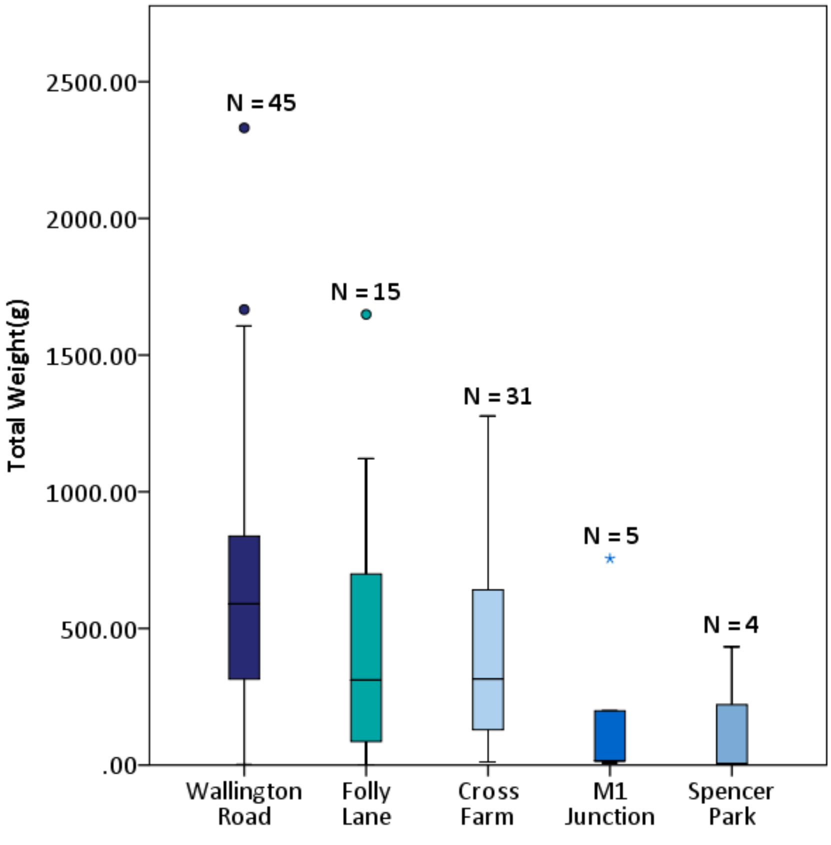


Figure 6.3 Distribution of weight according to cemetery. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.2.

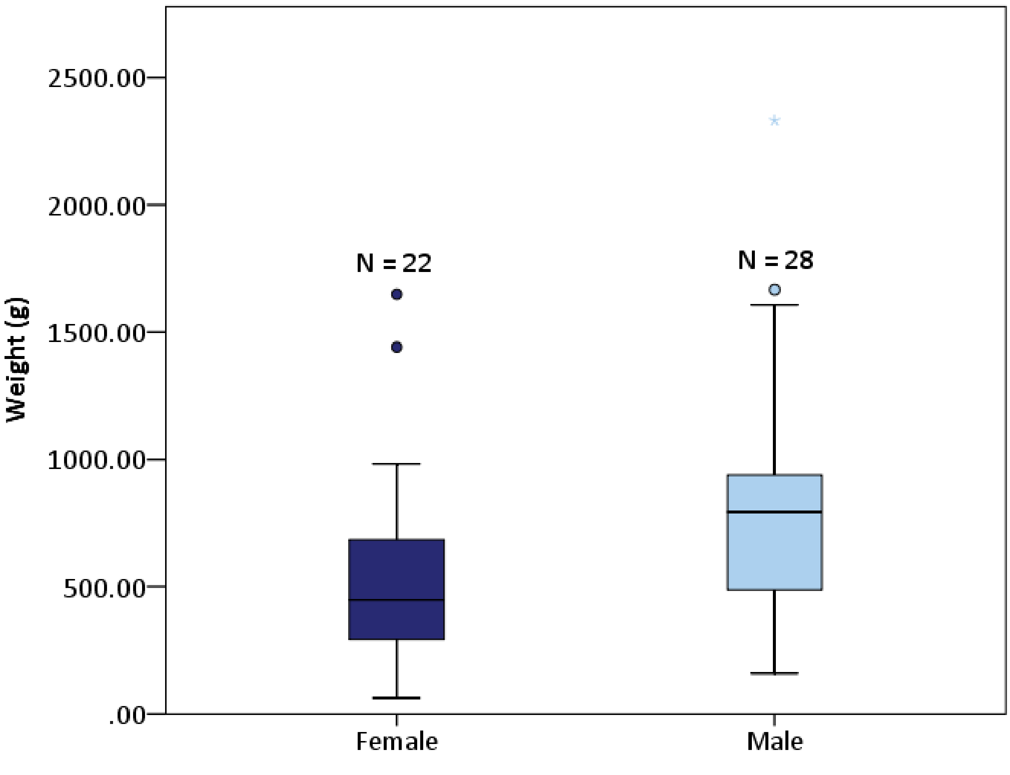


Figure 6.4 Distribution of weight according to sex. Pooled sample of all individuals in cremation technology study, apart from the one Late Iron Age individual. See accompanying table 6.2.

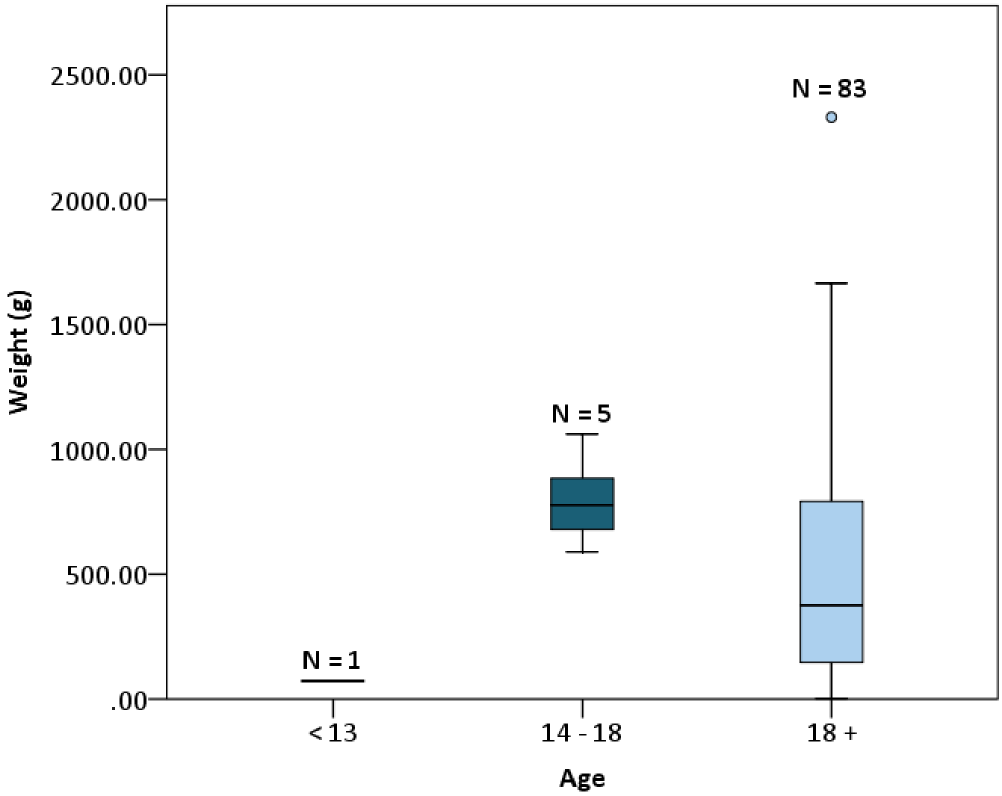


Figure 6.5 Distribution of weight according to age. Pooled sample of all individuals in cremation technology study, apart from the one Late Iron Age individual. See accompanying table 6.2.

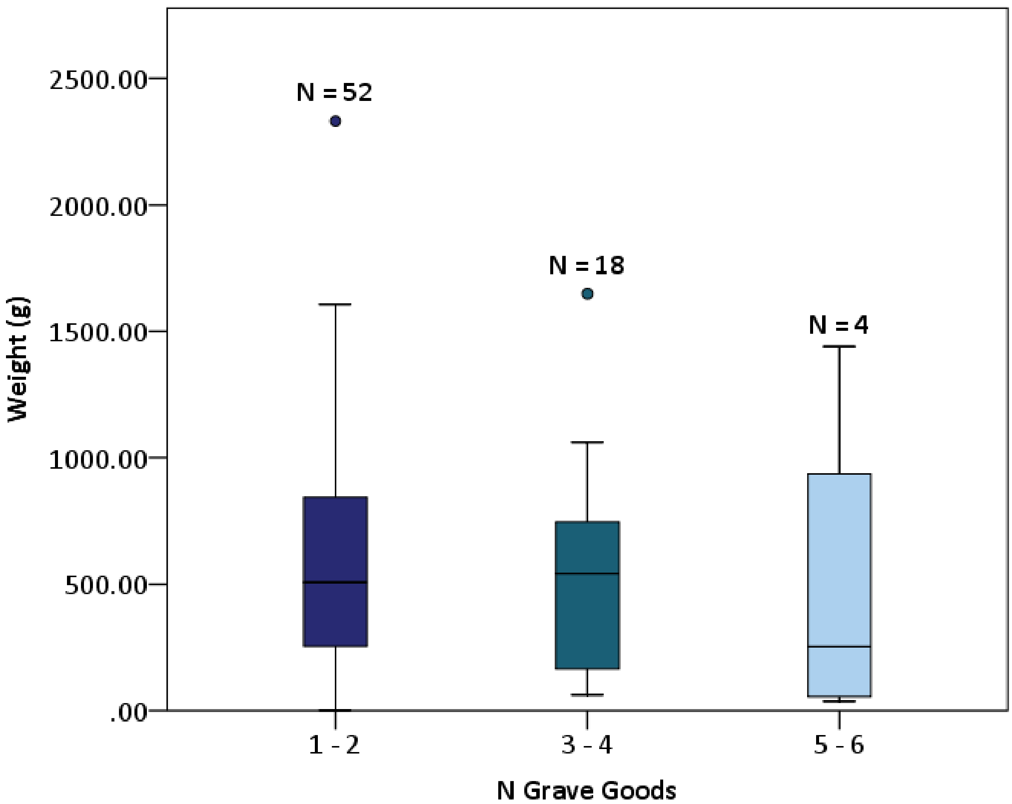


Figure 6.6 Distribution of weight according to number of grave goods. Pooled sample of all individuals in cremation technology study, apart from the one Late Iron Age individual. See accompanying table 6.2.

6.3 Fragmentation

Of the 50418.8g of burned bone examined in this part of the thesis, the majority of the material exceeds 10mm in size (39.9%, 20138g) (Table 6.4 – 6.6). Linear mixed models were performed to establish any differences in fragmentation. For each model enforced variance components were used, whereby the individuals from Hertfordshire were incorporated as the random intercepts, fragmentation was the dependent variable, while the fixed measures were the categorical independent variables examined (burial type, settlement type, cemetery, sex, age, and number of grave goods).

No significant difference in fragmentation between burial types was found (d.f = 190; p = 0.090) (Figure 6.7) (see Appendix 6 for statistic results). Burned bone fragmentation was significantly greater for Minor Urban individuals compared to the Major Urban group (d.f = 112; p = 0.008). When both groups are compared to the Rural sample, the difference was also significant (d.f = 190; p = < 0.001) (Table 6.7). Only 29.2% (4427g of 15167.4g) of the material from the Rural sample exceeded 10mm in size, compared to 43.1% (12245.5g of 28435.6g) of the burned bone from the Minor Urban and 50.8% (3465.5g of 6815.8g) from the Major Urban cremation deposits (Figure 6.8).

With regards to cemetery, the difference in burned bone fragmentation according to cemetery was significant (d.f = 186; p = 0.003) (Table 6.8). At Wallington Road (43.1%, 12245.5g of 28435.6g), Folly Lane (50.8%, 4162.1g of 6815.8g), and Spencer Park (45.3%, 201.8g of 445.7g), the majority of burned bone measured more than 10mm in size. However, a greater proportion of the burned bone from Cross Farm (43.7%, 5996.8 of 13727.1g) and M1 Junction (70.7% of 703.6g of 994.6g) came from the >2mm fraction (Figure 6.9).

Burned bone fragmentation was not significantly different according to sex (d.f = 92; p = 0.603), or the number of grave goods (d.f = 138; p = 0.289) (see Appendix 6 for statistic results) (Figures 6.10 and 6.12). However, fragmentation was significantly different according to age (d.f = 168; p = 0.035) (Table 6.10). 41.5% (17992.2g of 43388.6g) of burned bone from individuals over 18 years of age measured >10mm in size, while the largest proportion of material from the 14 – 18 year olds (52.6%, 2102.1g of 3994.4g) and <13 year olds (58.3%, 42.5g of 72.9g) came from the >2mm fraction (Figure 6.11).

Table 6.4 10mm fragmentation data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	199.1	134.6	0.0	1158.3	1158.3
Unurned	236.2	103	0.0	786.8	786.8
Unknown	54.1	54.1	4.1	104	99.9
Total	**201.4**	**129.4**	**0.0**	**1158.3**	**1158.3**
Settlement Type					
Rural	110.7	48	0.0	678.2	678.2
Minor Urban	272.1	214	1.5	1158.3	1156.8
Major Urban	231	132.3	0.0	786.8	786.8
TOTAL	**201.4**	**129.4**	**0.0**	**1158.3**	**1158.3**
Cemetery					
Wallington Road	272.1	214	1.5	1158.3	1156.8
Folly Lane	231	132.3	0.0	786.8	786.8
Cross Farm	134.3	86	0.0	678.2	678.2
M1 Junction	12.6	3.9	1.0	28	27
Spencer Park	50.5	0.5	0.0	200.8	200.8
TOTAL	**201.4**	**129.4**	**0.0**	**1158.3**	**1158.3**
Sex					
Female	244.5	159.1	14.6	785	770.4
Male	368	330.1	21.7	1158.3	1136.6
TOTAL	**313.7**	**266.8**	**14.6**	**1158.3**	**1143.7**
Age					
< 13	0.0	0.0	0.0	0.0	0.0
14 – 18	223.4	244.7	86	322.3	236.3
18 +	216.8	133.9	0.0	1158.3	1158.3
TOTAL	**214.7**	**135.2**	**0.0**	**1158.3**	**1158.3**
Grave Goods					
1 – 2	261	207.4	0.0	1158.3	1158.3
3 – 4	186.6	91.7	17.9	785	767.1
5 – 6	184.7	56.3	10.5	615.7	605.2
TOTAL	**238.8**	**180.1**	**0.0**	**1158.3**	**1158.3**

Table 6.5 5mm fragmentation data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	116.5	95.8	0.4	474.4	474
Unurned	135.8	96.6	0.90	568.5	567.6
Unknown	56.5	56.5	5	108	103
Total	**118**	**95.8**	**0.40**	**568.5**	**568.1**
Settlement Type					
Rural	98.6	69.7	0.9	330	329.1
Minor Urban	132.2	113.9	0.4	474.4	474
Major Urban	127.1	94.1	1.0	568.5	567.5
TOTAL	**118**	**95.8**	**0.40**	**568.5**	**568.1**
Cemetery					
Wallington Road	115.1	88	5	330	325
Folly Lane	127.1	94.1	1	568.5	567.5
Cross Farm	45.6	8.4	6.8	136.5	129.7
M1 Junction	37.3	2.3	0.9	143.6	142.7
Spencer Park	132.2	113.9	0.4	474.4	474
TOTAL	**118**	**95.8**	**0.40**	**568.5**	**568.1**
Sex					
Female	127.3	99.5	9.5	568.5	559
Male	189.2	171.8	36.5	474.4	437.9
TOTAL	**162**	**141.7**	**9.5**	**568.5**	**559**
Age					
< 13	30.4	30.4	30.4	30.4	0.0
14 – 18	155.1	149.5	71.5	263.6	192.1
18 +	123.7	97.5	0.9	568.5	567.6
TOTAL	**124.5**	**103.2**	**0.9**	**568.5**	**567.6**
Grave Goods					
1 – 2	125.9	106	1	397.5	396.5
3 – 4	150.7	118.2	10.6	568.5	557.9
5 – 6	138.2	107.1	12.7	326	313.3
TOTAL	**132.6**	**111.5**	**1**	**568.5**	**567.5**

Table 6.6 2mm fragmentation data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	200	132.8	0.0	904	904
Unurned	111.7	120.15	0.1	295.5	295.4
Unknown	59.9	59.9	2.3	117.5	115.2
Total	**184.8**	**127**	**0.0**	**904**	**904**
Settlement Type					
Rural	169.9	96.35	0.1	904	903.9
Minor Urban	227.6	198.5	0.0	775.5	775.5
Major Urban	96.3	98.5	0.0	295.5	295.5
TOTAL	**184.8**	**127**	**0.0**	**904**	**904**
Cemetery					
Wallington Road	227.6	198.5	0.0	775.5	775.5
Folly Lane	96.3	98.5	0.0	295.5	295.5
Cross Farm	193.5	126	2.3	904	901.7
M1 Junction	140.7	3.4	1.2	591	589.8
Spencer Park	23.7	3.3	0.1	88.1	88
TOTAL	**184.8**	**127**	**0.0**	**904**	**904**
Sex					
Female	189.2	121.8	1.9	499.5	497.6
Male	267.7	164.3	64	775.5	711.5
TOTAL	**233.2**	**159.6**	**1.9**	**775.5**	**773.6**
Age					
< 13	42.5	42.5	42.5	42.5	0.0
14 – 18	420.4	299.3	251.1	904	652.9
18 +	182.2	126	0.1	775.5	775.4
TOTAL	**194.1**	**128**	**0.1**	**904**	**903.9**
Grave Goods					
1 – 2	202.6	141.8	0.0	775.5	775.5
3 – 4	219.3	155.3	1.9	904	902.1
5 – 6	173	92.2	8.1	499.5	491.4
TOTAL	**205.1**	**150.8**	**0.0**	**904**	**904**

Table 6.7 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for fragmentation and settlement type. *Statistically significant.

Type I Tests of Fixed Effects				
Source	**Numerator d.f**	**Denominator d.f**	**F**	**Sig.**
Random Intercept (Individuals from Hertfordshire	1	95	132.076	0.000
Settlement Type	2	95	3.680	0.029
Fragmentation	2	190	14.502	0.000
Settlement Type * Fragmentation	4	190	5.472	*0.000

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	13426.92057
Intercept (Variance)	16909.75485

Table 6.8 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for fragmentation and cemetery. *Statistically significant.

Type I Tests of Fixed Effects				
Source	**Numerator d.f**	**Denominator d.f**	**F**	**Sig.**
Random Intercept (Individuals from Hertfordshire	1	93	133.336	0.000
Cemetery	4	93	2.584	0.042
Fragmentation	2	186	14.395	0.000
Cemetery * Fragmentation	8	186	3.040	*0.003

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	13527.07815
Intercept (Variance)	16674.39605

Table 6.9 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for fragmentation and cemetery. *Statistically significant.

Type I Tests of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig.
Random Intercept (Individuals from Hertfordshire	1	84	118.835	0.000
Age	2	84	1.351	0.265
Fragmentation	2	168	12.735	0.000
Age* Fragmentation	4	168	2.645	*0.035

Estimates of Covariance Parameters	
Parameter	Estimates
Residual	15625.993130
Intercept (Variance)	18450.728580

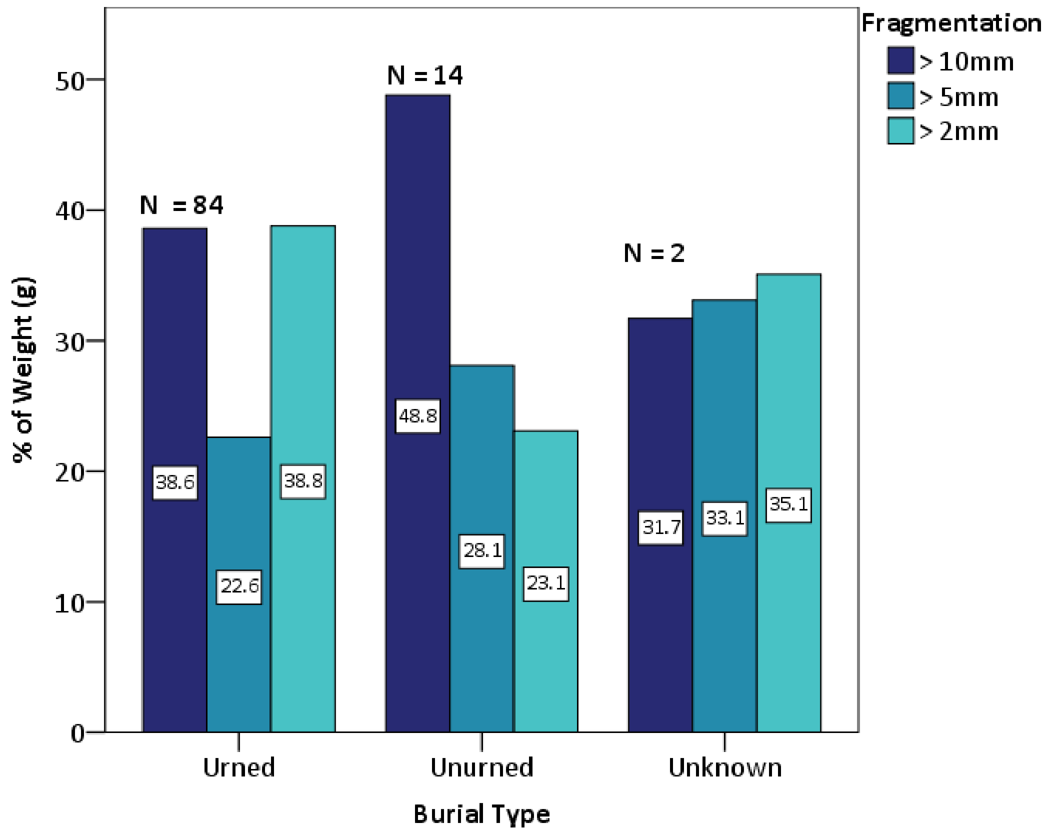


Figure 6.7 Percentage of fragmentation according to burial type. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying tables 6.4 – 6.6.

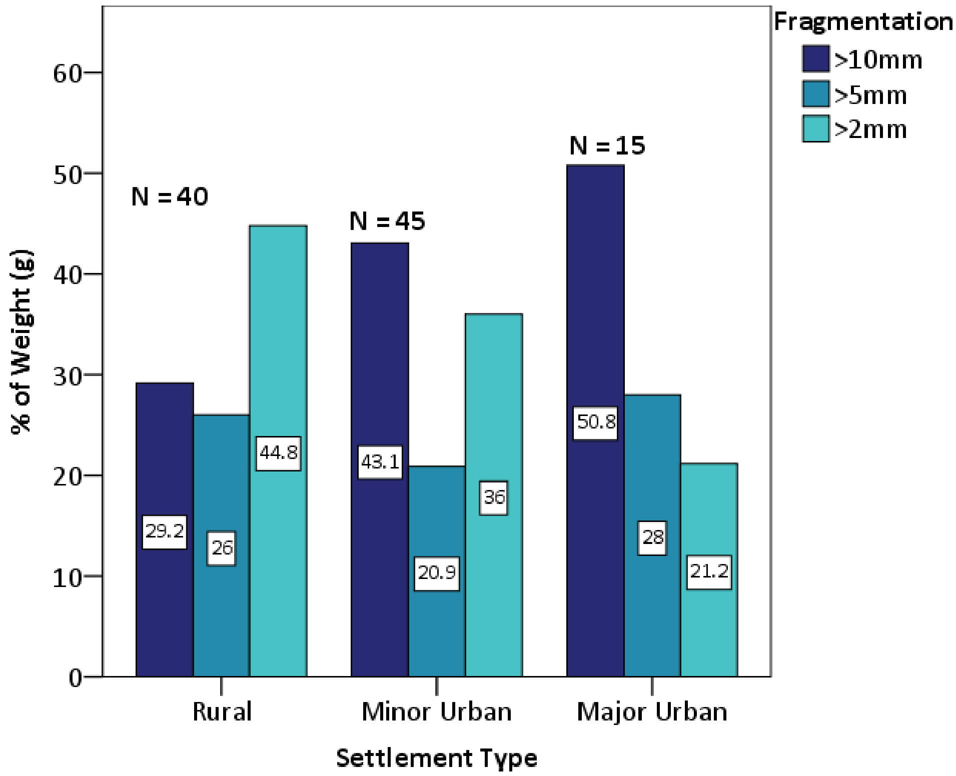


Figure 6.8 Percentage of fragmentation according to settlement type. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying tables 6.4 – 6.6.

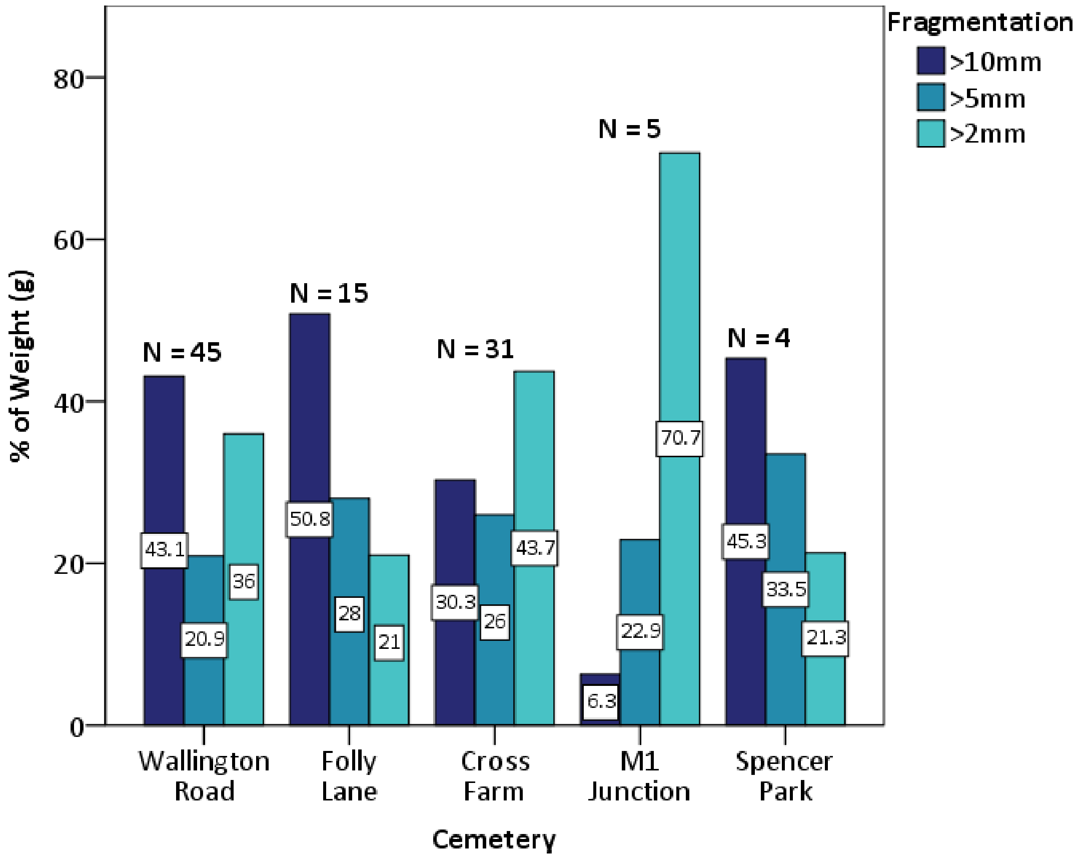


Figure 6.9 Percentage of fragmentation according to cemetery. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying tables 6.4 – 6.6.

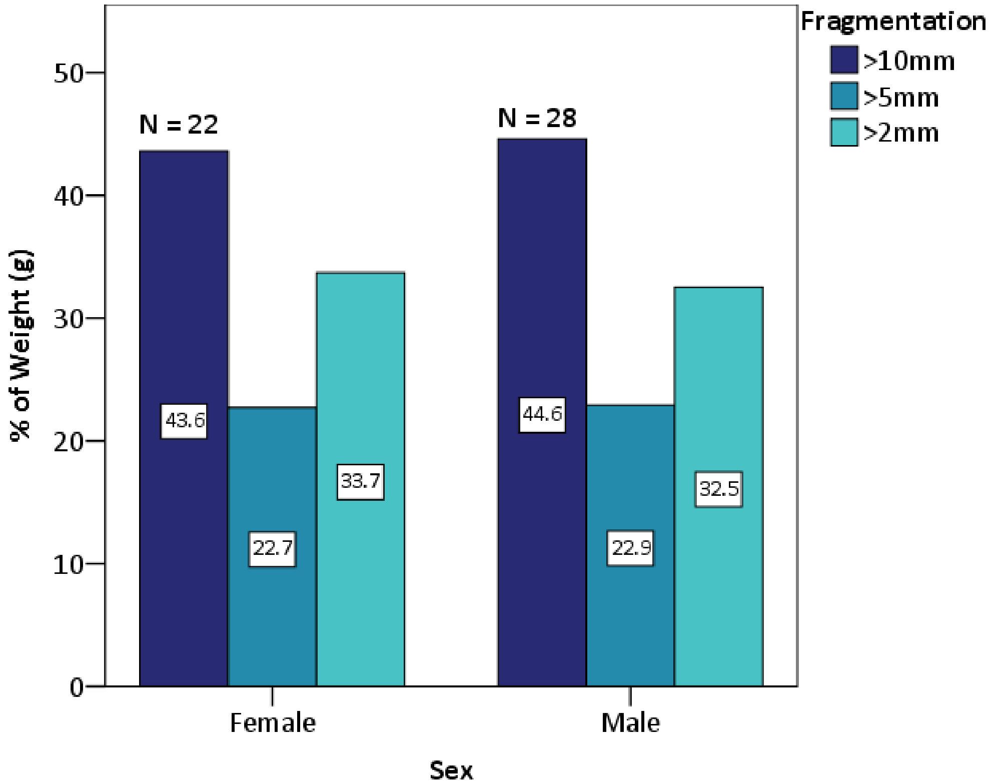


Figure 6.10 Percentage of fragmentation according to sex. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.4 – 6.6.

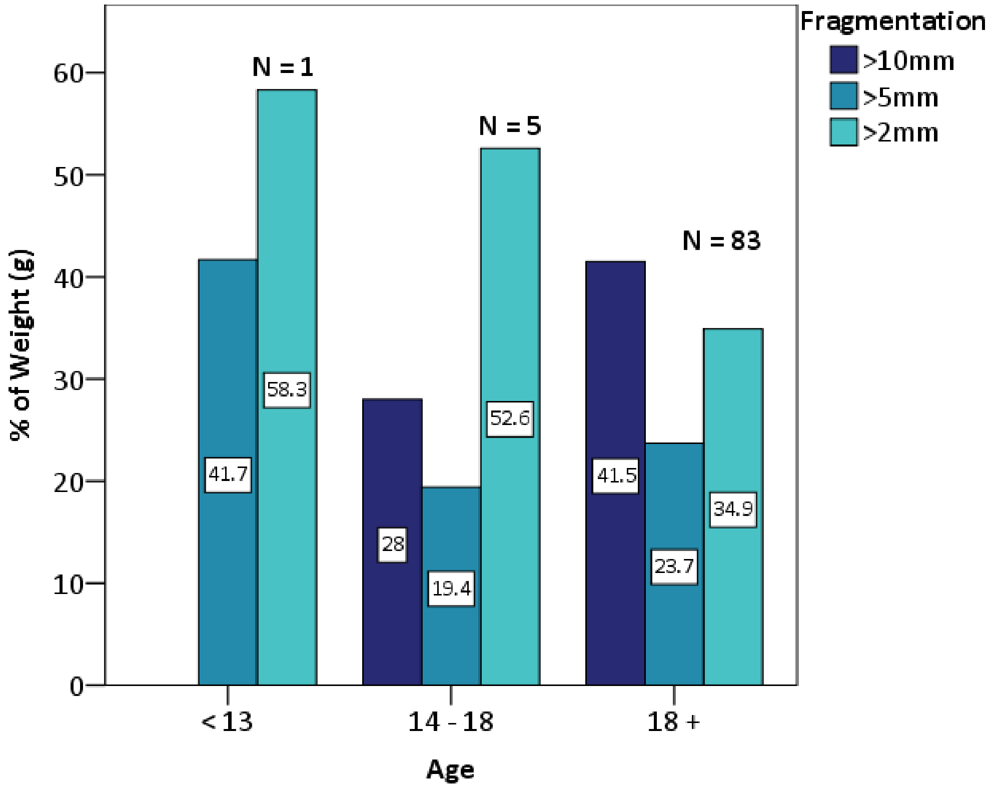


Figure 6.11 Percentage of fragmentation according to age. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.4 – 6.6.

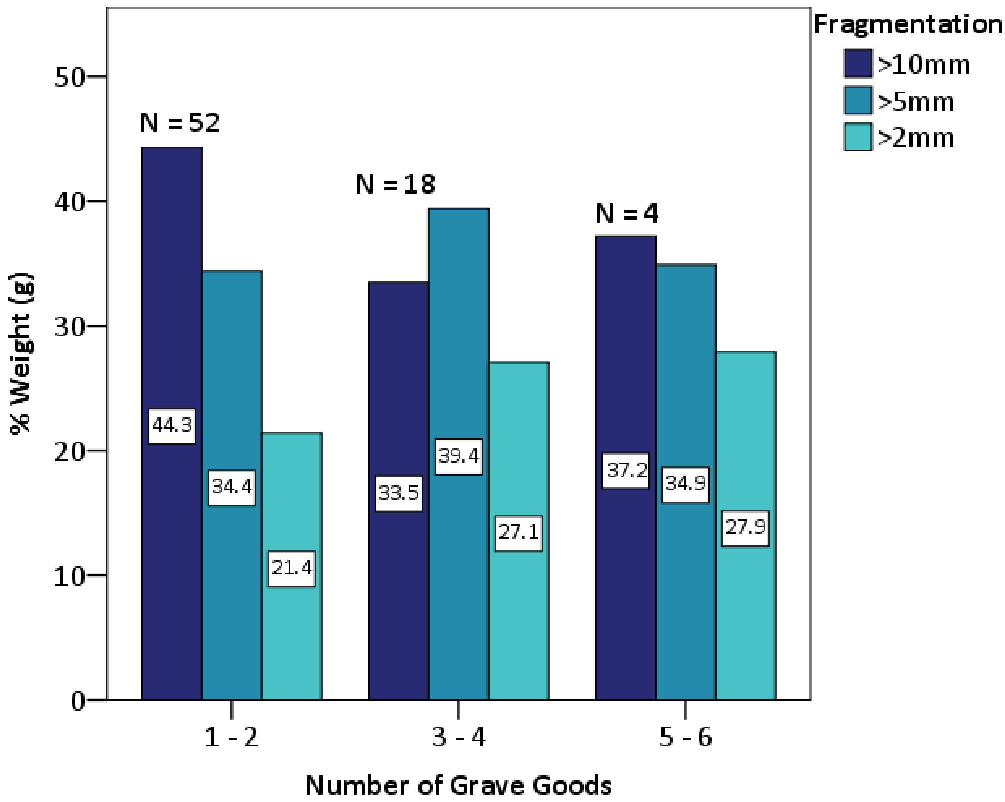


Figure 6.12 Percentage of fragmentation according to the number of grave goods. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.4 – 6.6.

6.4 Skeletal Representation

Of the 50418.8g of burned bone examined in this thesis, 27.7% (13953.9g) was identified to skeletal zone. Overall, the majority of material comes from the lower limbs (33%, 4593.6g), while only 17.9% (2528.7g) of the identified burned bone were cranial fragments. This is unsurprising as the lower limbs are the largest and densest bones in the skeleton (Table 6.10 – 6.13).

Linear mixed models were performed to establish any differences in skeletal representation. For each model enforced variance components were used, whereby the individuals from Hertfordshire were incorporated as the random intercepts and skeletal representation was the dependent variable. The fixed measures were the categorical independent variables examined (burial type, settlement type, cemetery, sex, age, and number of grave goods).

No difference in skeletal representation was found according to burial type (d.f = 285; p = 0.902), settlement type (d.f = 288; p = 0.187), cemetery (d.f = 279; P = 0.568), sex (d.f = 138; p = 0.944), age (d.f = 252; p = 1.000), or the number of grave goods (d.f = 207; p = 0.688) (Figures 6.13 – 6.18 and Appendix 6).

Table 6.10 Skull data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	25	14.3	0.0	208.9	208.9
Unurned	26.9	17.2	0.0	114.2	114.2
Unknown	11.4	11.4	0.7	22	21.3
Total	**25**	**14.3**	**0.0**	**208.9**	**208.9**
Settlement Type					
Rural	20.8	10.0	0.0	142.3	142.3
Urban	27.7	15.6	0.0	208.9	208.9
TOTAL	**25**	**14.3**	**0.0**	**208.9**	**208.9**
Cemetery					
Wallington Road	28.2	16	0.0	208.9	208.9
Folly Lane	26.1	11	0.0	114.2	114.2
Cross Farm	25.8	20.2	0.0	142.3	142.3
M1 Junction	2.6	0.2	0.0	7.4	7.4
Spencer Park	5	0.4	0.0	19.1	19.1
TOTAL	**25**	**14.3**	**0.0**	**208.9**	**208.9**
Sex					
Female	28.9	22.3	2.7	98.5	95.8
Male	44.2	26.4	0.0	208.9	208.9
TOTAL	**37.4**	**24**	**0.0**	**208.9**	**208.9**
Age					
< 13	9	9	9	9	0.0
14 – 18	29.5	35.2	2	58.4	56.4
18 +	27.5	19.1	0.0	208.9	208.9
TOTAL	**27.4**	**19.1**	**0.0**	**208.9**	**208.9**
Grave Goods					
1 – 2	27.4	15.6	0.0	208.9	208.9
3 – 4	32.5	24.9	0.0	98.5	98.5
5 – 6	20.7	19.2	5.8	38.5	32.7
TOTAL	**28.3**	**19.9**	**0.0**	**208.9**	**208.9**

Table 6.11 Axial data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	31.2	15.7	0	404.3	404.3
Unurned	28.3	10.0	0	191.5	191.5
Unknown	9.6	9.6	0.7	18.5	17.8
Total	**30.4**	**14.9**	**0.0**	**404.3**	**404.3**
Settlement Type					
Rural	22.6	5.2	0	404.3	404.3
Urban	35.6	25.4	0.2	191.5	191.3
TOTAL	**30.4**	**14.9**	**0.0**	**404.3**	**404.3**
Cemetery					
Wallington Road	33	25.5	1.1	111	109.9
Folly Lane	43.3	20.7	0.2	191.5	191.3
Cross Farm	27.7	7.7	0	404.3	404.3
M1 Junction	3.8	1.9	1.6	9.5	7.9
Spencer Park	6.1	0.1	0	24.1	24.1
TOTAL	**30.4**	**14.9**	**0.0**	**404.3**	**404.3**
Sex					
Female	36	25.9	0	191.5	191.5
Male	54.8	30.1	2.3	404.3	402
TOTAL	**46.5**	**27.7**	**0**	**404.3**	**404.3**
Age					
< 13	3	3	3	3	0
14 – 18	39.3	26.5	16	97.3	81.3
18 +	33.1	16.5	0	404.3	404.3
TOTAL	**33.1**	**18**	**0**	**404.3**	**404.3**
Grave Goods					
1 – 2	36.9	21.5	0	404.3	404.3
3 – 4	35.7	16.3	0	191.5	191.5
5 – 6	31.2	6.2	1.3	111	109.7
TOTAL	**36.3**	**19.7**	**0**	**404.3**	**404.3**

Table 6.12 Upper Limb data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	39.5	28.5	0	141.5	141.5
Unurned	30.9	30.7	0	78.9	78.9
Unknown	21.7	21.7	5.3	38	32.7
Total	**37.9**	**28.5**	**0**	**141.5**	**141.5**
Settlement Type					
Rural	26.8	10.1	0	124	124
Urban	45.3	39.5	0	141.5	141.5
TOTAL	**37.9**	**28.5**	**0**	**141.5**	**141.5**
Cemetery					
Wallington Road	48.8	44.5	0	141.5	141.5
Folly Lane	34.7	24.2	0	124	124
Cross Farm	31.1	23	0	124	124
M1 Junction	6.3	2.8	1.4	17	15.6
Spencer Park	19.8	1.7	0.3	75.3	75
TOTAL	**37.9**	**28.5**	**0**	**141.5**	**141.5**
Sex					
Female	37.5	39.5	1.8	107	105.2
Male	65.8	67.7	0	141.5	141.5
TOTAL	**53.4**	**48**	**0**	**141.5**	**141.5**
Age					
< 13	8.7	8.7	8.7	8.7	0
14 – 18	39.4	43.6	25	49.9	24.9
18 +	39.7	27.7	0	141.5	141.5
TOTAL	**39.4**	**29.2**	**0**	**141.5**	**141.5**
Grave Goods					
1 – 2	46	40	0	141.5	141.5
3 – 4	34.7	27.1	3	105.7	102.7
5 – 6	39.5	22.1	6.6	107	100.4
TOTAL	**42.9**	**38.8**	**0**	**141.5**	**141.5**

Table 6.13 Lower Limb data of individuals in cremation technology study, excluding the Late Iron Age data.

Burial Type					
	Mean(g)	**Median(g)**	**Minimum(g)**	**Maximum(g)**	**Range(g)**
Urned	46.6	29.3	0	364	364
Unurned	46.8	29.9	0	200.6	200.6
Unknown	10.5	10.5	0	21	21
Total	**45.9**	**29.2**	**0**	**364**	**364**
Settlement Type					
Rural	31.1	15.75	0	109.6	109.6
Urban	55.8	35	0	364	364
TOTAL	**45.9**	**29.2**	**0**	**364**	**364**
Cemetery					
Wallington Road	59.1	36.5	0	364	364
Folly Lane	46	30	0	128	128
Cross Farm	37.2	21	0	109.6	109.6
M1 Junction	5.7	3.7	1.0	10.5	9.5
Spencer Park	15.8	0.1	0	63	63
TOTAL	**45.9**	**29.2**	**0**	**364**	**364**
Sex					
Female	57.6	33.1	2.5	210	207.5
Male	73.7	66.5	3.5	364	360.5
TOTAL	**66.6**	**57.4**	**2.5**	**364**	**361.5**
Age					
< 13	3.7	3.7	3.7	3.7	0
14 – 18	47.3	41.3	14.5	83.2	68.7
18 +	49.4	29.7	0	364	364
TOTAL	**48.7**	**30**	**0**	**364**	**364**
Grave Goods					
1 – 2	63.4	46.4	0	364	364
3 – 4	37.8	22.5	6.5	128	121.5
5 – 6	33.3	8.1	0	117	117
TOTAL	**55.6**	**36.6**	**0**	**364**	**364**

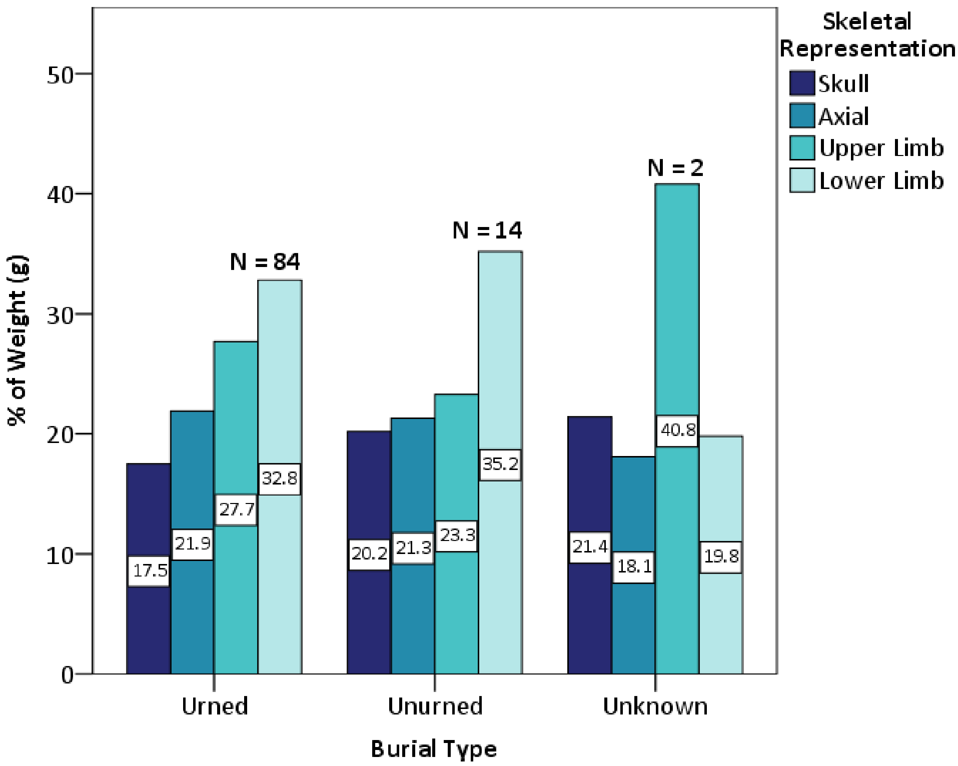


Figure 6.13 Percentage of skeletal representation according to burial type. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying tables 6.10 – 13.

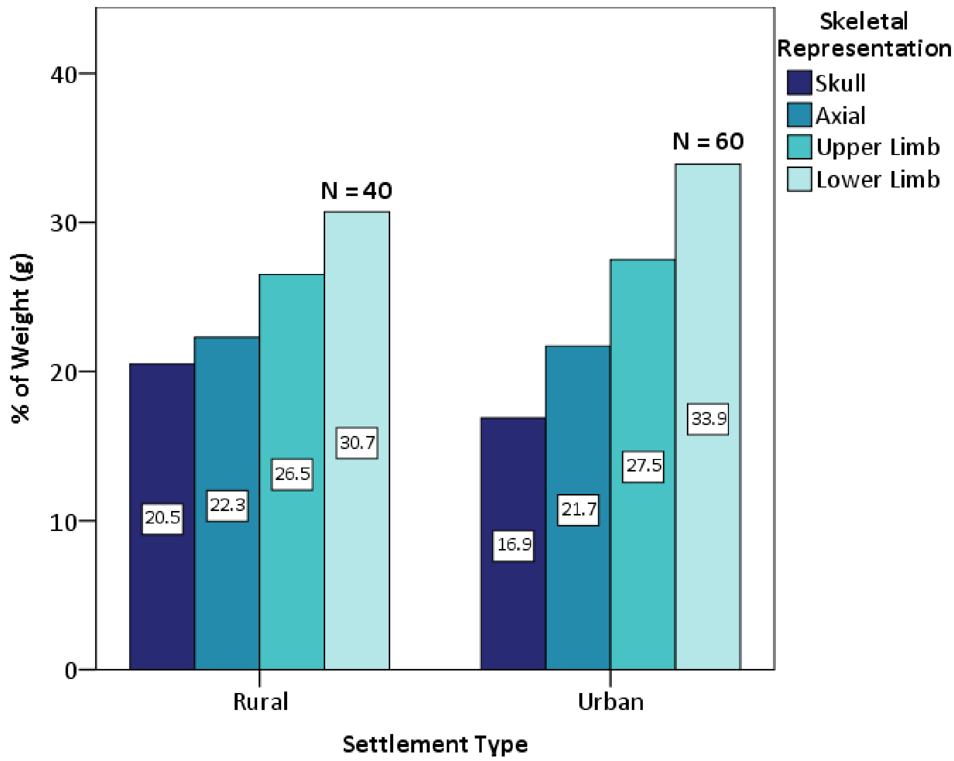


Figure 6.14 Percentage of skeletal representation according to settlement type. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying tables 6.10 – 13.

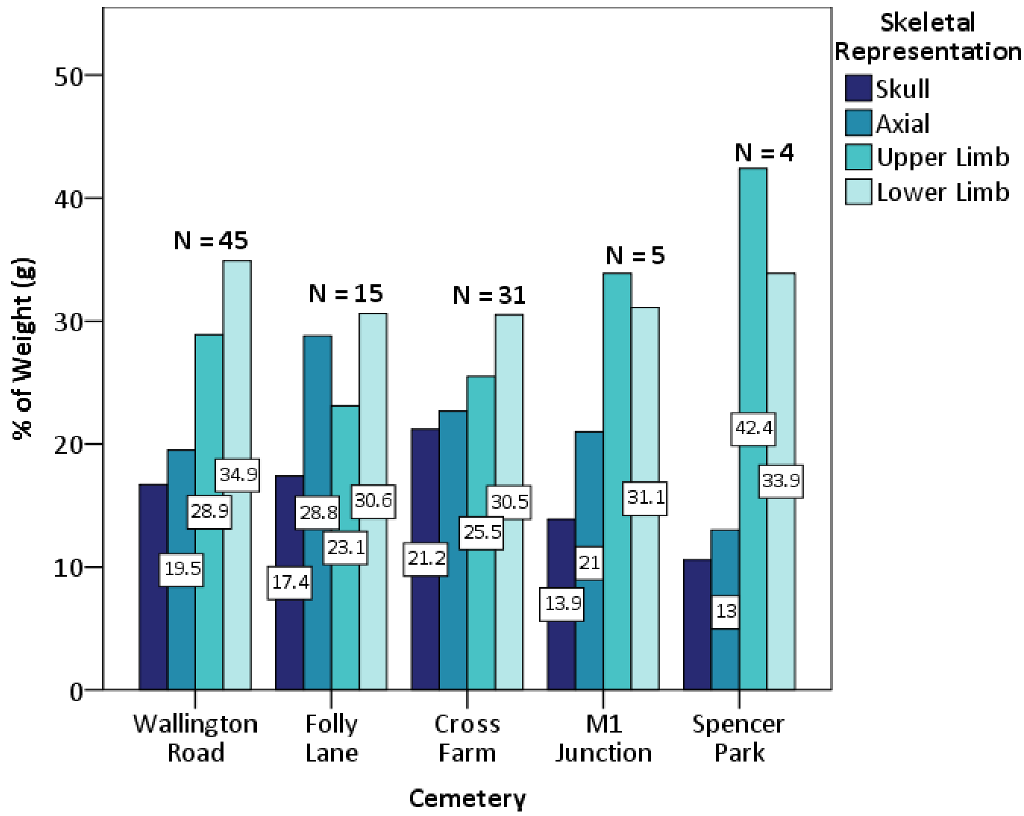


Figure 6.15 Percentage of skeletal representation according to cemetery. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.10 – 13.

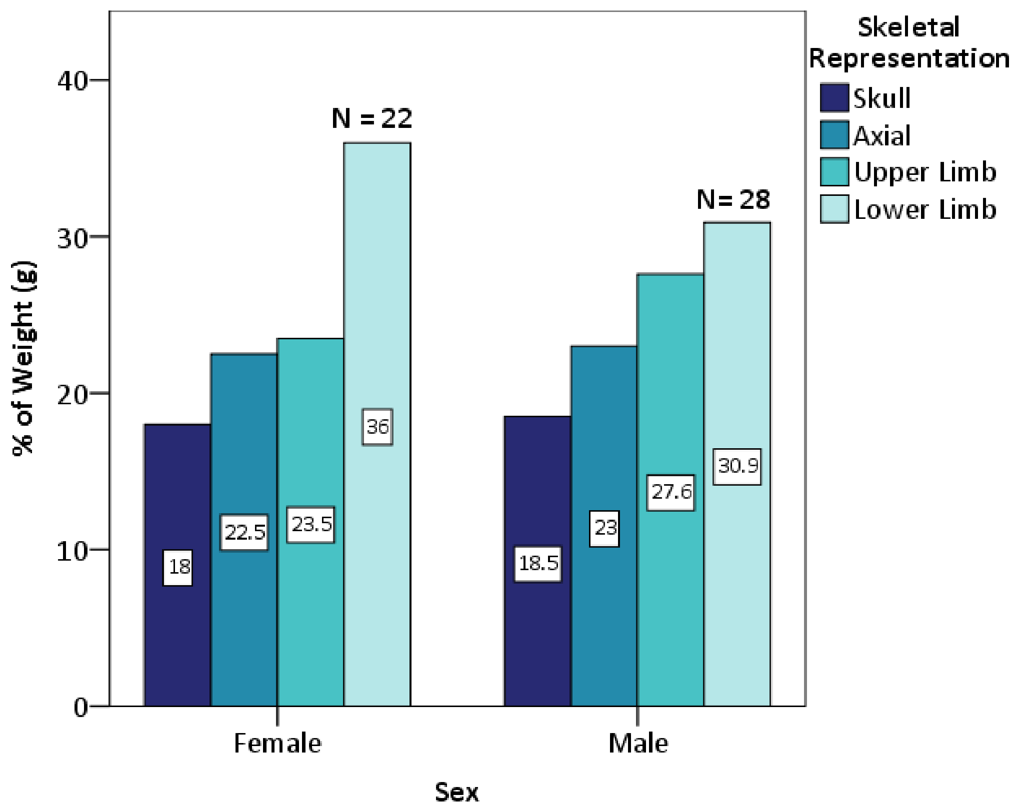


Figure 6.16 Percentage of skeletal representation according to sex. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.10 – 13.

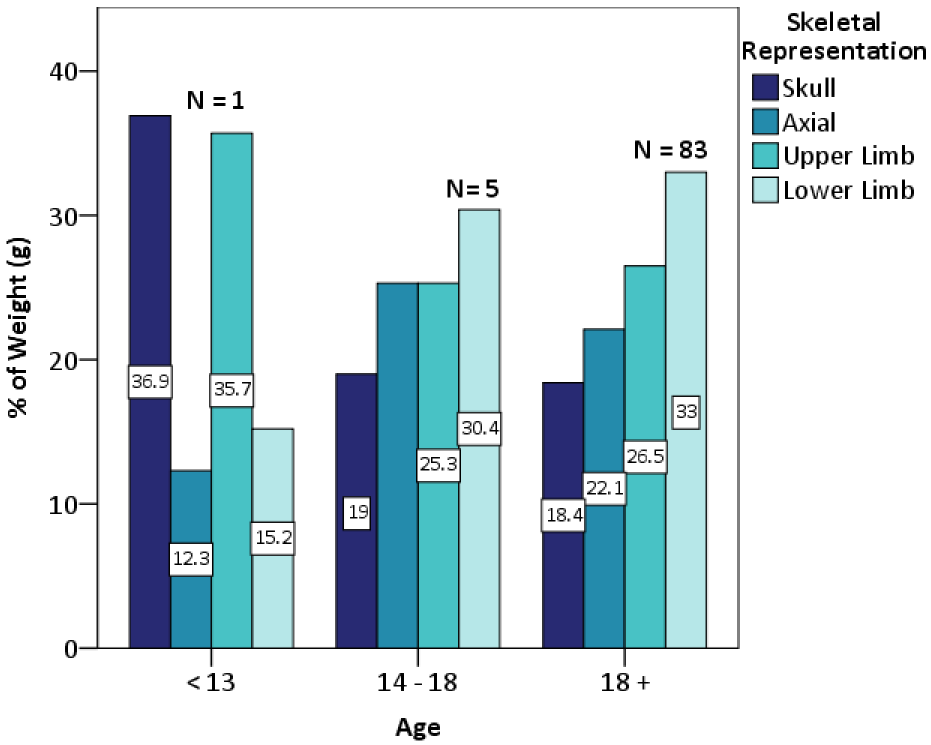


Figure 6.17 Percentage of skeletal representation according to age. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.10 – 13.

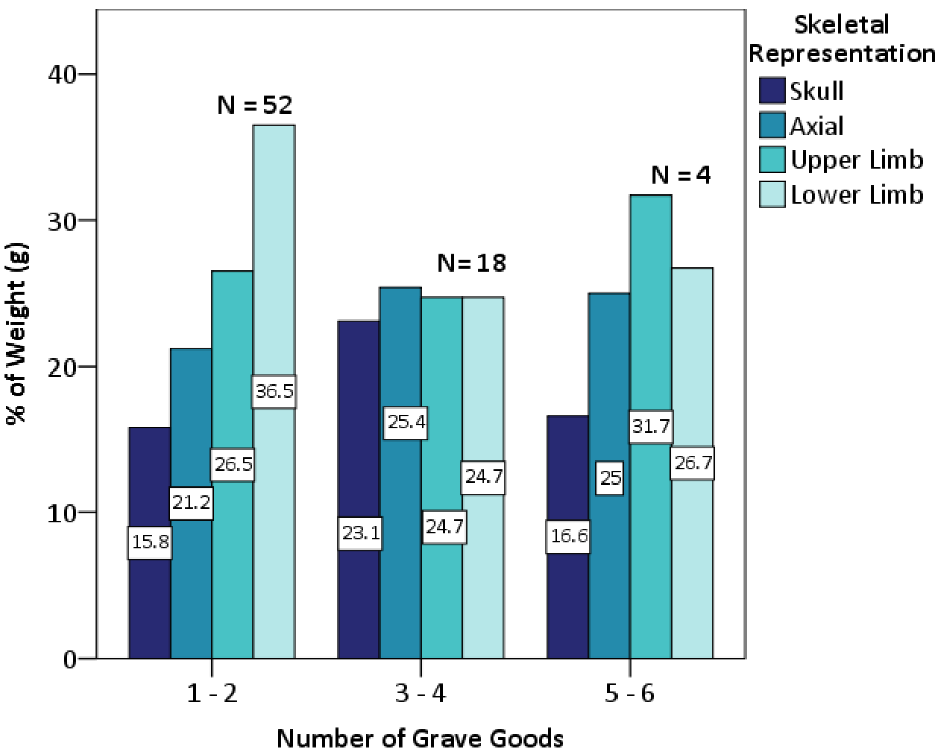


Figure 6.18 Percentage of skeletal representation according to the number of grave goods. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying tables 6.10 – 13.

6.5 Oxidisation of Burned Bone

Colour was analysed using a 7 point scoring system based on the sequential spectrum of colour provided by Thompson et al. (2016) developed from Munro et al., (2007). A score was given to each individual that represented the colour(s) observed (Normal = 1; Brown = 2; Black = 3; Taupe = 4; Grey = 5; Blue = 6; White = 7). If multiple colours were visible in a cremation deposit, the median score was used (see Section 4.3.2.4 and Figure 4.8).

For the 102 individuals examined, the entire spectrum of colour alteration was recorded ranging from brown to white, indicative of incomplete oxidisation (Table 6.14). White was the predominant colour; however, black (charring) was recorded for 8 individuals.

No significant differences in colour was found between the Major and Minor samples (Mann-Whitney U: $p = 0.107$). When compared to the Rural sample, colour was significantly different ($p = < 0.001$). The individuals from the Urban cemeteries displayed a greater range of macroscopic alteration, ranging from black to white. In comparison, the individuals from the Rural sample clustered towards the higher end of the colour spectrum representing mostly grey, blue and white colours (Figure 6.19).

With regards to cemetery, a Kruskal-Wallis pairwise comparison found that macroscopic colour differed significantly between Wallington Road and Cross Farm ($p = 0.043$) (Table 6.15). The individuals from Cross Farm displayed mostly grey to white colouration, while the burials from Wallington Road were more diverse indicating incomplete oxidisation caused by inefficient firing (Figure 6.20).

No difference in macroscopic colour were found according to sex (Mann-Whitney U: $p = 0.134$), age group (Kruskal-Wallis U: $p = 0.489$) or relating to grave goods (Kruskal-Wallis U: $p = 0.966$) indicating uniform oxidisation (Figures 6.21 – 6.23).

Table 6.14 Macroscopic colour scores for individuals in cremation technology study, excluding the Late Iron Age data.

Settlement Type							
	Normal	**Brown**	**Black**	**Taupe**	**Grey**	**Blue**	**White**
Rural	0	0	0	0	2	37	1
Urban	0	0	0	1	21	37	1
TOTAL	**0**	**0**	**0**	**1**	**23**	**74**	**2**
Cemetery							
Wallington Road	0	0	0	1	15	28	1
Folly Lane	0	0	0	0	6	9	0
Cross Farm	0	0	0	0	2	28	1
M1 Junction	0	0	0	0	0	5	0
Spencer Park	0	0	0	0	0	4	0
TOTAL	**0**	**0**	**0**	**1**	**23**	**74**	**2**
Sex							
Female	0	0	0	0	3	19	0
Male	0	0	0	1	9	17	1
TOTAL	**0**	**0**	**0**	**1**	**12**	**36**	**1**
Age							
< 13	0	0	0	0	0	1	0
14 – 18	0	0	0	0	2	3	0
18 +	0	0	0	1	15	66	1
TOTAL	**0**	**0**	**0**	**1**	**17**	**70**	**1**
Grave Goods							
1 – 2	0	0	0	0	14	37	1
3 – 4	0	0	0	0	4	14	0
5 – 6	0	0	0	0	1	3	0
TOTAL	**0**	**0**	**0**	**0**	**19**	**54**	**1**

Table 6.15 Summary of Kruskal-Wallis pairwise comparison results. Significant values of cemeteries according to macroscopic colour. * Statistically significant.

Cemetery	Test Statistic	Standard Error	Adjusted Sig.
Folly Lane – Wallington Road	2.733	6.602	1.000
Folly Lane – Cross Farm	-17.497	6.965	0.120
Folly Lane – M1 Junction	-19.400	11.436	0.898
Folly Lane – Spencer Park	-19.400	12.462	1.00
Wallington Road – Cross Farm	-14.763	5.169	0.043*
Wallington Road – M1 Junction	-16.667	10.439	1.000
Wallington Road – Spencer Park	-16.667	11.554	1.000
Cross Farm – M1 Junction	-1.903	10.672	1.000
Cross Farm – Spencer Park	-1.903	11.765	1.000
M1 Junction – Spencer Park	0.000	14.855	1.000

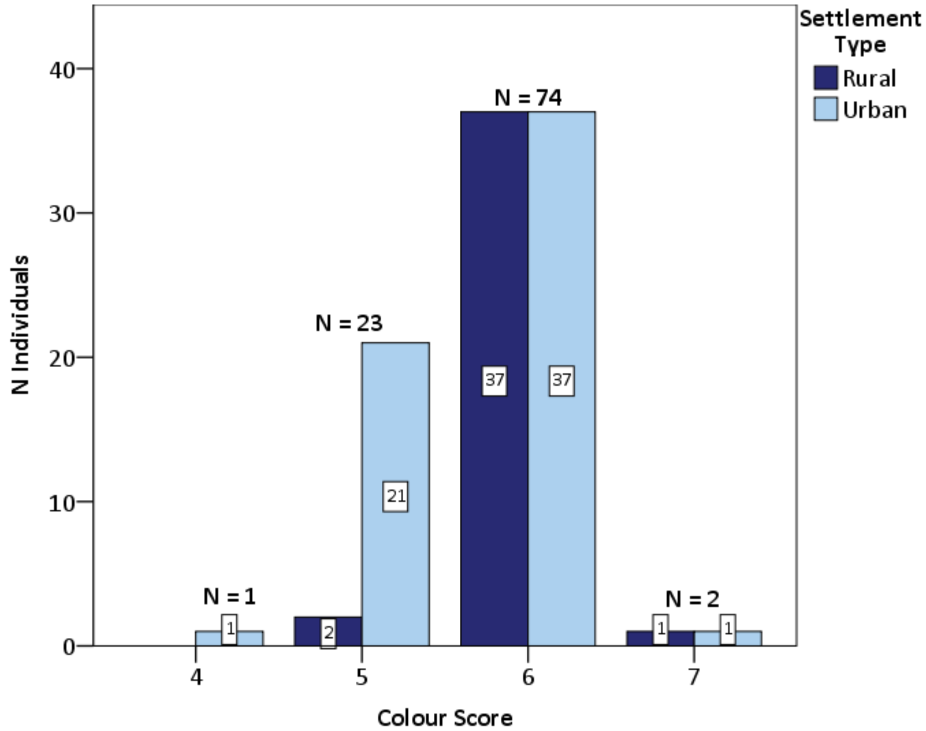


Figure 6.19 Colour score according to settlement type. Normal = 1; Brown = 2; Black = 3; Taupe = 4; Grey = 5; Blue = 6; White = 7. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.14.

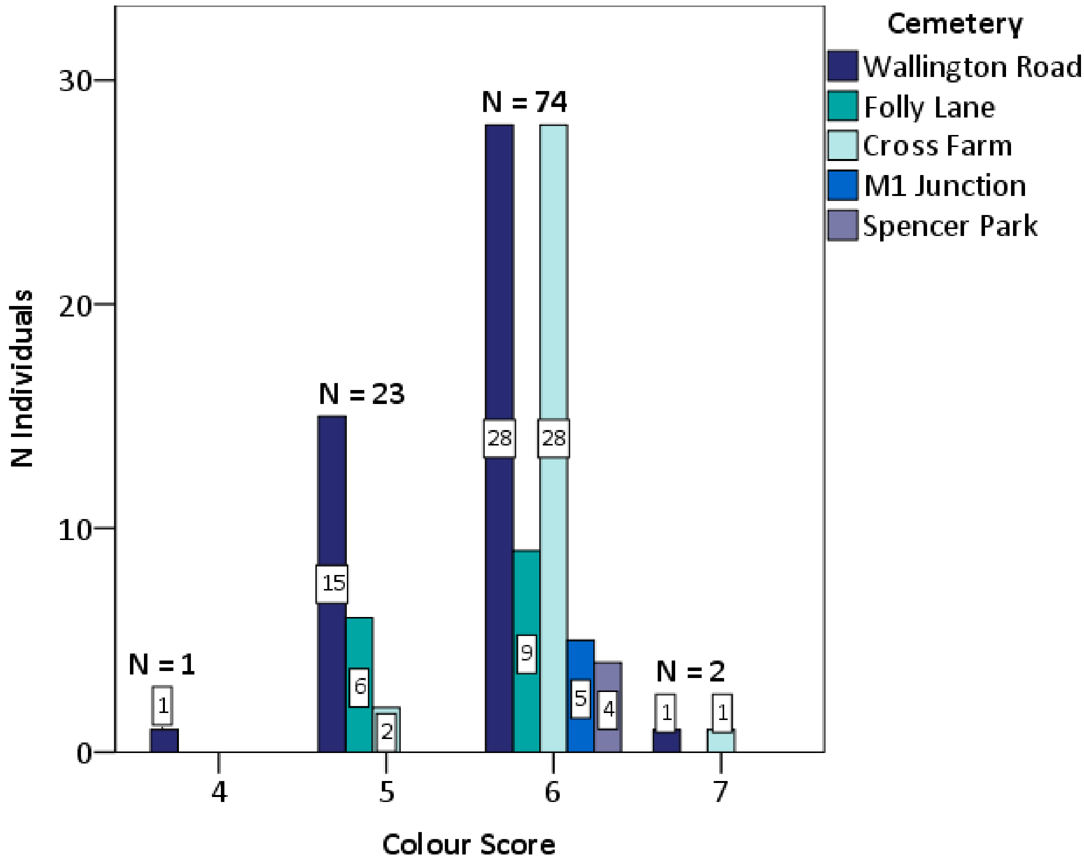


Figure 6.20 Colour score according to cemetery. Normal = 1; Brown = 2; Black = 3; Taupe = 4; Grey = 5; Blue = 6; White = 7. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.14.

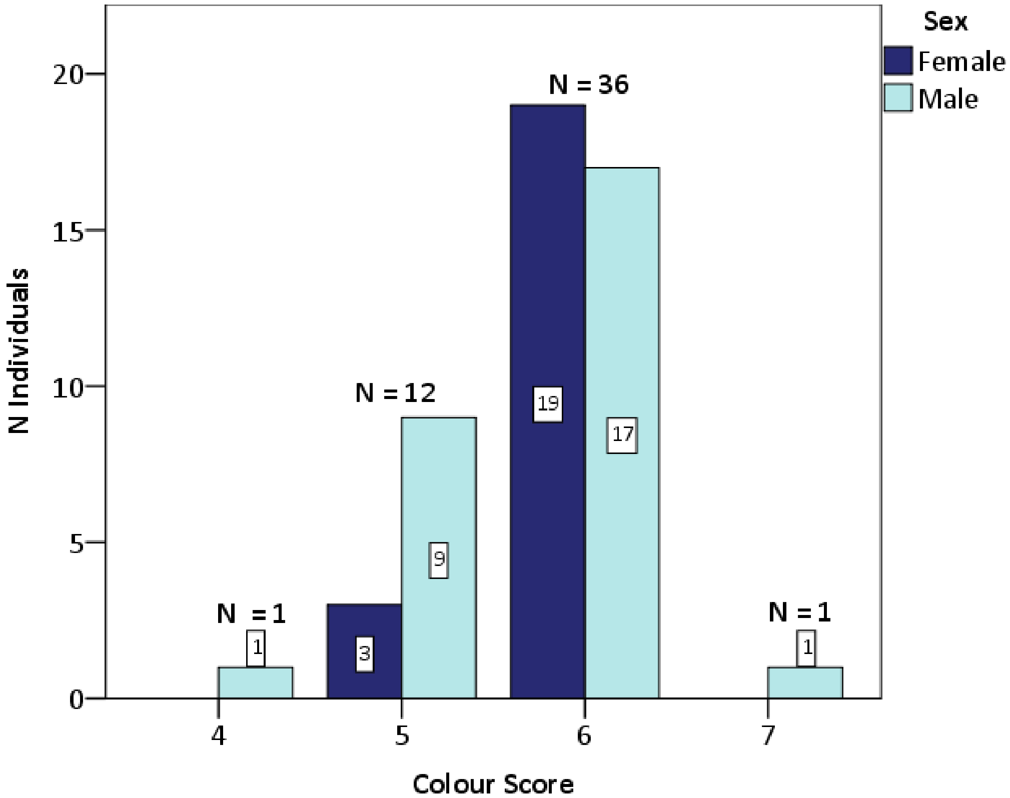


Figure 6.21 Colour score according to sex. Normal = 1; Brown = 2; Black = 3; Taupe = 4; Grey = 5; Blue = 6; White = 7. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.14.

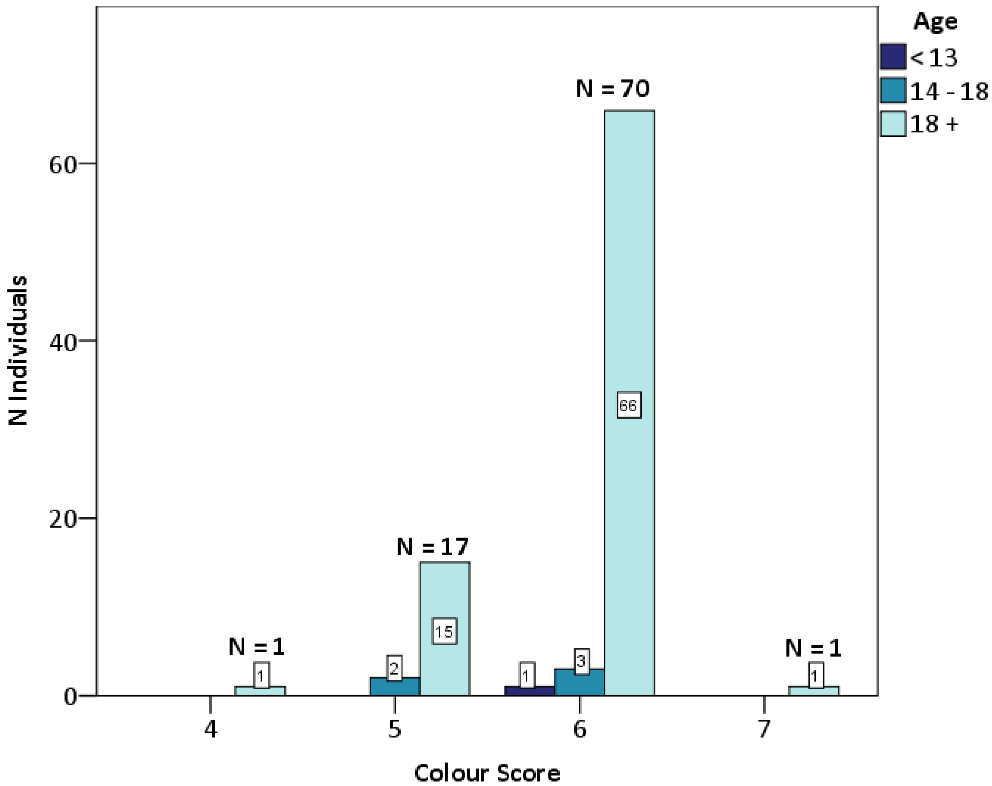


Figure 6.22 Colour score according to age. Normal = 1; Brown = 2; Black = 3; Taupe = 4; Grey = 5; Blue = 6; White = 7.Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.14.

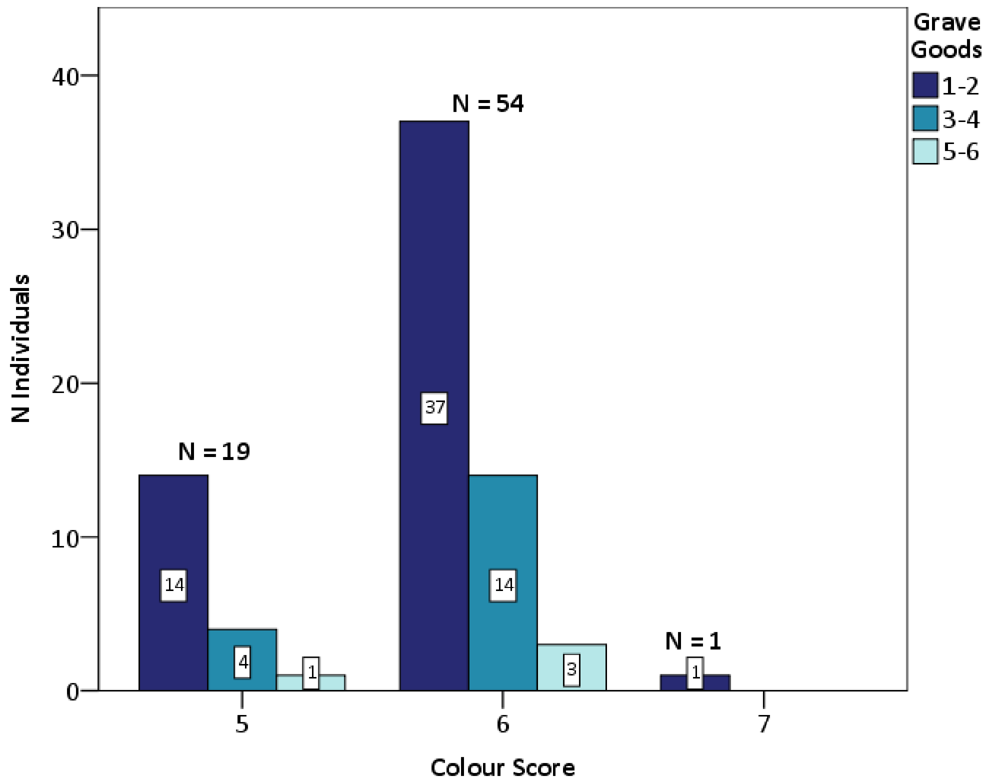


Figure 6.23 Colour score according to the number of grave goods. Normal = 1; Brown = 2; Black = 3; Taupe = 4; Grey = 5; Blue = 6; White = 7. Pooled sample of all individuals in cremation technology study, apart from the two Late Iron Age individuals. See accompanying table 6.14.

6.6 Histological Changes to Burned Bone

A score was assigned to each individual that represented the category of burning intensity achieved. These included: 1 = Less Intensely Cremated (300°C - 600°C). 2 = Intensely Cremated (600°C - 900°C). 3 = Completely Cremated (900°C+). These ranked scores were taken from the criterion provided by Squires et al. (2011) (see Section 4.3.2.7.3).

Overall, burned bone microstructure varies from the preservation of organic material to the complete fusion of hydroxyapatite crystals; indicating temperatures ranging from 300˚C to 900˚C+, with the majority of individuals (63%, N = 63) falling into the completely cremated category (900˚C+) (Table 6.16).

No difference in histology was identified between the Major and Minor Urban individuals (Mann-Whitney U: p = 0.239). When the urban samples are compared to the Rural individuals, the microscopic alterations between the two settlement types are significantly different (Mann-Whitney U: p = < 0.001). The Rural sample displays fewer Haversian systems and Volkmann's Canals', with 85% (N = 34) reaching temperatures of at least 900°C. However, the microscopic preservation of the Urban individuals is far more diverse and ranges from Less Intensely Cremated to Completely Cremated (300˚C – 900˚C+) (Figure 6.24).

In relation to cemetery, a Kruskal-Wallis pairwise comparison found that the microstructure of the individuals from Wallington Road and Cross Farm are significantly different (p = 0.008) (Table 6.17). The Wallington Road samples showed greater diversification of microscopic features, with two individuals with organic material indicative of relatively low temperatures between 300°C and 600°C (Less Intensely Cremated). However, the individuals from Cross Farm display more hydroxyapatite fusion, which suggests higher burning temperatures overall (Figure 6.25).

A Mann-Whitney U test found no difference in histology according to sex (p = 0.964), while a Kruskal-Wallis test found no difference according to age (p = 0.427) or the number of grave goods (p = 0.821) (Figures 6.26 – 6.28).

Table 6.16 Histological scores for individuals in cremation technology study, excluding the Late Iron Age data.

	Less Intensely Cremated (300˚C - 600˚C)	Intensely Cremated (600˚C - 900˚C)	Completely Cremated (900˚C+)
Settlement Type			
Rural	0	6	34
Urban	4	27	29
TOTAL	**4**	**33**	**63**
Cemetery			
Wallington Road	2	24	19
Folly Lane	2	3	10
Cross Farm	0	6	25
M1 Junction	0	0	5
Spencer Park	0	0	4
TOTAL	**4**	**33**	**63**
Sex			
Female	0	10	12
Male	2	10	16
TOTAL	**2**	**20**	**28**
Age			
< 13	0	0	1
14 – 18	0	3	2
18 +	3	25	55
TOTAL	**3**	**28**	**58**
Grave Goods			
1 – 2	1	21	30
3 – 4	1	5	12
5 – 6	0	2	2
TOTAL	**2**	**28**	**44**

Table 6.17 Summary of Kruskal-Wallis pairwise comparison results. Significant values of cemeteries according to histology. * Statistically significant.

Cemetery	Test Statistic	Standard Error	Adjusted Sig.
Wallington Road – Folly Lane	-10.089	7.309	1.000
Wallington Road – Cross Farm	-19.265	5.722	0.008*
Wallington Road – M1 Junction	-28.556	11.556	0.135
Wallington Road – Spencer Park	-28.556	12.791	0.256
Folly Lane – Cross Farm	-9.176	7.710	1.000
Folly Lane – M1 Junction	-18.467	12.659	1.000
Folly Lane – Spencer Park	-18.467	13.795	1.000
Cross Farm – M1 Junction	-9.290	11.814	1.000
Cross Farm – Spencer Park	-9.290	13.024	1.000
M1 Junction - Spencer Park	0.000	16.445	1.000

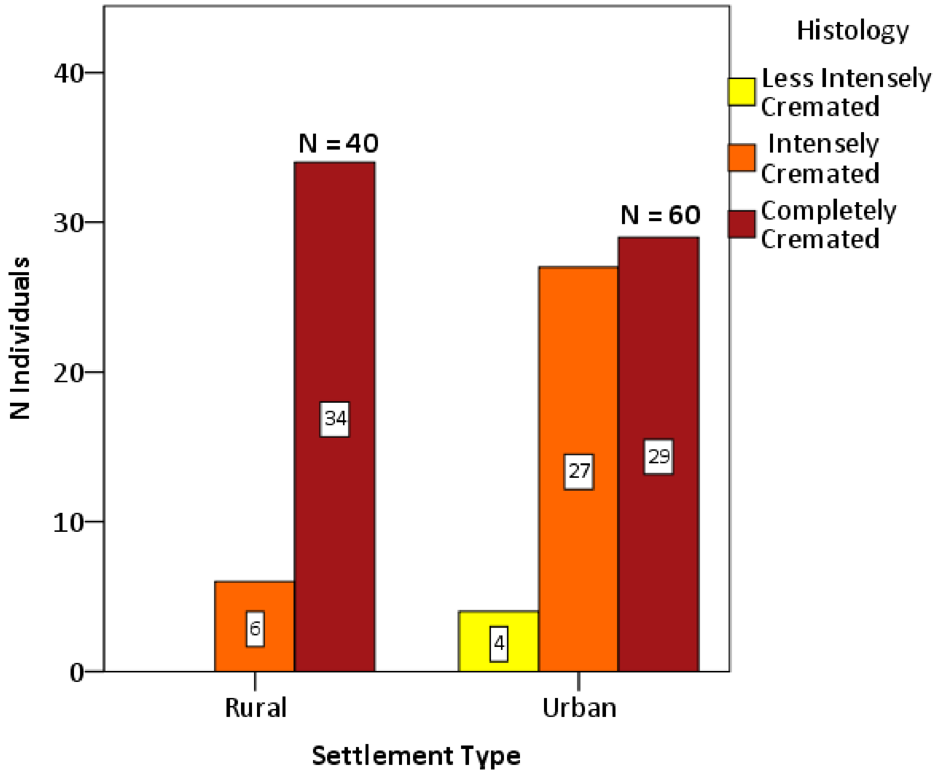


Figure 6.24 Histological scores according to settlement type. 1 = Less Intensely Cremated (300°C – 600°C). 2 = Intensely Cremated (600°C – 900°C). 3 = Completely Cremated (900°C+). Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying table 6.16.

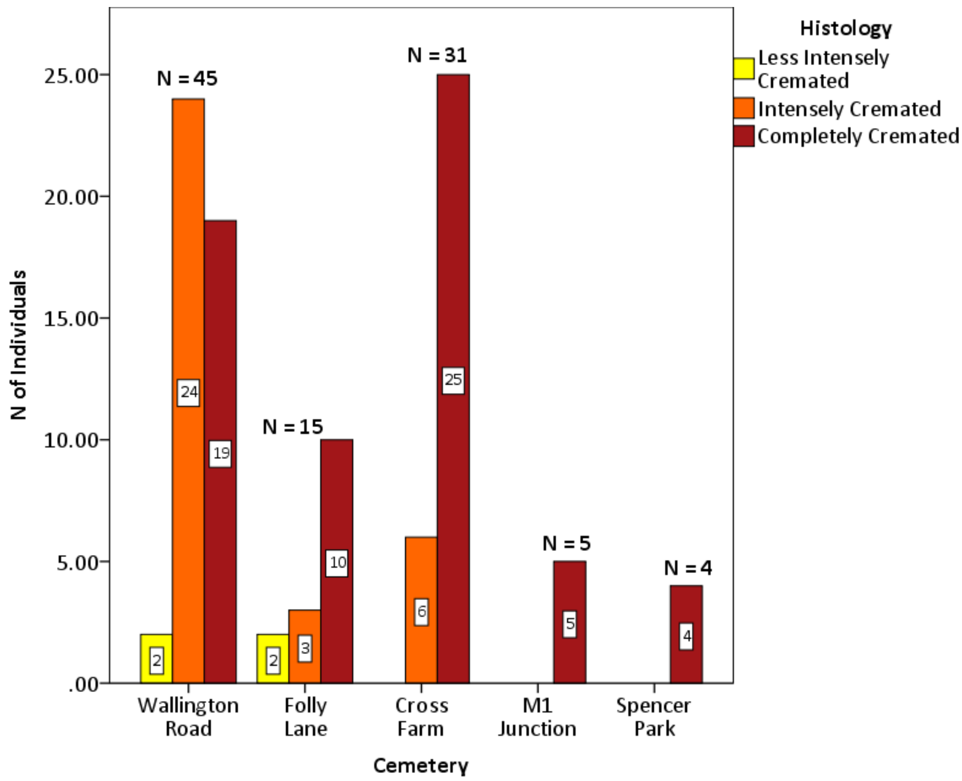


Figure 6.25 Histological scores according to cemetery. 1 = Less Intensely Cremated (300°C – 600°C). 2 = Intensely Cremated (600°C – 900°C). 3 = Completely Cremated (900°C+). Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying table 6.16.

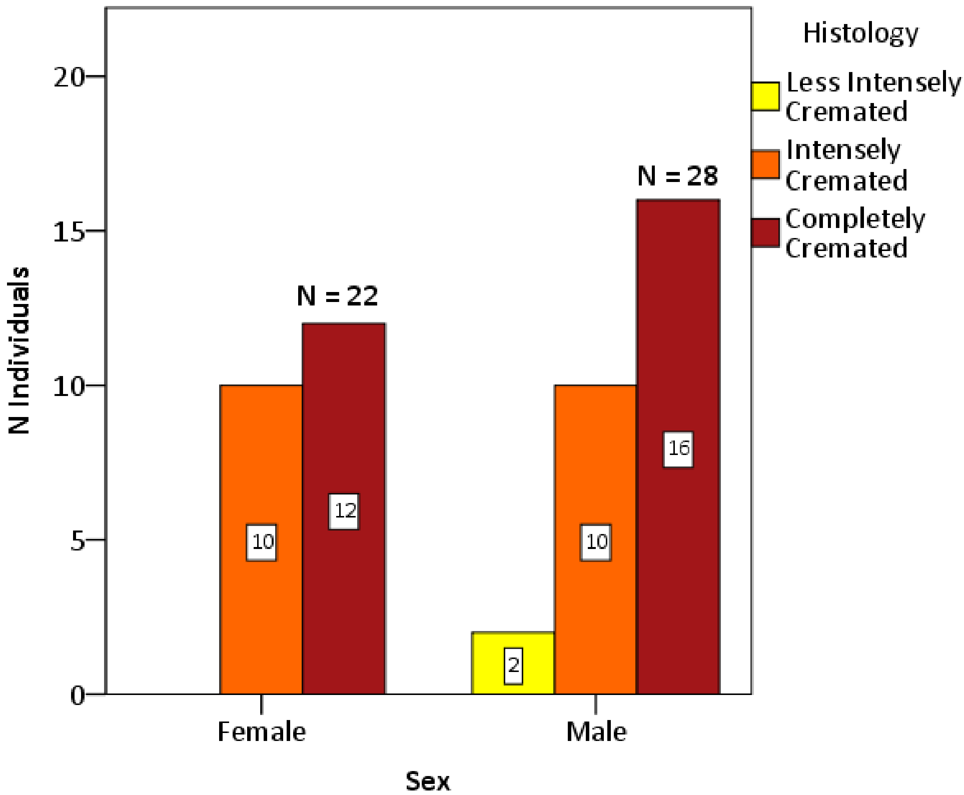


Figure 6.26 Histological scores according to sex. 1 = Less Intensely Cremated (300°C – 600°C). 2 = Intensely Cremated (600°C – 900°C). 3 = Completely Cremated (900°C+). Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying table 6.16.

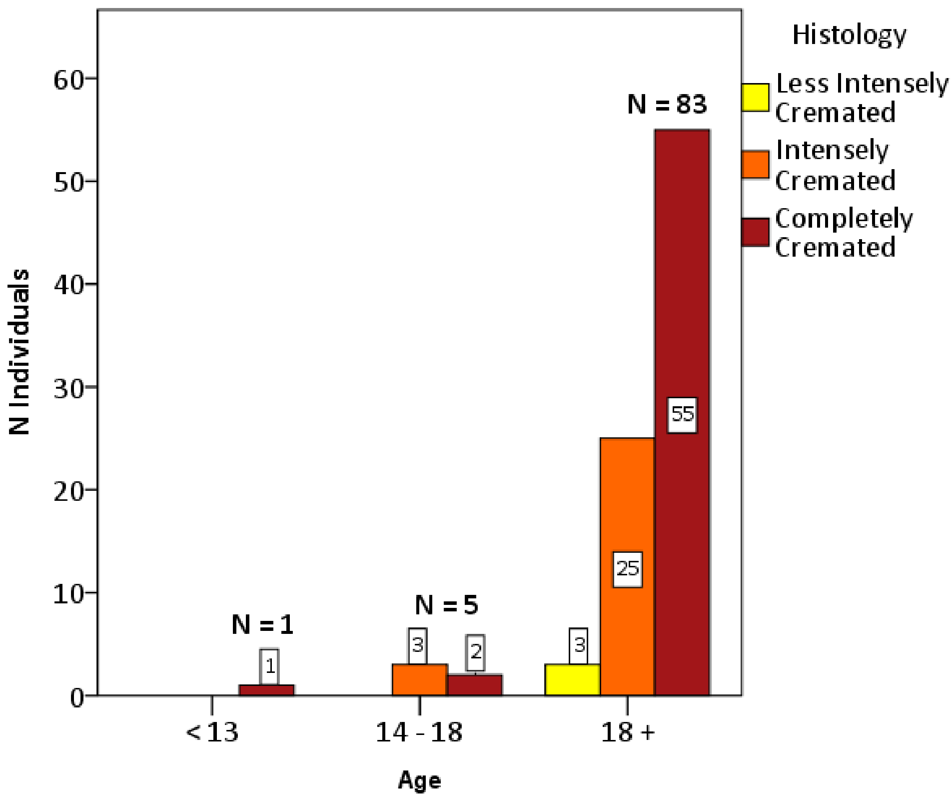


Figure 6.27 Histological scores according to age. 1 = Less Intensely Cremated (300°C – 600°C). 2 = Intensely Cremated (600°C – 900°C). 3 = Completely Cremated (900°C+). Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying table 6.16.

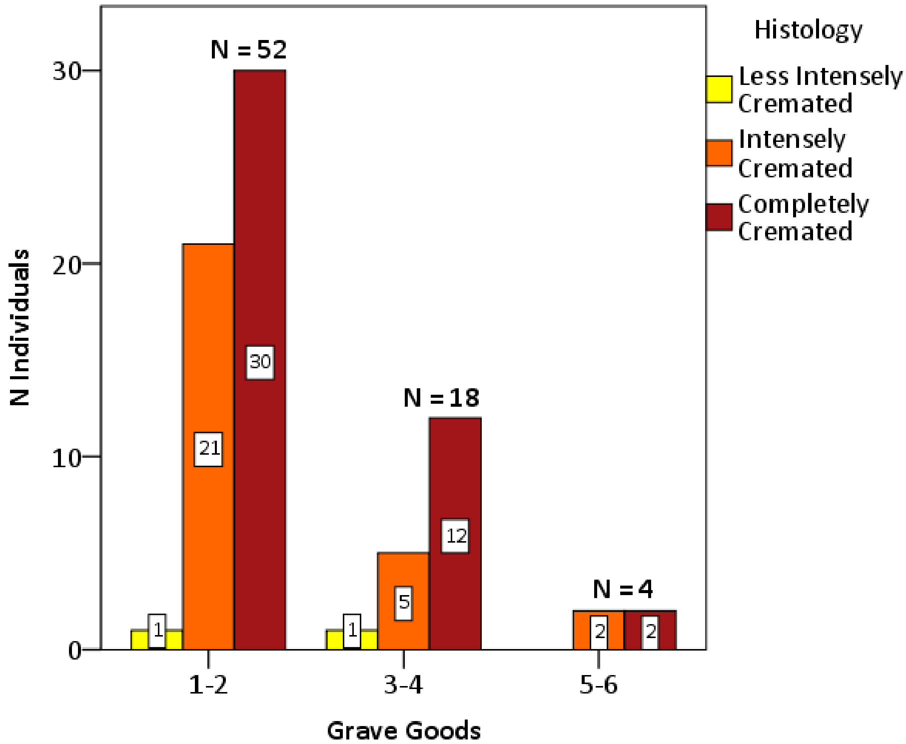


Figure 6.28 Histological scores according to the number of grave goods. 1 = Less Intensely Cremated (300°C – 600°C). 2 = Intensely Cremated (600°C – 900°C). 3 = Completely Cremated (900°C+). Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying table 6.16.

6.7 Quantitative Petrography of Burned Bone

6.7.1 Categories of Burning: Experimental Data

The K-means cluster analysis conducted on the quantitative petrographic data identified four categories of burning (Table 6.18 and Figure 6.29). These results are consistent with findings provided by other publications (Squires, et al., 2011; Castillo, et al., 2013), which indicates that these categories are reliable.

The identified categories are as follows:

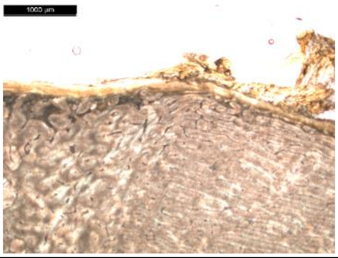
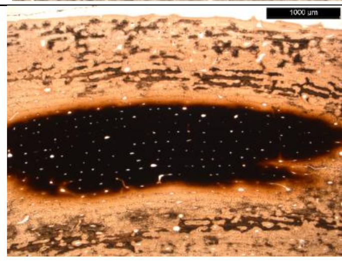
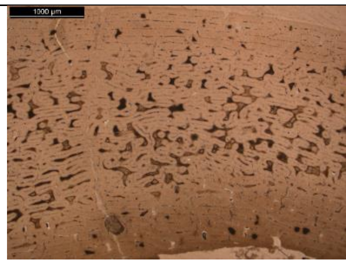
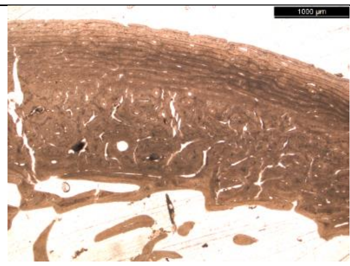
Category I: Between 100˚C and 400˚C the microstructure of the bone is well preserved; Haversian systems are consistently circular, with no malformation and smaller features including Volkmann's Canals, osteons and canaliculi are relatively un-altered. Between 48.3% and 53.6% of the sample area consists of organic material, while the remainder includes well-defined microscopic features.

Category II: The depletion of bone's organic material and the fusion of hydroxyapatite crystals becomes more frequent at temperatures between 500˚C and 600˚C. At this stage, micro-features are still identifiable, but they are less well-preserved and show signs of deterioration, with between 14.7% and 18.3% of the sample area displaying poorly defined microstructures.

Category III: The degeneration of microscopic features and the increase in hydroxyapatite fusion becomes more apparent in temperatures ranging between 700˚C and 900˚C. Haversian systems are the only discernible microscopic features remaining, and their form has become misshapen due to the decomposition of bones organic component and fusion of hydroxyapatite, which constitutes 50.6% to 59.6% of the sample area.

Category IV: For temperatures above 1000˚C, a minimum of 86.3% of the sample area displays hydroxyapatite fusion, evident from the lack of discernible osteons, Volkmann's Canals, and canaliculi. Few misshaped Haversian systems may remain, making up to 14% of the sample area.

Table 6.18 Categorising system for quantitative petrography.

Category	Temperature Range	Micrograph
I	100°C - 400˚C	
II	500°C - 600˚C	
III	700°C - 900°C	
IV	1000°C - 1100°C	

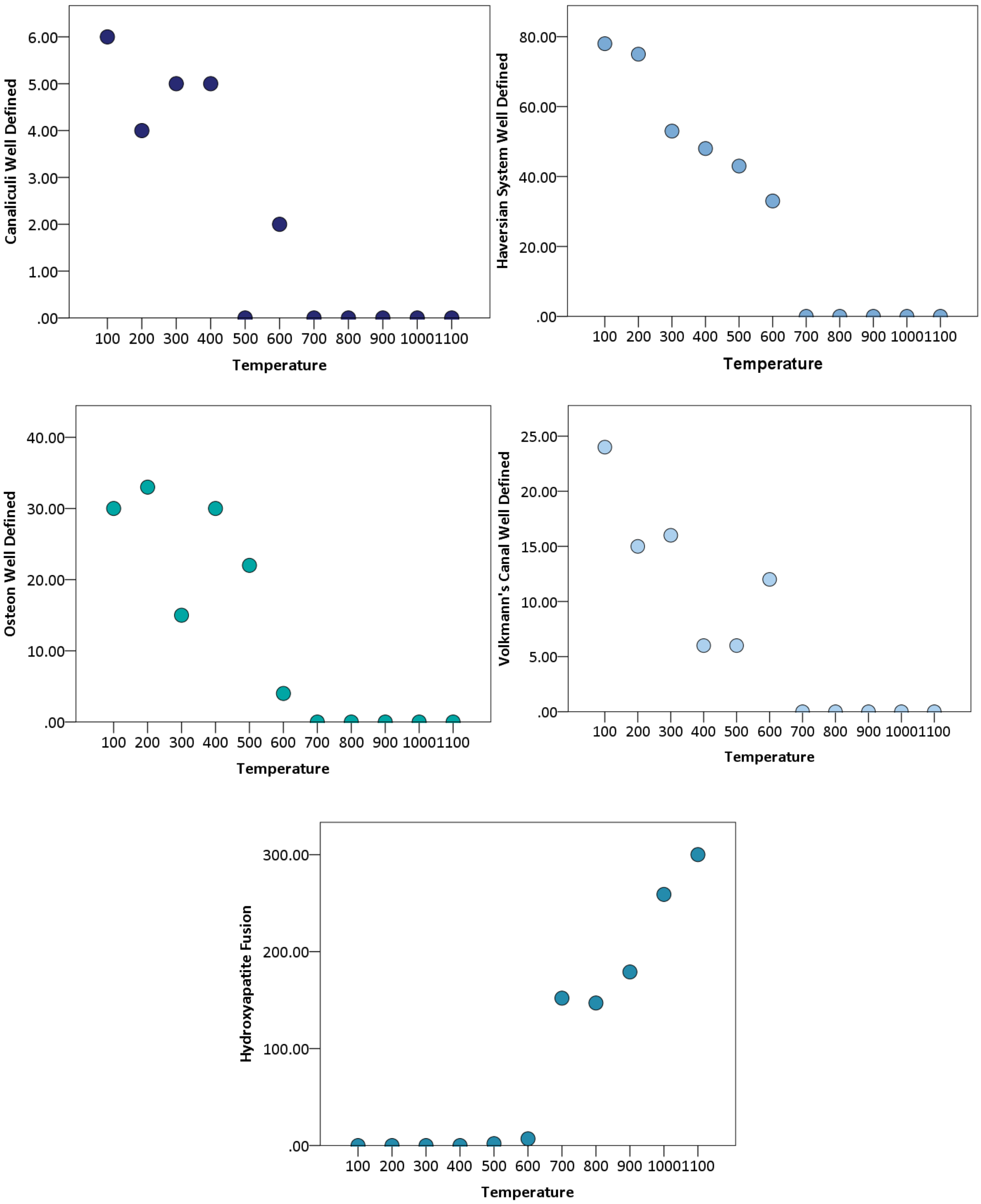


Figure 6.29a Distribution of quantitative petrographic data from modern animal bone standards fired at intervals of 100°C, ranging from 100°C to 1100°C. Comparison of well defined heat-induced alterations.

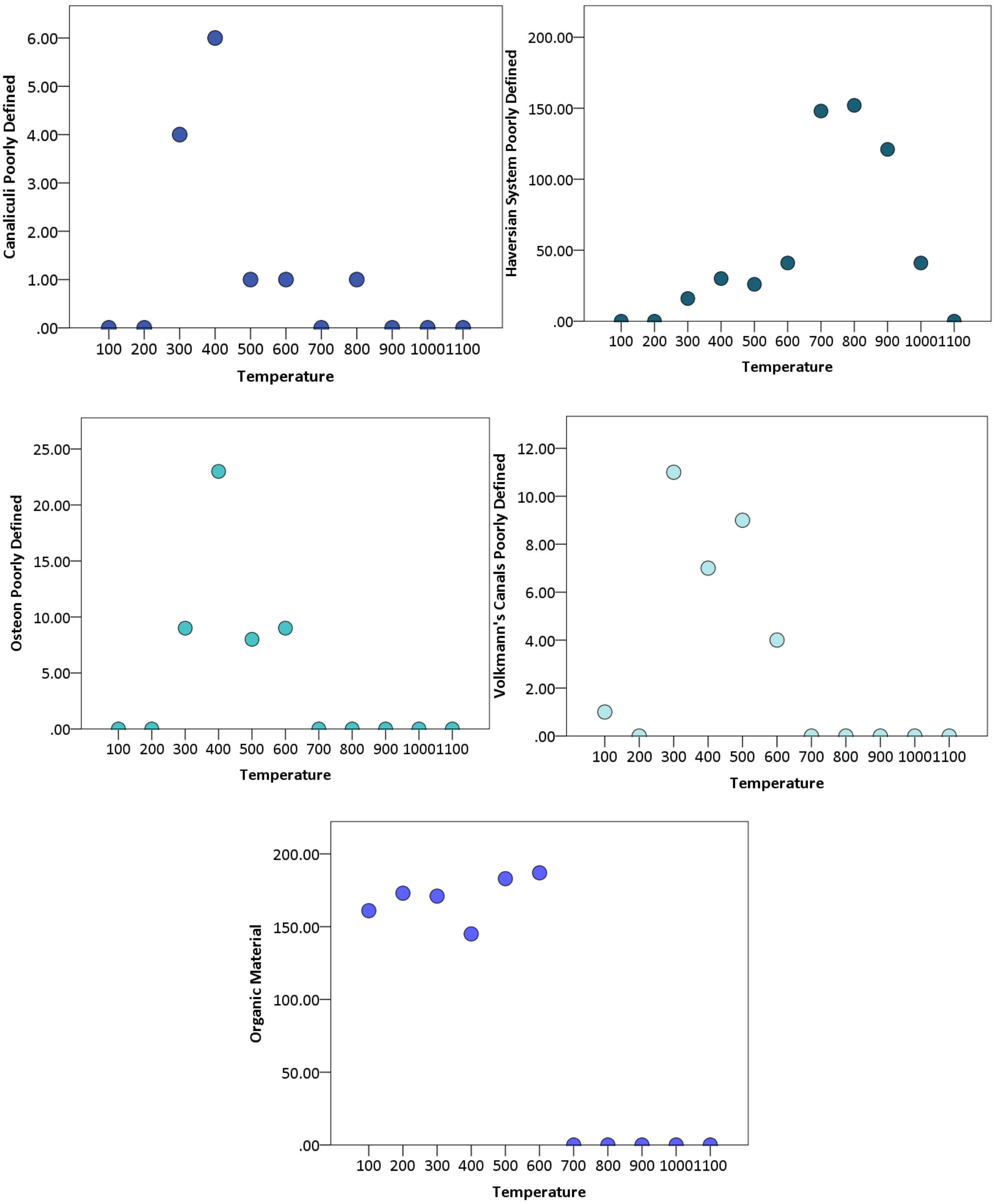


Figure 6.29b Distribution of quantitative petrographic data from modern animal bone standards fired at intervals of 100°C, ranging from 100°C to 1100°C. Comparison of poorly defined heat-induced alterations.

6.7.2 Inter-Observer Study

A total of five examiners were asked to repeat the quantitative petrographic method on the same two archaeological thin-sections to establish the degree of inter-observer reliability; all the heat-induced alterations described in table 4.7 were examined. Permission to conduct this study was given by Reading University's SAGES Research Ethics Committee (see Appendix 7). Three of the examiners were osteologists with varying levels of experience, while the other two were not human bone specialists. Of the five examiners, four produced the same results that resulted in an overall agreement level of 80% (Table 6.19). The reason for the misclassification obtained by the 2nd Osteologist was simply a result of the observer selecting the wrong option from the dictionary of heat-induced alterations by accident. This result from this admittedly small study suggests that quantitative petrography is not influenced by inter-observer bias, regardless of the expertise of the examiner, and encourages greater standardisation.

Table 6.19 Results of inter-observer study of quantitative petrography.

Examiner	Sample	Author's Category	Examiners Category	Agreement %
1st Osteologist	FL4	IV	IV	100%
	WR54	II	II	
2nd Osteologist	FL4	IV	III	50%
	WR54	II	II	
3rd Osteologist	FL4	IV	IV	100%
	WR54	II	II	
1st Non-Osteologist	FL4	IV	IV	100%
	WR54	II	II	
2nd Non-Osteologist	FL4	IV	IV	100%
	WR54	II	II	

6.7.3 Archaeological samples

A discriminant function analysis was performed on the data from Hertfordshire using the QP results from the K-means cluster analysis to assign each individual to one of the four categories of burning. A score was then assigned to each individual that represented the quantitative petrographic category assigned: 1 = Category I (100°C - 400°C). 2 = Category II (500°C - 600°C). 3 = Category III (700°C - 600°C). 4 = Category IV (1000 - 1100°C+) (see Section 4.3.1.7.2).

Overall, the results from the quantitative petrographic study are generally consistent with those from the histological examinations (see section 6.6), showing that these data are reliable. Of the 100 individuals examined, the range of microscopic features recorded suggest temperatures from 500°C to 1100°C; 64% (N = 64) of individuals were assigned to category IV, indicative of temperatures over 1000°C (Table 6.20).

Individuals from Minor and Major Urban settlements were pooled together as no significant difference was identified (Mann-Whitney U: $p = 0.176$). A Mann-Whitney U test found that that the categories of burning according to settlement type were significantly different ($p < 0.001$). All Rural individuals fell within the categories III and IV, with 85% (N = 34) reaching temperatures above 1000°C. However, the Urban sample achieved temperatures that ranged from 500°C to 1100°C (Figure 6.30).

A Kruskal-Wallis pairwise comparison found that the categories of burning differed significantly between the individuals from Cross Farm and Wallington Road ($p = 0.006$) (Table 6.21). The microscopic features recorded for the Cross Farm group placed the majority into categories III and VI, i.e 80.6% (N = 25) of individuals reached a minimum of 1000°C. However, the Wallington Road sample exhibits greater diversification in microscopic alteration, with 55.6% (N = 25) of the sample achieving temperatures between 500°C and 900°C (Figure 6.31) and the remaning 44.4% (N = 20) reaching 1000˚C.

No difference was found according to sex (Mann-Whitney U: $p = 0.715$), age group (Kruskal-Wallis H: $p = 0.501$), or number of grave goods (Kruskal-Wallis H: $p = 0.595$) (Figures 6.32 – 6.34).

Table 6.20 Quantitative petrographic scores for all individuals in cremation technology study, excluding the Late Iron Age data.

Settlement Type				
	Category I (100˚C - 400˚C)	**Category II (500˚C - 600˚C)**	**Category III (700˚C - 900 ˚C)**	**Category IV (1000˚C - 1100 ˚C)**
Rural	0	0	6	34
Urban	0	11	19	30
TOTAL	**0**	**11**	**25**	**64**
Cemetery				
Wallington Road	0	9	16	20
Folly Lane	0	2	3	10
Cross Farm	0	0	6	25
M1 Junction	0	0	0	5
Spencer Park	0	0	0	4
TOTAL	**0**	**11**	**25**	**64**
Sex				
Female	0	2	7	13
Male	0	5	7	16
TOTAL	**0**	**7**	**14**	**29**
Age				
< 13	0	0	0	1
14 – 18	0	0	3	2
18 +	0	9	18	56
TOTAL	**0**	**9**	**21**	**59**
Grave Goods				
1 – 2	0	6	16	30
3 – 4	0	1	5	12
5 – 6	0	0	1	3
TOTAL	**0**	**7**	**22**	**45**

Table 6.21 Summary of Kruskal-Wallis pairwise comparison results. Significant values of cemeteries according to quantitative petrography. * Statistically significant.

Cemetery	Test Statistic	Standard Error	Adjusted Sig.
Wallington Road – Folly Lane	-11.089	7.344	1.000
Wallington Road – Cross Farm	-19.709	5.750	*0.006
Wallington Road – M1 Junction	-28.322	11.612	0.147
Wallington Road – Spencer Park	-28.322	12.853	0.276
Folly Lane – Cross Farm	-8.620	7.748	1.000
Folly Lane – M1 Junction	-17.233	12.721	1.000
Folly Lane – Spencer Park	-17.233	13.862	1.000
Cross Farm – M1 Junction	-8.613	11.872	1.000
Cross Farm – Spencer Park	-8.613	13.087	1.000
M1 Junction – Spencer Park	0.000	16.525	1.000

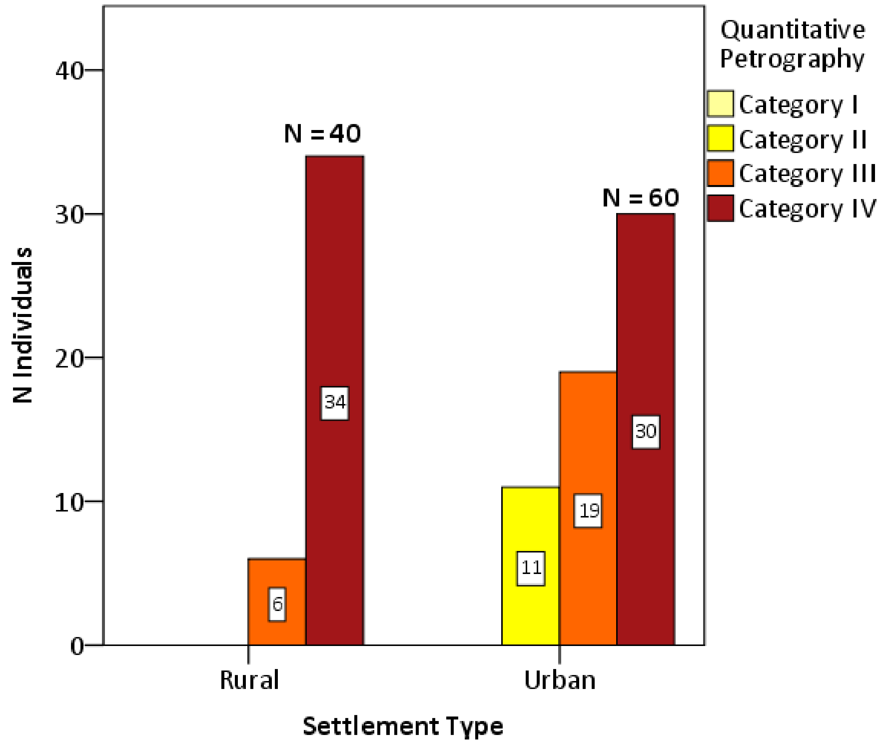


Figure 6.30 Quantitative petrography according to settlement type. 1 = Category I (100°C – 400°C). 2 = Category II (500°C – 600°C). 3 = Category III (700°C – 900°C). 4 = Category IV (1000 – 1100°C+). Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying table 6.20.

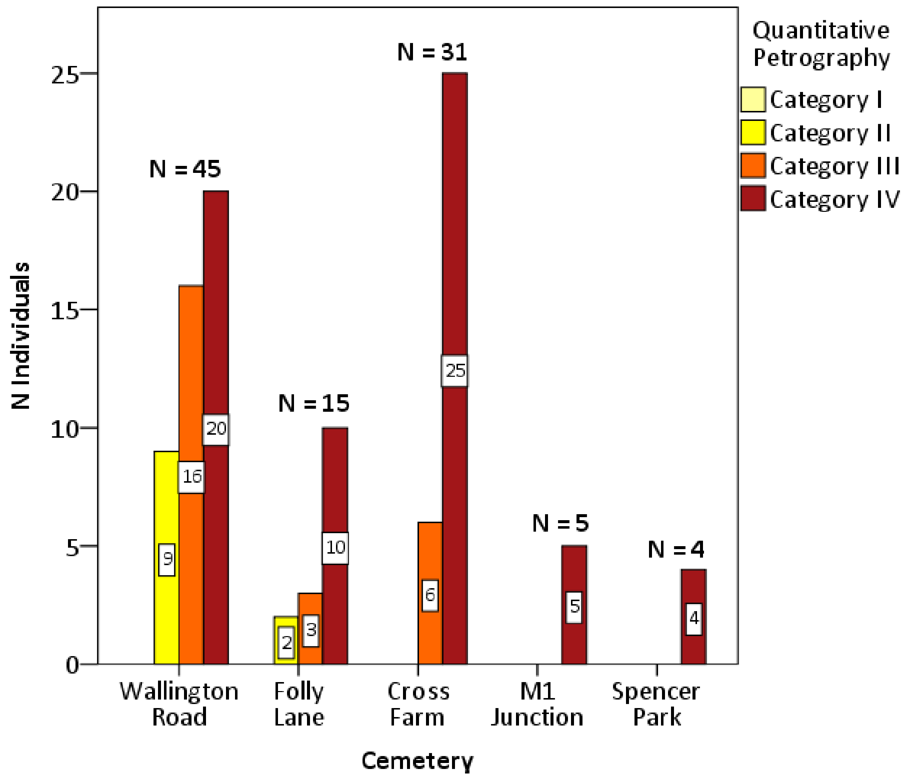


Figure 6.31 Quantitative petrography according to cemetery. 1 = Category I (100°C – 400°C). 2 = Category II (500°C – 600°C). 3 = Category III (700°C – 900°C). 4 = Category IV (1000 – 1100°C+). Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals. See accompanying table 6.20.

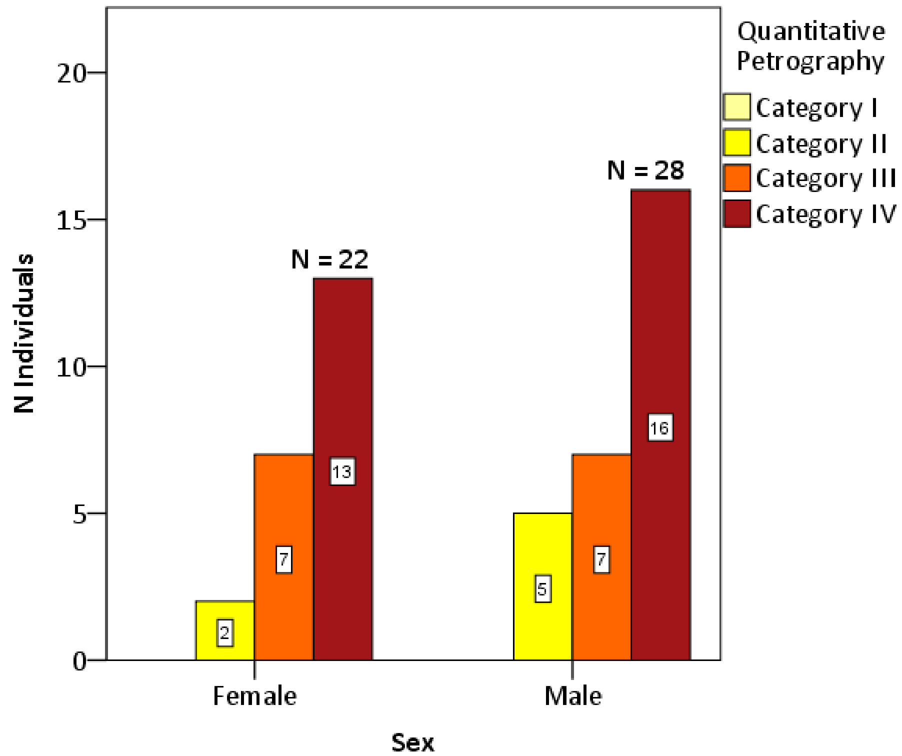


Figure 6.32 Quantitative petrography according to sex. 1 = Category I (100°C – 400°C). 2 = Category II (500°C – 600°C). 3 = Category III (700°C – 900°C). 4 = Category IV (1000 – 1100°C+). Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying table 6.20.

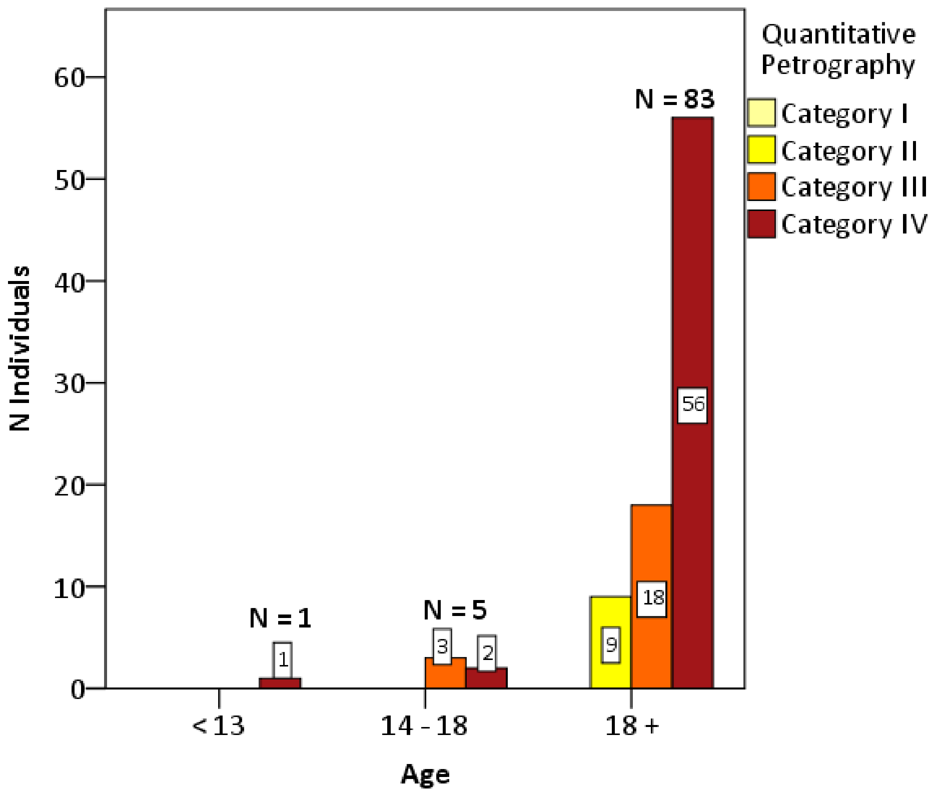


Figure 6.33 Quantitative petrography according to age. 1 = Category I (100°C – 400°C). 2 = Category II (500°C – 600°C). 3 = Category III (700°C – 900°C). 4 = Category IV (1000 – 1100°C+). Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying table 6.20.

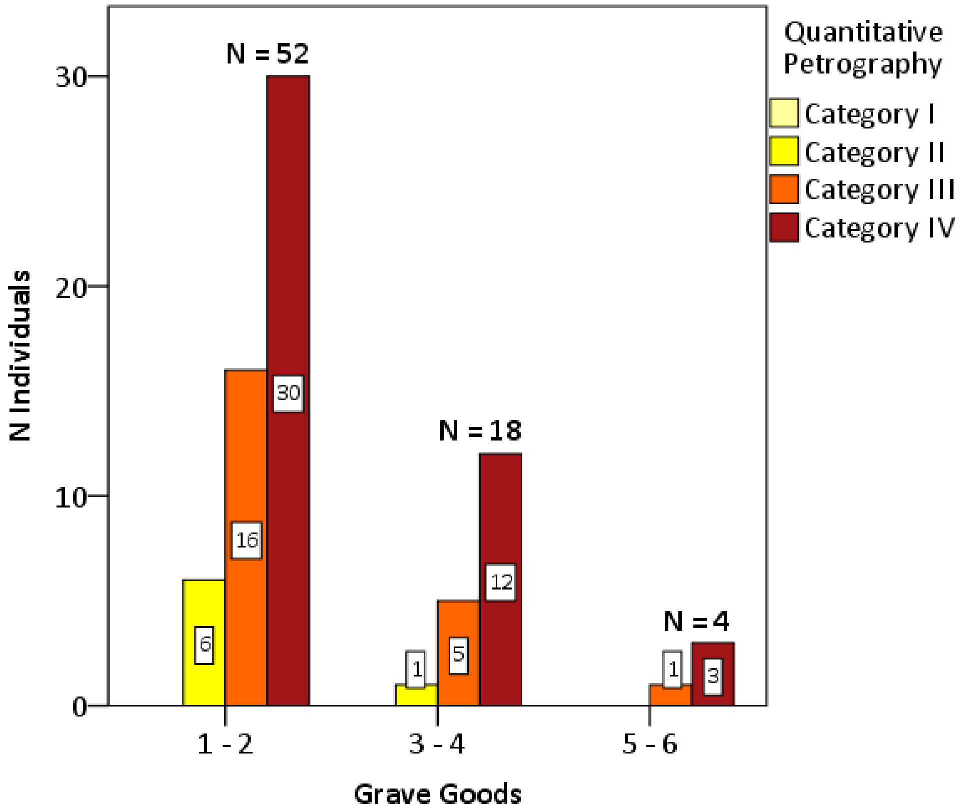


Figure 6.34 Quantitative petrography according to the number of grave goods. 1 = Category I (100°C – 400°C). 2 = Category II (500°C – 600°C). 3 = Category III (700°C – 900°C). 4 = Category IV (1000 – 1100°C+). Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual. See accompanying table 6.20.

6.8 Crystallinity of Burned Bone

6.8.1 Categories of Burning: Experimental Data

The K-means cluster analysis conducted on the FTIR-ATR data of modern animal bone samples cremated at known temperatures identified three categories of burning (Low, Medium and High) (Table 6.22 and Figure 6.35). Eleven sections of pig long bone were burned in an industrial furnace for 45 minutes at intervals of 100˚C, ranging from 100˚C to 1100˚C. The results obtained are consistent with findings provided by other publications (Thompson, et al., 2013). The lower temperature burning categories range from 100°C to 300°C, the middle temperature results are found between 400°C to 700°C and the higher temperatures are from 800°C onwards. Sample 11 has been assigned to the middle burning category despite being fired at 1100°C. However, this is unsurprising as pointed out by Thompson (2015b, p.329) because the CI value drops at temperatures over 1000°C (see Section 3.2.6).

Table 6.22 Categories of burning from FTIR-ATR data from modern animal bone.

Sample Number	Temperature	CI	C/P	Category of Burning
1	100°C	2.174419	0.776730	Low
2	200°C	2.786667	0.350917	Low
3	300°C	2.727941	0.380896	Low
4	400°C	3.397549	0.135314	Middle
5	500°C	3.535885	0.324891	Middle
6	600°C	3.643485	0.081281	Middle
7	700°C	4.163265	0.090061	Middle
8	800°C	6.564168	0.049985	High
9	900°C	6.284944	0.065776	High
10	1000°C	6.037920	0.050797	High
11	1100°C	3.667539	0.066214	Middle

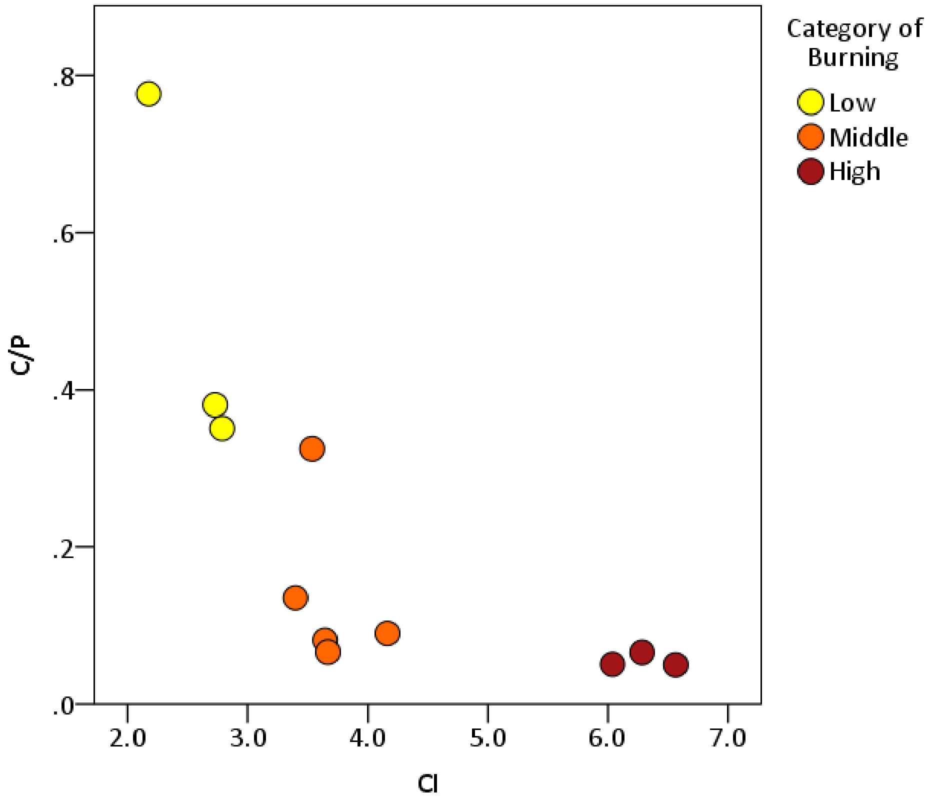


Figure 6.35 Distribution of crystallinity measures. Crystallinity recorded for modern animal bone fired at intervals of 100°C, ranging from 100°C to 1100°C.

6.8.2 Archaeological Samples

A discriminate function analysis using the QP results from the K-means cluster analysis assigned the archaeological data to a burning category. A ranked score was then given to each individual that represented that burning category. These included: 1 = Low (100°C - 300°C). 2 = Middle (400°C - 700°C). 3 = High (800°C - 1100°C) (see Section 4.3.1.6).

Overall, the FTIR-ATR results show a mix of middle and high burning intensities, with 78% (N = 78) of individuals clustering at the higher end of the spectrum indicative of temperatures around 800°C and above. This outcome is consistent with the histological examinations and quantitative petrographic results, demonstrating that the data are reliable (Table 6.23).

No significant difference in crystallinity was found between Minor and Major Urban cemeteries (Mann-Whitney U: p = 0.634). When both groups are compared with Rural individuals, burning intensity differed significantly (Mann-Whitney U: p = 0.004). The Urban individuals were more widely dispersed, while the Rural individuals clustered towards the higher end of the spectrum (Figure 6.36).

No significant difference in crystallinity was found according to cemetery (Kruskal-Wallis H test: p = 0.068), sex (Mann-Whitney U: p = 0.529), age (Kruskal-Wallis H: p = 0.398) or number of grave goods (Kruskal-Wallis H: p = 0.268) (Figures 6.37 – 6.40).

Table 6.23 Crystallinity scores for individuals in cremation technology study, excluding the Late Iron Age data.

Settlement Type			
	Low (100°C - 300°C)	**Middle (400°C - 700°C)**	**High (800°C - 1000°C)**
Rural	0	3	37
Urban	0	19	41
TOTAL	**0**	**22**	**78**
Cemetery			
Wallington Road	0	15	30
Folly Lane	0	4	11
Cross Farm	0	3	28
M1 Junction	0	0	5
Spencer Park	0	0	4
TOTAL	**0**	**22**	**78**
Sex			
Female	0	6	16
Male	0	10	18
TOTAL	**0**	**16**	**34**
Age			
< 13	0	0	1
14 – 18	0	0	5
18 +	0	20	63
TOTAL	**0**	**20**	**83**
Grave Goods			
1 – 2	0	13	39
3 – 4	0	2	16
5 – 6	0	0	4
TOTAL	**0**	**15**	**59**

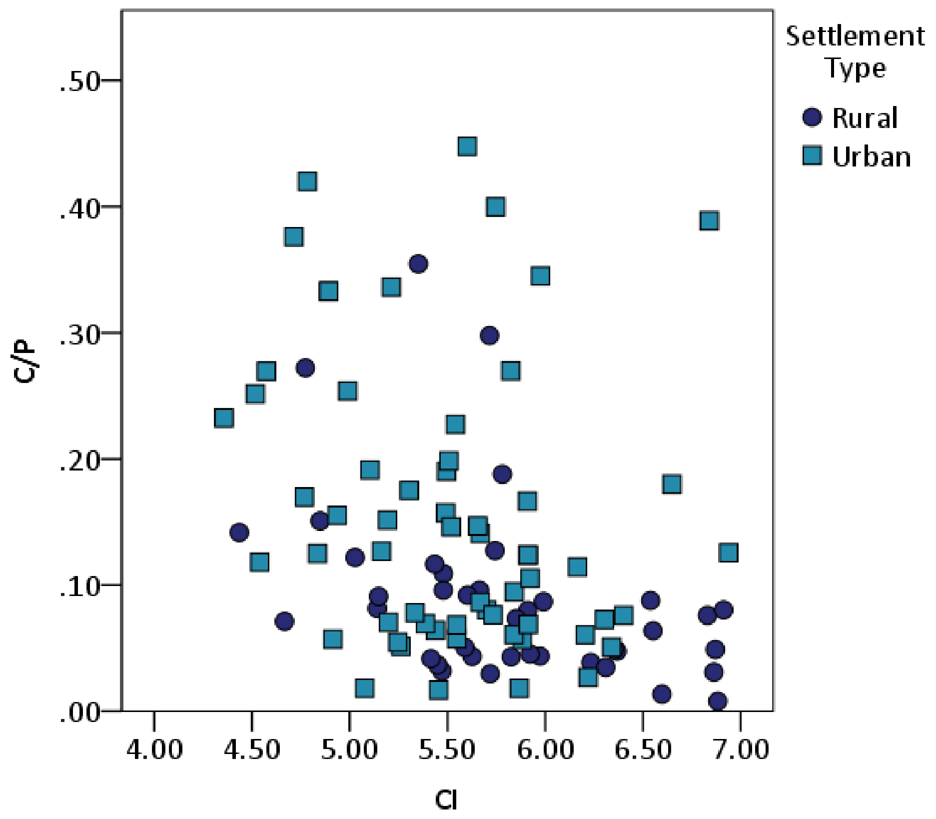


Figure 6.36 CI (Crystallinity Index) and C/P (Carbon to Phosphate) ratios according to settlement type. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals.

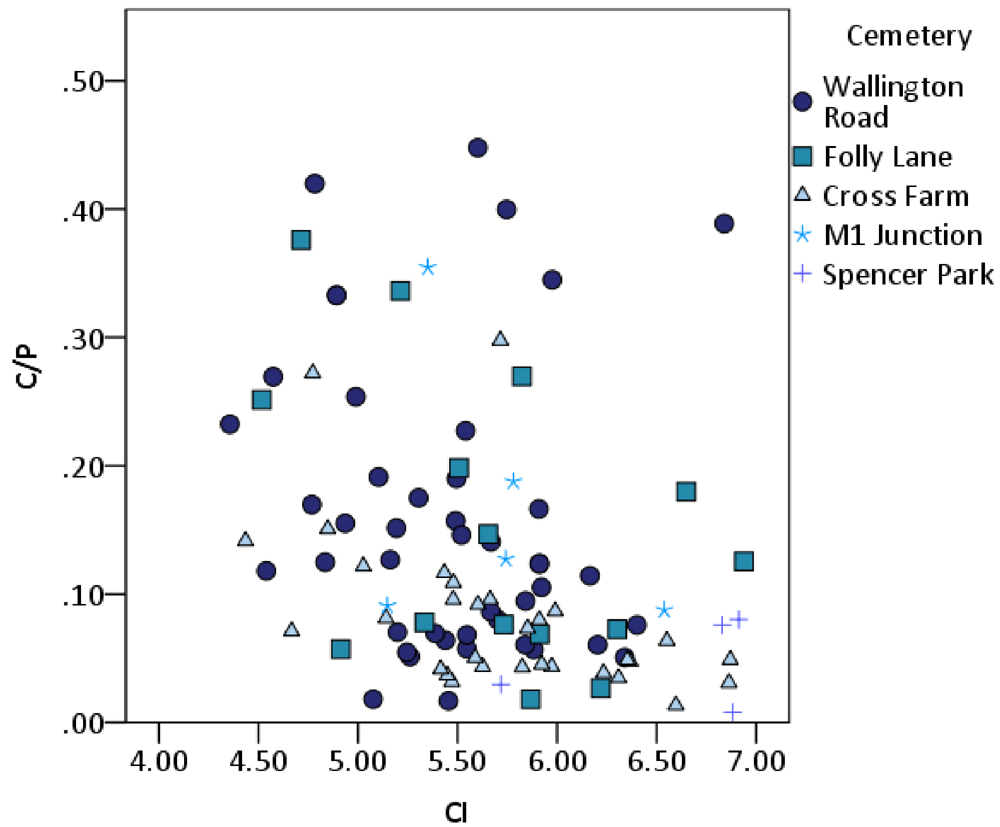


Figure 6.37 CI (Crystallinity Index) and C/P (Carbon to Phosphate) ratios according to cemetery. Pooled sample of all individuals in cremation technology study apart from the two Late Iron Age individuals.

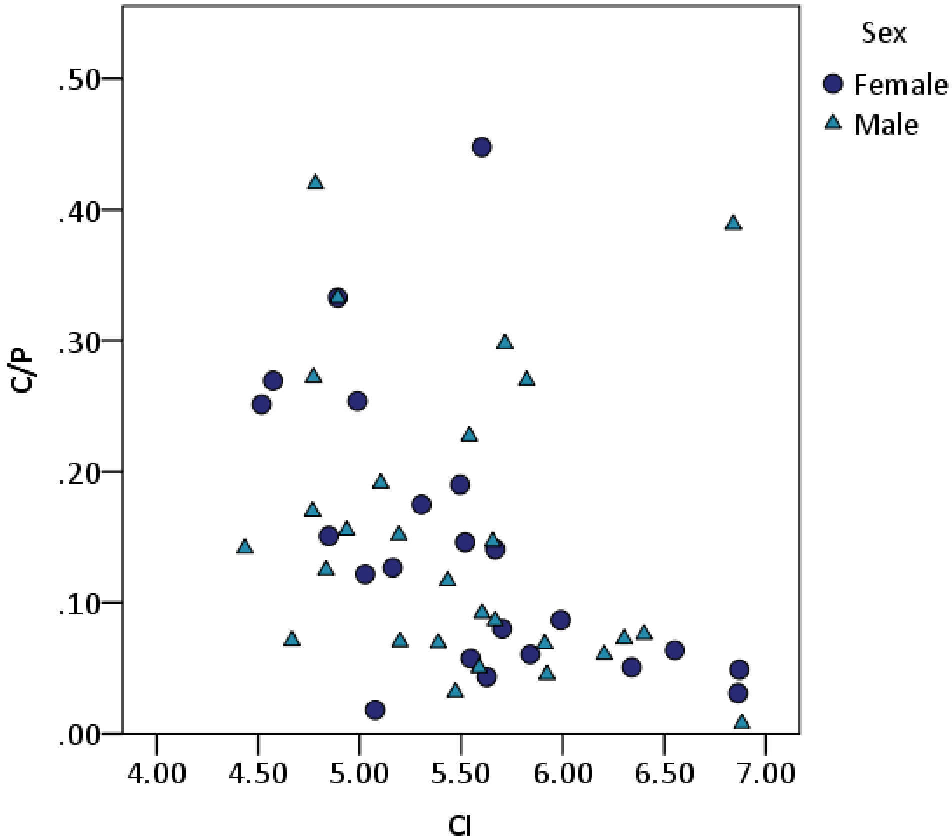


Figure 6.38 CI (Crystallinity Index) and C/P (Carbon to Phosphate) ratios according to sex. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual.

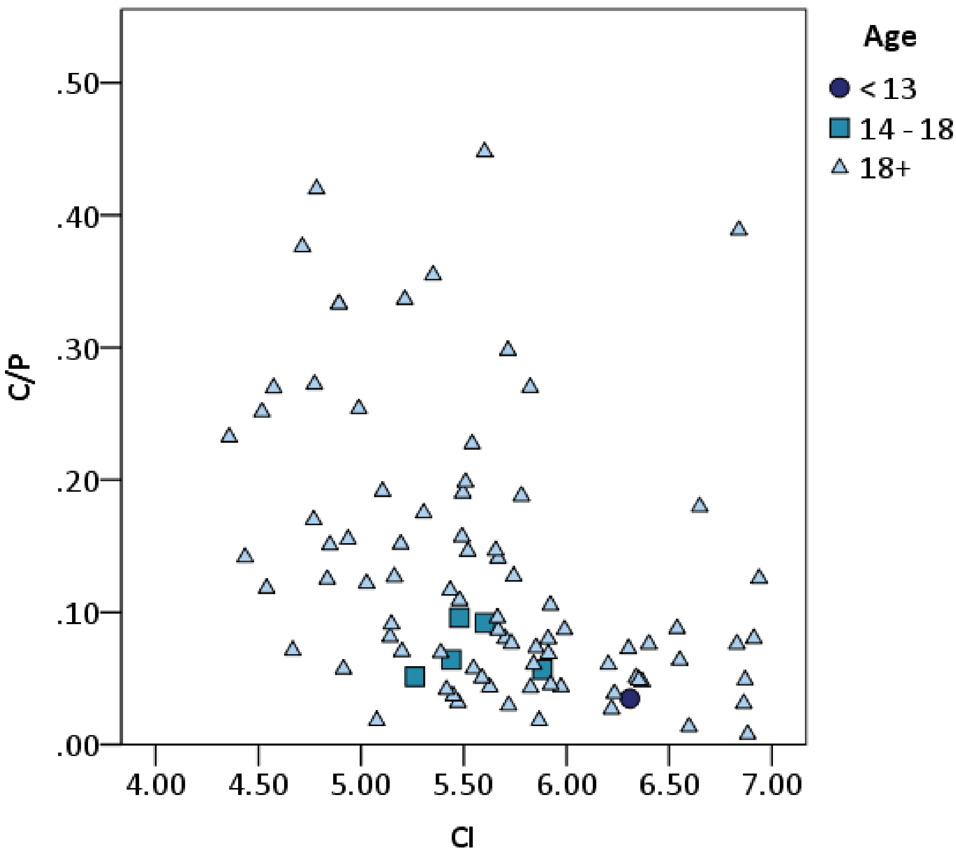


Figure 6.39 CI (Crystallinity Index) and C/P (Carbon to Phosphate) ratios according to age. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual.

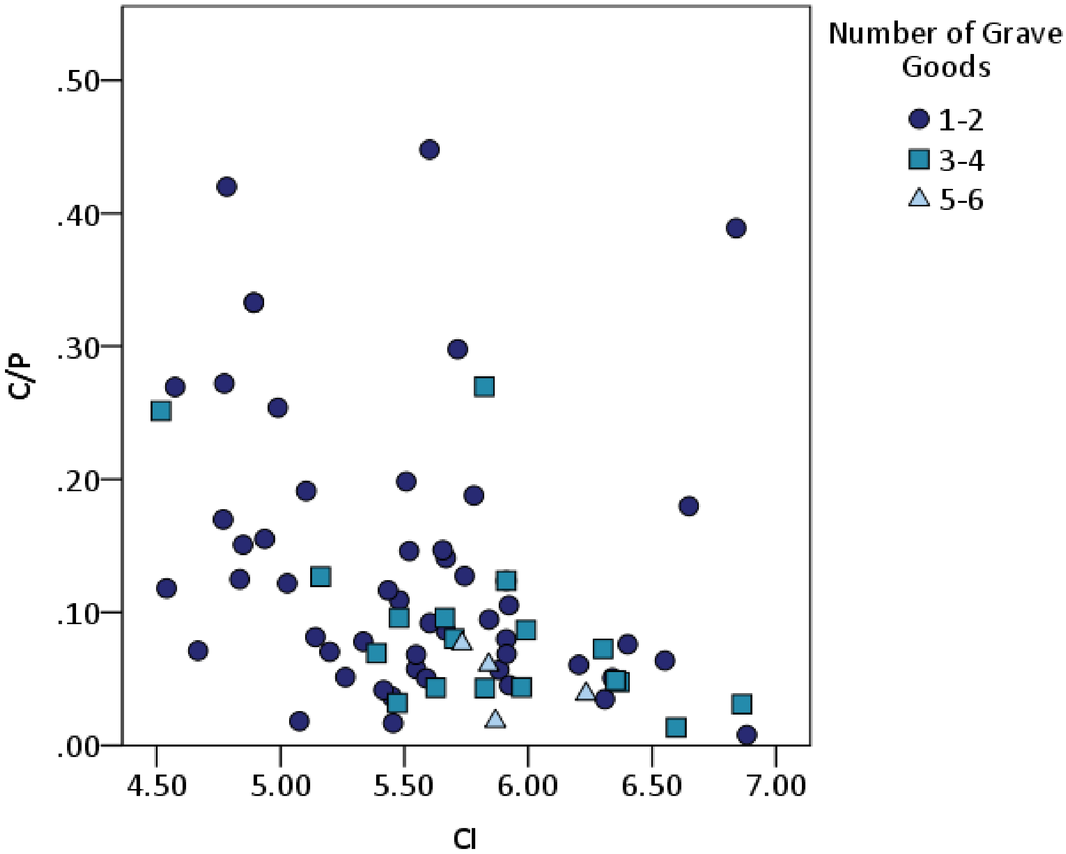


Figure 6.40 CI (Crystallinity Index) and C/P (Carbon to Phosphate) ratios according to number of grave goods. Pooled sample of all individuals in cremation technology study apart from the one Late Iron Age individual.

6.9 Charcoal Analysis

All available cremation deposits were sampled for botanical remains; however, due to the conditions of the museum archives as well as the retention bias of the material following excavation, only a small unevenly distributed dataset could be assembled (see section 4.3.2.3).

The few samples from cremation contexts retained from Wallington Road, Baldock, Folly Lane, St Albans, and Cross Farm, Hemel Hempstead were floated by the author to extract the microfossils from the soil matrix. This process had already been done for the cremation deposits from Spencer Park and M1 Junction following excavation. With regards to the pyre site from Wallington Road, no environmental samples were taken. Instead the volunteers who excavated the site handpicked some large fragments of charcoal. As a result, the assemblage is biased towards the best-preserved samples; however, the results are valuable in relation to the presence/absence of taxa, as well as ubiquity.

A total of 2493 charcoal fragments were examined by the author from 27 cremation deposits (see Appendix 9 for a breakdown of the tree and shrub taxa represented and the catalogue of individual sample descriptions) (Table 6.24 – 6.25).

6.9.1 Distribution of Study Sample

With regards to settlement type, the distribution of data are generally even with 48.1% (N = 13) of the samples and 53.7% (N = 1338) of the fragments deriving from Rural cemeteries (Table 6.24 – 6.25). However, only 5.7% (N = 143) of the examined charcoal fragments from 5 samples (18.5%) come from Minor Urban settlements. If appropriate, the Major and Minor Urban samples are pooled together to form a larger, Urban group (see section 4.3.1.3). In relation to cemetery, the data are relatively uniform, apart from Folly Lane from which the majority of samples (33.3%, N = 9) and fragments (40.6%, N = 1012) have been obtained. The smallest proportion of data come from Wallington Road, where only 5.7% (N = 143) of the fragments (18.5%, N = 5 samples) were recorded. Chronologically, 96.3% (N = 26) of the samples and 95.9% (N = 2391) of the charcoal fragments date to the Early and Middle Roman period; only one cremation deposit (3.7%) including 102 fragments (4.1%) come from the Late Iron Age period. As before in this chapter, the pre-Roman data are removed from the study sample. Section 6.10 will then compare the general trends identified with the one Late Iron Age cremation deposit. Alongside settlement type and cemetery, patterns in relation to sex, age and the number of grave goods are also be examined.

Table 6.24 Number and percentage of all samples in the charcoal study.

	Wallington Road	Folly Lane	Cross Farm	M1 Junction	Spencer Park	TOTAL	%
Time Period							
Late Iron Age	0	0	0	1	0	**1**	3.7
Early Roman	4	9	1	0	4	**18**	66.7
Middle Roman	1	0	3	4	0	**8**	29.6
Late Roman	0	0	0	0	0	**0**	0
TOTAL	**5**	**9**	**4**	**5**	**4**	**27**	100
Settlement Type							
Rural	0	0	4	5	4	**13**	48.1
Minor Urban	5	0	0	0	0	**5**	18.5
Major Urban	0	9	0	0	0	**9**	33.4
TOTAL	**5**	**9**	**4**	**5**	**4**	**27**	100
Sex							
Female	0	0	1	0	0	**1**	20
Male	1	2	0	0	1	**4**	80
TOTAL	**1**	**2**	**1**	**0**	**1**	**5**	100
Age							
< 13	0	1	1	0	0	**2**	9.5
14 – 18	0	0	2	0	0	**2**	9.5
18 +	1	7	1	4	4	**17**	81
TOTAL	**1**	**8**	**4**	**4**	**4**	**21**	100
Grave Goods							
1 – 2	1	0	1	2	1	**5**	31.3
3 – 4	2	5	3	0	0	**10**	62.5
5 - 6	0	1	0	0	0	**1**	6.2
TOTAL	**3**	**6**	**4**	**2**	**1**	**16**	100

Table 6.25 Number and percentage of all fragments in the charcoal study.

	Wallington Road	Folly Lane	Cross Farm	M1 Junction	Spencer Park	TOTAL	%
Time Period							
Late Iron Age	0	0	0	102	0	**102**	4.1
Early Roman	138	1012	100	0	501	**1751**	70.2
Middle Roman	5	0	301	334	0	**640**	25.7
Late Roman	0	0	0	0	0	**0**	0
TOTAL	**143**	**1012**	**401**	**436**	**501**	**2493**	100
Settlement Type							
Rural	0	0	401	436	501	**1338**	53.7
Minor Urban	143	0	0	0	0	**143**	5.7
Major Urban	0	1012	0	0	0	**1012**	40.6
TOTAL	**143**	**1012**	**401**	**436**	**501**	**2493**	100
Sex							
Female	0	0	100	0	0	**100**	19.8
Male	100	206	0	0	100	**406**	80.2
TOTAL	**100**	**206**	**100**	**0**	**100**	**506**	100
Age							
< 13	0	200	101	0	0	301	13.4
14 – 18	0	0	200	0	0	200	8.9
18 +	100	712	100	334	501	1747	77.7
TOTAL	**100**	**912**	**401**	**334**	**501**	**2248**	100
Grave Goods							
1 – 2	5	0	101	133	100	339	23.4
3 – 4	102	606	300	0	0	1008	69.7
5 - 6	0	100	0	0	0	100	6.9
TOTAL	**107**	**706**	**401**	**133**	**100**	**1447**	100

Overall, a minimum of eleven tree and shrub types were identified. Although a variety of taxa were present, the charcoal assemblages were dominated by oak (*Quercus sp.*) that was found in 96.2% (N = 25) of the cremation contexts and was found exclusively in 6 (23.1%). Maloideae (Pomaceous fruits) was the next most dominant taxon identified in 19 (73.1%) samples but was never the sole taxon within a context. Of the 2391 charcoal fragments examined from the Roman cremation deposits, 92.4% (N = 2209) were roundwood, while 182 (7.6%) where twigwood. These included hazel (*Corylus avellana)* (N = 5), ash (*Fraxinus Excelsior*) (N = 7), oak (*Quercus sp.*) (N = 159) and unidentified (N = 11). A total of 19 (73.1%) cremation deposits included more than one taxon; the most taxa found in one cremation deposit was 6. The inclusion of maloideae (Pomaceous fruits) and oak (*Quercus sp.*) was identified in 9 (34.6%) cremation deposits and was the most common combination of taxa found.

The data from the Minor and Major Urban cremation deposits were kept separate because a one-way ANOVA test found that the number of oak (*Quercus sp.*) fragments identified differed significantly (p = 0.003) (Table 6.27). The Rural cremation deposits contained a greater variety of species, where a total of 9 (81.8% of 11) taxa were recorded; in comparison, only 3 (27.3% of 11) taxa were identified from the Minor Urban sample, and 6 were recorded for the Major Urban sample. Once again, oak (*Quercus sp.*) was the most common taxon identified across all settlement types (74.3% of 2338 identified fragments). Alder (*Alnus glutinosa gaertn*), birch (*Betula*), hazel (*Corylus avellana*), beech (*Fagus sylvatica*), and ash (*Fraxinus excelsior*) were exclusively found at Rural cemeteries, while hornbeam (*Carpinus betulus*), hawthorn (*Pomoideae cf. crataegus*), and elm (*Ulmus sp*.) were only associated with Major Urban cremation deposits. The only significant difference in taxa was a greater prevalence of oak (*Quercus sp.*) at Major Urban sites compared to the Minor Urban (one-way ANOVA: p = 0.003) (Table 6.27).

The cemetery with the greatest number of species recorded was Spencer Park, where 7 different types were found; the least was Wallington Road (N = 3), which is most likely a reflection of its small sample size (Table 6.28). Overall, oak (*Quercus sp.*) was the most dominant taxon identified at Wallington Road, Folly Lane, Cross Farm and M1 Junction, contributing 83.2% (N = 1852) of the identified fragments. The only exception was Spencer Park, where maloideae (Pomaceous fruits) were more abundant (51.2% of 486). Alder (*Alnus glutinosa gaertn*) and hazel (*Corylus avellana*) were only found at Spencer Park, while hornbeam (*Carpinus betulus*), hawthorn (*Pomoideae cf. crataegus*), and elm (*Ulmus* sp.) were exclusive to Folly Lane, and beech (*Fagus sylvatica*) was only recorded at M1 Junction. A one-way ANOVA found that the total number of alder (*Alnus glutinosa gaertn*) fragments at Spencer Park was significantly different to most other cemeteries apart from Cross Farm (Wallington Road. p = 0.026; Folly Lane. P = 0.011; M1 Junction. P = 0.037), as was the prevalence of hazel (*Corylus avellana*) twigwood (Wallington Road. p = 0.032; Folly Lane. P = 0.014; M1 Junction. P = 0.045). The large proportion of maloideae (Pomaceous fruits) at Spencer Park was significantly different to all other cemeteries (p < 0.001). In addition, the dominance of oak (*Quercus sp.*) roundwood at Folly Lane is significantly different to the few fragments found at Wallington Road (p = 0.012) (Table 6.29).

In relation to age, oak (*Quercus sp.*) was the most dominant taxon identified across all age groups (Table 6.31). Interestingly, 93% (N = 186 of 200) of the fragments from the 14 to 18 year olds were twigwood, compared to 0.3% (N = 6 of 1747) of the fragments from the 18+ group. With regards to the total number of fragments per taxa, a one-way ANOVA found that birch (*Betulaceae sp.*) (p = 0.004), hornbeam (*Carpinus betulus*) (p = 0.004), hawthorn (*Pomoideae cf. crataegus*) (p = 0.004) and oak (*Quercus sp.*) roundwood (p = 0.022) and twigwood (p = < 0.001) differed significantly between groups. Unfortunately, Tukey post-hoc tests could not be performed because of the small sample sizes (Table 6.32).

No significant difference in the total number of fragments per taxa were identified according to sex, or the number of grave goods (Tables 6.30 and 6.33) (see Appendix 6 statistic results).

Table 6.26 Wood taxa according to settlement type. *N = Number of fragments of each taxon identified. *Ub = Ubiquity (how often a species appears in each category). Pooled data of all individuals in charcoal study, excluding the Late Iron Age data.

	Rural	**Minor Urban**	**Major Urban**	**TOTAL**	
				N	**Ub**
Alnus glutinosa gaertn	13			**13**	**1**
Betula pubescens	4			**4**	**2**
Betulaceae sp.	1			**1**	**1**
Corylus avellana cf.	1			**1**	**1**
Corylus avellana twigwood	5			**5**	**1**
Carpinus betulus			2	**2**	**1**
Coal	1		1	**2**	**2**
Fagus sylvatica	1			**1**	**1**
Fraxinus excelsior	12			**12**	**2**
Fraxinus excelsior twigwood	7			**7**	**1**
Maloideae	303	8	57	**368**	**5**
Pomoideae cf. crataegus			1	**1**	**1**
Prunus cf. spinosa	2			**2**	**1**
Prunus sp.	16	3	1	**20**	**3**
Quercus sp.	682	130	926	**1743**	**5**
Quercus sp. twigwood	158		1	**159**	**2**
Ulmus sp.			2	**2**	**1**
TOTAL IDENTIFIED	**1206**	**141**	**991**	**2343**	
Unidentified	21	2	19	**42**	**3**
Unidentified twigwood	9		2	**11**	**2**
TOTAL INCLUDING UNIDENTIFIED	**1236**	**143**	**1012**	**2396**	

Table 6.27 Test statistics of One-Way ANOVA Tukey post-hoc. Oak (*Quercus sp*.) according to settlement type. * Statistically significant.

Species	Settlement Type (I)	Settlement Type (J)	Mean Difference	Standard Error	Sig.	Lower Bound	Upper Bound
Quercus sp.	Rural	Minor Urban	36.00000	19.77891	0.186	-13.6859	85.6859
		Major Urban	-40.88889	16.48242	0.053	-82.2938	.5160
	Minor Urban	Rural	-36.00000	19.77891	0.186	-85.6859	13.6859
		Major Urban	-76.88889	20.45415	*0.003	-128.2710	-25.5068
	Major Urban	Rural	40.88889	16.48242	0.053	-.5160	82.2938
		Minor Urban	76.88889	20.45415	*0.003	25.5068	128.2710

Table 6.28 Wood taxa according to cemetery. *N = Number of fragments of each taxon identified. *Ub = Ubiquity (how often a species appears in each category). Pooled data of all individuals in charcoal study, excluding the Late Iron Age data.

	Wallington Road	Folly Lane	Cross Farm	M1 Junction	Spencer Park	TOTAL N.	TOTAL Ub.
Alnus glutinosa gaertn					13	13	1
Betula pubescens				3	1	4	2
Betulaceae sp.			1			1	1
Corylus avellana cf.					1	1	1
Corylus avellana twigwood					5	5	1
Carpinus betulus		2				2	1
Coal		1			1	2	2
Fagus sylvatica				1		1	1
Fraxinus excelsior			11		1	12	2
Fraxinus excelsior twigwood			7			7	1
Maloideae	8	57	27	27	249	368	5
Pomoideae cf. crataegus		1				1	1
Prunus cf. spinosa					2	2	1
Prunus sp.	3	1			16	20	3
Quercus sp.	130	926	183	302	197	1738	5
Quercus sp. twigwood		1	158			159	2
Ulmus sp.		2				2	1
TOTAL IDENTIFIED	**141**	**991**	**387**	**333**	**486**	**2338**	
Unidentified	2	19	5	1	15	**42**	**5**
Unidentified twigwood		2	9			**11**	**2**
TOTAL INCLUDING UNIDENTIFIED	**143**	**1012**	**401**	**334**	**501**	**2391**	

Table 6.29 Test statistics of One-Way ANOVA Tukey post-hoc. Alder (*Alnus glutinosa gaertn*), hazel (*Corylus avellana*) twigwood, maloideae (Pomaceous fruits) and oak (*Quercus sp.*) according to cemetery. * Statistically significant.

Species	Cemetery (I)	Cemetery (J)	Mean Difference	Standard Error	Sig.	Lower Bound	Upper Bound
Alnus glutinosa gaertn	Spencer Park	Wallington Road	3.25000	.98075	*0.026	.3152	6.1848
		Folly Lane	3.25000	.87856	*0.011	.6210	5.8790
		Cross Farm	3.25000	1.11664	0.059	-.0914	6.5914
		M1 Junction	3.25000	1.03380	*0.037	.1565	6.3435
Corylus avellana twigwood	Spencer Park	Wallington Road	1.25000	.38971	*0.032	.0838	2.4162
		Folly Lane	1.25000	.34911	*0.014	.2053	2.2947
		Cross Farm	1.25000	.44371	0.071	-.0777	2.5777
		M1 Junction	1.25000	.41079	*0.045	.0208	2.4792
Maloideae	Spencer Park	Wallington Road	60.65000	8.91800	*0.000	33.9640	87.3360
		Folly Lane	55.91667	7.98880	*0.000	32.0112	79.8222
		Cross Farm	53.25000	10.15359	*0.000	22.8667	83.6333
		M1 Junction	55.50000	9.40040	*0.000	27.3705	83.6295
Quercus sp.	Wallington Road	Folly Lane	-76.88889	20.94535	*0.012	-139.5652	-14.2126
		Cross Farm	-35.00000	27.42390	*0.708	-117.0626	47.0626
		M1 Junction	-49.50000	25.19046	*0.318	-124.8793	25.8793
		Spencer Park	-23.25000	25.19046	*0.885	-98.6293	52.1293

Table 6.30 Wood taxa according to sex. *N = Number of fragments of each taxon identified. *Ub = Ubiquity (how often a species appears in each category). Pooled data of all individuals in charcoal study, excluding the Late Iron Age data.

	Female	Male	TOTAL N.	TOTAL Ub.
Maloideae	3	58	**61**	**2**
Prunus sp.		3	**3**	**1**
Quercus sp.	97	341	**3**	**1**
TOTAL IDENTIFIED	**100**	**402**	**502**	
Unidentified		4	**4**	**1**
TOTAL INCLUDING UNIDENTIFIED	**100**	**406**	**506**	

Table 6.31 Wood taxa according to age. *N = Number of fragments of each taxon identified. *Ub = Ubiquity (how often a species appears in each category). Pooled data of all individuals in charcoal study, excluding the Late Iron Age data.

	< 13	**14 - 18**	**18 +**	**TOTAL N**	**TOTAL Ub**
Alnus glutinosa gaertn			13	**13**	**1**
Betula pubescens			4	**4**	**1**
Betulaceae sp.	1			**1**	**1**
Corylus avellana cf.			1	**1**	**1**
Corylus avellana twigwood			5	**5**	**1**
Carpinus betulus	2			**2**	**1**
Coal			2	**2**	**1**
Fagus sylvatica			1	**1**	**1**
Fraxinus excelsior	11		1	**12**	**1**
Fraxinus excelsior twigwood		7		**7**	**1**
Maloideae	20	21	325	**366**	**3**
Pomoideae cf. crataegus	1			**1**	**1**
Prunus cf. spinosa			2	**2**	**1**
Prunus sp.			20	**20**	**1**
Quercus sp.	264		1337	**1601**	**2**
Quercus sp. twigwood		158	1	**159**	**2**
Ulmus sp.			2	**2**	**1**
TOTAL IDENTIFIED	**299**	**186**	**1714**	**2199**	
Unidentified	2	5	31	**38**	**3**
Unidentified twigwood		9	2	**11**	**2**
TOTAL INCLUDING UNIDENTIFIED	**301**	**200**	**1747**	**2248**	

Table 6.32 Test statistics of One-Way ANOVA. Birch (*Betulaceae sp.*), hornbeam (*Carpinus betulus*), ash (*Fraxinus Excelsior*), hawthorn (*Pomoideae cf. crataegus*), and oak (*Quercus sp.*) roundwood and twigwood according to age. * Statistically Significant.

Species	**Groups**	**Sum of Squares**	**d.f.**	**Mean Square**	**F**	**Sig.**
Betulaceae sp.	Between Groups	0.450	2	0.225	7.650	*0.004
Carpinus betulus	Between Groups	1.800	2	.900	7.650	*0.004
Quercus sp. roundwood	Between Groups	11839.068	2	5919.534	4.793	*0.022
Quercus sp. twigwood	Between Groups	23700.009	2	11850.004	214040.705	*0.000

Table 6.33 Wood taxa according to number of grave goods. *N = Number of fragments of each taxon identified. *Ub = Ubiquity (how often a species appears in each category). Pooled data of all individuals in charcoal study, excluding the Late Iron Age data.

	1 - 2	3 - 4	5 - 6	TOTAL N.	TOTAL Ub.
Betulaceae sp.	1			**1**	**1**
Carpinus betulus		2		**2**	**1**
Fagus sylvatica	1			**1**	**1**
Fraxinus excelsior roundwood	11			**11**	**1**
Fraxinus excelsior twigwood		7		**7**	**1**
Maloideae	63	57	8	**128**	**3**
Pomoideae cf. crataegus		1		**1**	**1**
Prunus sp.		3		**3**	**1**
Quercus sp.	262	753	88	**1103**	**3**
Quercus sp. twigwood		158	1	**159**	**2**
TOTAL IDENTIFIED	**338**	**981**	**97**	**1416**	
Unidentified	1	18	3	**22**	**3**
Unidentified twigwood		9		**9**	**1**
TOTAL INCLUDING UNIDENTIFIED	**339**	**1008**	**100**	**1447**	

6.10 Comparisons with Late Iron Age Data

Only two individuals in this cremation technology study pre-date the Roman conquest. This temporal bias is not surprising considering how little Late Iron Age data were collected in the survey of cremation practices (see Chapter 5). These individuals come from the cemeteries of Wallington Road and M1 Junction; one of the individuals was identified as an adult male, who was buried with one grave good. Due to this small sample size, it is only possible to discuss these individuals in relation to any general trends identified amongst the pooled Roman data; because of this sample bias, no statistical analyses were conducted.

6.10.1 Weight

Overall, very little burned bone was deposited in the Late Iron Age graves. The weight from these contexts ranges was 1.1g and 36.9g, with a median weight of 19g. Unsurprisingly, the urned burial from Wallington Road included more burned material (36.9g) than the unurned cremation deposit from M1 Junction (1.1g). Compared to the Roman urned and unurned burials, the Late Iron Age deposits include considerably less burned bone material (Figure 6.41). It is not possible to comment on whether this represents a genuine temporal trend in cremation technology; however, it is interesting that the two Late Iron Age deposits are considerably smaller than others of the same burial type, but of Roman date from the same cemeteries.

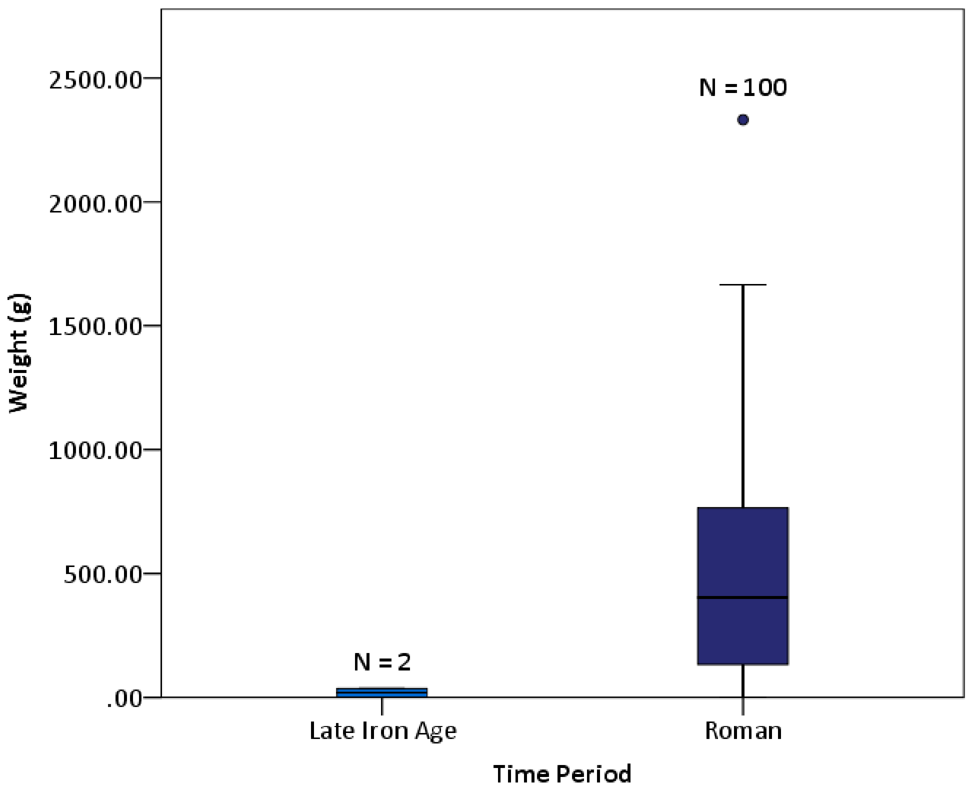


Figure 6.41 Distribution of weight according to Late Iron Age and Roman data. Pooled sample of all individuals in cremation technology study.

6.10.2 Fragmentation

The majority of the burned bone from Wallington Road (93.5%, 34.5g) exceeds 10mm in size; same as the pooled Roman data. Interestingly, the majority of burned bone from the Roman cremation deposits at M1 Junction comes from the >2mm fraction (71%). However, all of the material from the Late Iron Age burial from the same cemetery came from the >10mm fraction (Figure 6.42). It is not possible to comment of whether this represents a temporal trend; however, as the pre-conquest burial was unurned, it is possible that smaller fragments of bone did not survive excavation.

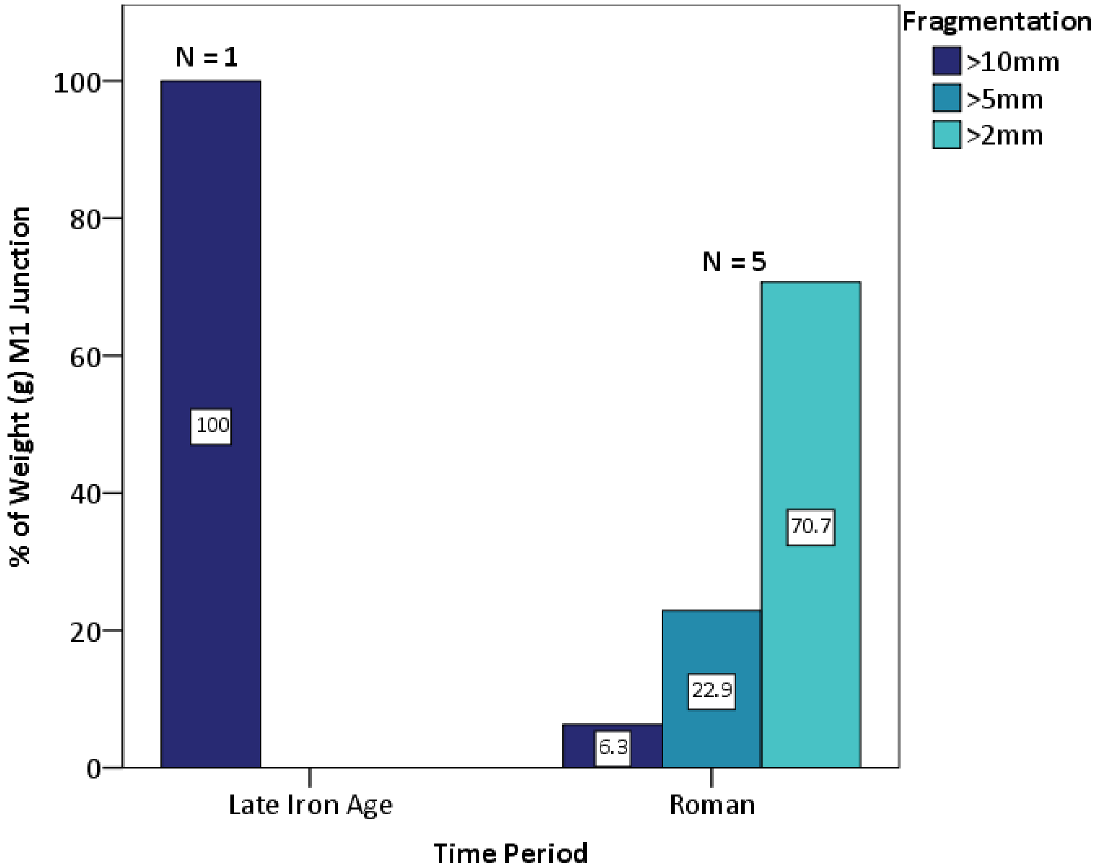


Figure 6.42 Fragmentation of burned bone from M1 Junction. Pooled Roman data compared to the Late Iron Age individual.

6.10.3 Skeletal Representation

A total of 36.7g (96.6% of 38g) of burned bone form the Late Iron Age cremation deposits were identified to skeletal zone. The majority of burned bone from the Roman cremation deposits are lower limb fragments (33%, 4593.6g), 91.8% (33.7g) of the Late Iron Age material are cranial fragments (Figure 6.43). The burned bone fragments from the M1 Junction burial were from the proximal humerus (1.1g), while the Wallington Road cremation deposit included exclusively cranial (33.7g) and vertebral fragments (1.9g).

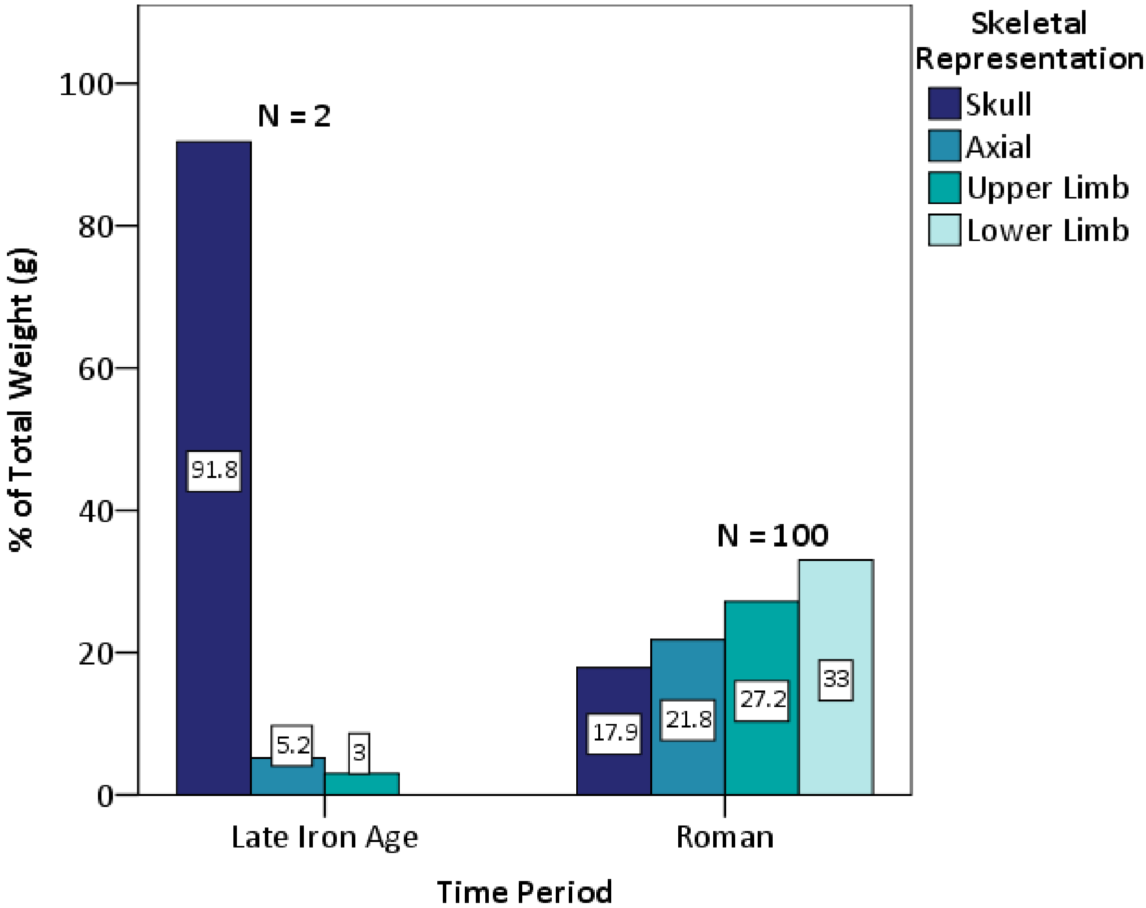


Figure 6.43 Skeletal representation of burned bone according to Late Iron Age and Roman data. Pooled Roman data compared to the Late Iron Age individual from M1 Junction.

6.10.4 Oxidisation

Similar to the Roman data, the Late Iron Age individuals exhibit the full spectrum of chromatic alteration ranging from brown to buff white, which suggests incomplete oxidisation.

6.10.5 Histology

The microstructure of the burned bone from the Late Iron Age contexts was very poorly preserved. Both samples showed almost complete hydroxyapatite fusion, with very few Haversian systems, indicative of complete cremation (+900°C). Most of the individuals from the Roman sample (63%, N = 63) also reached temperatures above 900°C.

6.10.6 Quantitative Petrography

The Late Iron Age results from the quantitative petrographic study are similar to those from the histological examinations (demonstrating that the results are reliable). Both individuals that pre-date the Roman conquest were assigned to category IV (1000-1100°C), because of the lack of microscopic features and fusion of hydroxyapatite. Similarly, 64% (N = 64) of the Roman sample were also assigned to this category reaching temperatures over 1000°C.

6.10.7 Crystallinity

The results from the crystallinity analyses by FTIR-ATR are similar to those from the histological examinations and quantitative petrography, showing that they are reliable. The crystallinity measures for the two Late Iron age individuals clustered at values indicative of higher burning intensity; similarly the majority of the Roman data (78%, N = 78) also fell within the higher burning category.

6.10.8 Charcoal Analysis

Charcoal data were only collected for the Late Iron Age individual from M1 Junction. Even though 3 taxa were identified, 56.6% (N = 56) of the charcoal assemblage was oak (*Quercus sp.*). The other dominating taxon identified was maloideae (Pomaceous fruits) (39.4%, N = 39); this combined use of oak (*Quercus sp*) and maloideae (Pomaceous fruits) was also identified in 9 of the Roman cremation deposits. With regards to species ubiquity holly (*Llex aquifolium*) fragments were identified in the Late Iron Age assemblage, which were not present in any of the Roman cremation deposits from M1 Junction (Table 6.34).

Table 6.34 Wood taxa according to Late Iron Age and Roman cremation deposits from M1 Junction. *Ub = Ubiquity (how often a species appears in each category). Pooled data of all individuals from M1 Junction.

	Late Iron Age	Roman	TOTAL	
			N	Ub
Betula pubescens		3	**3**	**1**
Fagus sylvatica		1	**1**	**1**
Llex aquifolium	3		**3**	**1**
Maloideae	39	27	**66**	**2**
Quercus sp.	56	302	**358**	**2**
TOTAL IDENTIFIED	**98**	**333**	**431**	
Unidentified	1	1	**2**	**2**
TOTAL INCLUDING UNIDENTIFIED	**99**	**334**	**433**	

6.11 Summary of Hertfordshire Results

The results from the primary analysis have highlighted several trends within the Hertfordshire data. In relation to burned bone weight, the Rural cremation deposits were significantly smaller than the Urban sample (p = 0.019). More specifically, the individuals from Spencer Park had a significantly smaller median weight than those from Wallington Road (p = 0.041). Even though the female cremation deposits were statistically smaller than the Male individuals (p = 0.029), this does not explain the variation according to cemetery and settlement type.

The size of burned bone fragments were also found to differ significantly according to settlement type (d.f = 190; p = < 0.001) and cemetery (d.f = 186; p = 0.003). Unsurprisingly, the 14 to 18 year olds and <13 year olds had a greater proportion of 2mm fragments then those over 18 years of age (d.f = 168; p = 0.35). This difference according to age however does not explain the variation between settlement type and cemetery.

The results from the macroscopic, and microscopic examinations found that burning intensity was not subject to differences in sex, age or the number of grave goods. Instead, the Rural individuals displayed significantly higher burning temperatures, than the pooled Urban sample. In addition, the FTIR-ATR data found no difference according to cemetery; however, burned bone colour, histology and quantitative petrography found that Cross Farm achieved significantly higher burning temperatures than Wallington Road.

With regards to charcoal analysis, oak (*Quercus sp.*) was the dominant taxon identified at most cemeteries and all settlement types. The combined use of oak (*Quercus sp*.) and maloideae was recorded in 9 samples, representing the most prevalent combination of taxa. The pooled Rural data, included the highest number of species according to settlement type, which is caused by Spencer Park. Several tree types were only recorded for certain cemeteries, and settlement types. Interestingly, the majority of twigwood identified was recovered from a single burial, the grave fill of an individual between 14 and 18 years of age from Spencer Park, while several species were found to differ significantly between age groups, including, birch (*Betulaceae sp*.), hornbeam (*Carpinus betulus*), hawthorn (*Pomoideae cf. crataegus*) and oak (*Quercus sp*.) roundwood and twigwood. No difference according to sex or the number of grave goods was found.

Overall, the Late Iron Age data showed the same trends as the Roman sample. The only difference was in the distribution of weight and fragmentation. The Late Iron Age cremation deposits had considerably less burned bone than the Roman burials. In addition, the pre-conquest individual from

M1 Junction had larger bone fragments compared to the Roman group. However, these results are most likely circumstantial considering the difference in sample size.

Chapter 7: Discussion - The Application of Quantitative Petrography in Cremation Research

7.1 Quantitative vs. Qualitative Analysis

The new quantitative petrography approach pioneered here for cremation analyses compliments the results ascertained by previous histological research (Squires, et al., 2011; Absolonová, et al., 2012; Castillo, et al., 2013), as well as those derived from the examination of macroscopic colour (Munro, et al., 2007; Thompson et al., 2016), and crystallinity (Thompson, et al., 2013). The results therefore demonstrate that the quantitative method could potentially replace traditional histological methods and be used in combination with other techniques. By comparing Quantiative Petrography with Squire and colleagues (2011) qualitative analysis of the histological changes in burned bone, broad similarities were identified in the microscopic changes that occur to bone when heated. Squires found three main phases of taphonomic alteration between 300-600°C, 600-900°C, and 900°C+. These correlate with those found by this new method; the only difference was that Quantitative Petrography found additional alterations between 100-400°C. This is because the bone samples used by Squires were heated to a minimum temperature of 300°C. As such, no consideration was given to lower firing temperatures.

The new categorising system presented in this study generates narrower temperatures ranges than other, non-quantitative, methods (Squires, et al., 2011) and thus allows a more precise reconstruction of burning conditions. The K-means cluster statistical analysis identified four significant categories of heat-induced alteration between 100 – 1100°C degrees, which is similar to the burning stages identified by other studies (Hanson and Cain, 2007; Squires, et al., 2011; Castillo, et al., 2013). A similar statistical approach was successfully used by Absolonová et al., (2013) to compare the microscopic dimensions of bone shrinkage between human unburned bone with samples fired at 700°C, 800°C, and 1000°C. This study found that the greatest changes in burned bones microstructure occurred around 800°C.

Minimal microscopic alteration took place at temperatures between 100°C and 400°C, which is understandable considering that these temperatures are used in cooking and do not result in heat-induced bone modification. At this stage, between 48.3% and 53.6% of the sample area consisted of organic material, which includes carbon and collagen (Ellingham, et al., 2015b). The remainder constitutes mostly well preserved micro-features such as Volkmann's canals and canaliculi. This is to be expected and represents the dehydration stage of burned bones' transformation whereby hydroxyl-bonds start breaking resulting in the loss of water (Ellingham, et al., 2015b). Between 500˚C

– 600˚C, the sample area demonstrates increased depletion of microscopic definition, whereby between 14.7% and 18.3% of the sample area displays poorly defined features including Haversian systems and Volkmann's canals. Previous research has established that this represents the decomposition and removal of carbon and collagen within the bone's matrix (Hanson and Cain, 2007; Squires, et al., 2011). At 700˚C and 900˚C all organic material is removed from the sample area due to pyrolization (Ellingham, et al., 2015b). Haversian systems are the only discernible microscopic features remaining, and their form has become misshapen due to the decomposition of bones organic components and fusion of hydroxyapatite, which makes up 50.6% to 59.6% of the sample area. By 1000°C 86.3% of the sample area shows hydroxyapatite fusion, representing the melting and coalescing of the crystal matrix (Ellingham, et al., 2015b). This is evident by the overall lack of discernible microscopic features and white colouration of the bone (Squires, et al., 2011; Castillo, et al., 2013).

7.2 Inter-Observer Study

Overall, the results from all five examiners (human bone specialists and non-human bone specialists) were highly consistent, achieving a percentage agreement of 80% in their assessments. This outcome shows that this method reduces the risk of inter-observer bias and encourages standardised assessment of burned bone histology. None of the participants had any difficulty in using the PETROG set-up or software, and three of the examiners commented on how easy the method was to use and understand. Both groups of participants quickly learnt the terminologies and became increasingly confident in their observations over the duration of the study. Nevertheless, the entire process was relatively time consuming; on average, it took the participants one hour to analyse two burned bone thin-sections, and some commented on how repetitive the process became. However, it is worth noting that over time and with practice, this process becomes quicker once users are more familiar with the set up and software. The author is now able to analyse a minimum of five slides per hour. Overall, this first test of inter-observer reliability in quantitative burned bone histology successfully demonstrated how reliable this method is.

The results ascertained from this study demonstrate the value of quantitative petrography in the analysis of burned human remains and show that it should be applied more widely in this field alongside other modes of analysis; future research would benefit from exploring its potential more. For instance, by using the measuring application of the PETROG software to conduct a metric assessment of the microscopic features of burned bone to identify how their size changes during the cremation process.

Chapter 8: Discussion - Cultural Transitions in Late Iron Age and Roman Cremation

8.1 Nature of Data

8.1.1 Distribution of Data: Time Period and Region

The secondary data collated in this study is unevenly distributed. The majority of cremation deposits come from South-East England (74.1%, N = 1759 of 2375), while other regions such as the North (12.4%, N = 294) and South-West (2.6%, N = 62) are underrepresented (Figure 8.1). This is even more pronounced in the Late Iron Age where data were only recorded for the South-East and Midlands. Due to this uneven distribution, this investigation has shown that it is not possible to investigate trends in cremation practices from the Late Iron Age to the Early Roman period for most of the country; comparisons can only be made between the South-East and Midlands.

It is well established in Late Iron Age and Roman studies that burial data are heavily skewed towards the South-East of the country, while the Northern territories and most areas in the South-West have been comparatively understudied (Pearce, 2008; 2013; Redfern and DeWitte, 2011). This bias in the available data is clear in Figure 8.1, which is a distribution map of excavated funerary sites generated from the *Rural Settlement of Roman Britain* database (Allen, et al., 2016). Of the 15,579 inhumation and cremation burials from 1162 excavated rural cemeteries included in this survey, there is a discernible concentration in the central belt, particularly in the South-East (Smith, et al., 2018). This uneven distribution is a result of greater activity of commercial archaeology in this region that has been stimulated by economic development (Haselgrove and Moore, 2007; Pearce, 2008; 2013; 2016; Fulford and Holbrook, 2011; Redfern and DeWitte, 2011).

This bias towards evidence from central and southern Britain has led to a distorted perception of cultural change during the Late Iron Age and Roman periods (Pearce, 2008). For instance, cultural change was thought to have started in South-East Britain and then filtered to the North and West (Hill, 1995; Sargent, 2002). As pointed out by Hill (1995) and Sargent (2002) this interpretation defines the South-East as culturally dominant compared to other areas and neglects the complexity of other communities outside of this district. It also overlooks the possibility that burial rites in other areas were different, less visible or comparatively understudied; a characterisation that resembles modern socio-political divides in the UK.

This investigation has confirmed that previous interpretations of provincial Roman society in Britain are inaccurate due to the lack of regional data from the North and South-West. It has also demonstrated that with Late Iron Age and Roman burial data in its current state, it is not possible to attempt a holistic interpretation of regional trends in cremation practices during the Late Iron Age to Early Roman transition. Due to the scarcity of burial information from the North and South-West, it is not possible to comment on whether any patterns identified are characteristic of that region, or simply a reflection of a handful of cemeteries. The paucity of cremation deposits could represent different funerary practices, where cremation was not the predominant rite. However, at present this cannot be confirmed given the poor quality of the archaeological data from these areas. This study emphasises that future research should focus on exploring the burial record from geographical areas other than central and southern England and collect new data, as well as re-analysing known cemeteries to examine cultural transitions through burial practices (see section 9.3).

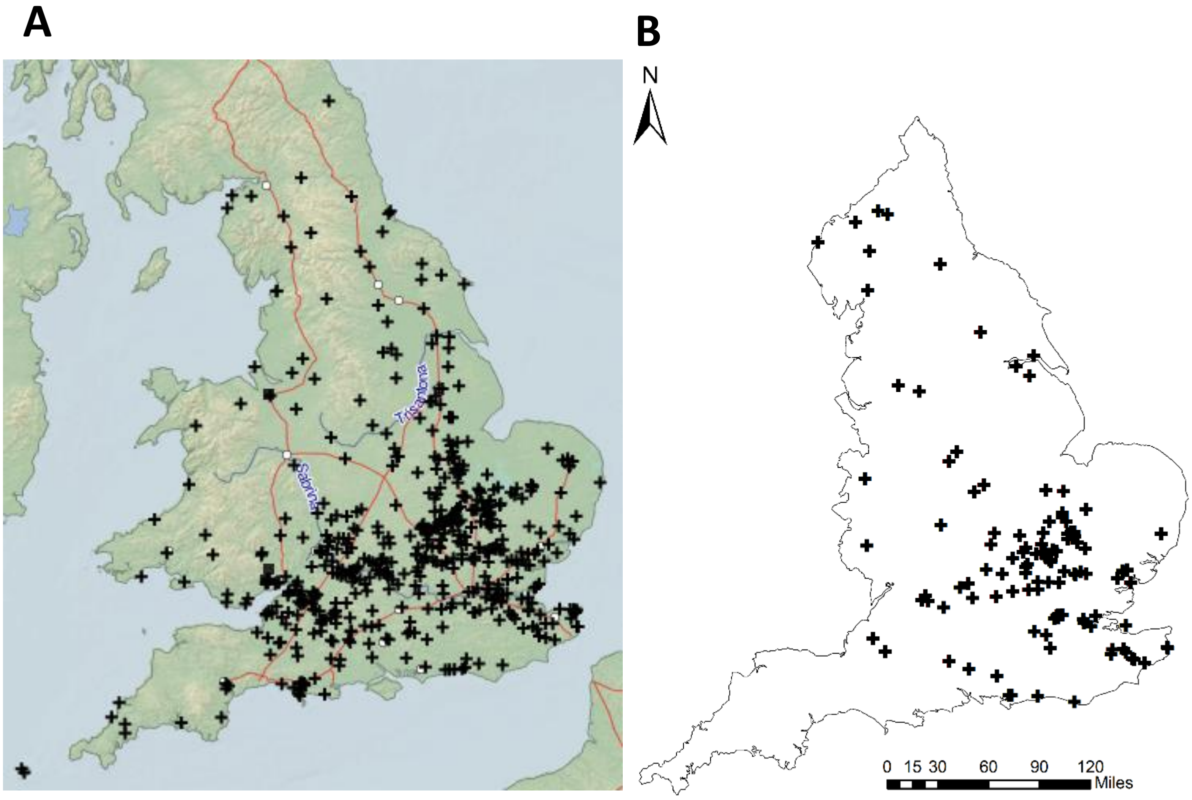


Figure 8.1 A) Distribution of excavated rural funerary sites (cremation and inhumation). Data provided by the *Rural Settlement of Roman Britain* database (Allen, et al., 2016). B) Distribution of cemeteries in survey of cremation practices. Data collected in this thesis.

8.1.2 Distribution of Data: Settlement Type

Both the primary and secondary investigations in this study have demonstrated that the majority of burial data derive from urban settlements. In relation to the primary examination of Hertfordshire, 59.8% (N = 61 of 102) of the cremation deposits came from either minor or major urban sites, while 75.2% (N = 1787 of 2375) of the cremation deposits from the secondary dataset came from urban cemeteries. However, for both investigations the majority of the burial grounds examined were rural

(Figure 8.2). In other words, while there were more rural cemeteries overall, the large urban cemeteries included far more cremation deposits. On more than one occasion the urban study samples included more cremation burials that derived from only one, or several dominating cemeteries. This investigation has highlighted that most of the available burial data comes from a handful of well-documented urban settlements. However, it has also shown that there is sufficient data from rural sites to allow for cross-comparisons of cremation practices from the Late Iron Age to the Early Roman period.

Several scholars have already drawn attention to this bias towards urban cemeteries and commented on how it is skewing perceptions of cultural change during the Late Iron Age and Roman periods in Britain (Pearce, 2013; Redfern and DeWitte, 2011). Rural funerary data has been largely understudied, excluding the *Rural Settlement of Roman Britain* project launched at the University of Reading in 2012. Again, this bias in the burial record has its foundations in modern economic growth; the surge in commercial archaeology within the last few decades has focused predominantly on cities and towns as a result of the increase in infrastructure projects (Fulford and Holbrook, 2011; Redfern, et al., 2015). Consequently, urban complexes are more often excavated, better documented and more extensively studied compared to rural settlements.

As a result, previous research has predominantly focused on these large urban samples, which as pointed out by Pearce (2008, p.39) has created an inaccurate interpretation of cultural change that is not representative of provincial society as a whole. In other words, this bias towards urban sites assumes that the cultural transitions that took place in towns resembled the processes that happened in rural communities. Again, this not only overlooks the diversity of burial practices between different settlement types, but also the role rural communities played in the process of 'Romanisation'.

This study has shown that, in fact, cremation practices were not homogenous across all settlement types; in particular, the Hertfordshire data shows significant variation between urban and rural cemeteries (see section 8.3). As such, it is inappropriate for scholars to use these large urban samples as a model for Romano-British society. Specifically, burning intensity was consistently higher at rural cemeteries, while the urban sample showed greater variation in firing conditions. This suggests that cremation technology was not the same and was subject to varying responses to cultural change. However, it is appreciated that this bias towards urban burial data is not easy to overcome and rural data are particularly difficult to locate, and even more challenging to sample. This is because finds are not as well documented, and the archives are consistently poor. The research conducted here highlights that future research should strive to resolve this issue to avert problems induced by comparatively small sample sizes available from rural populations (see section 9.3).

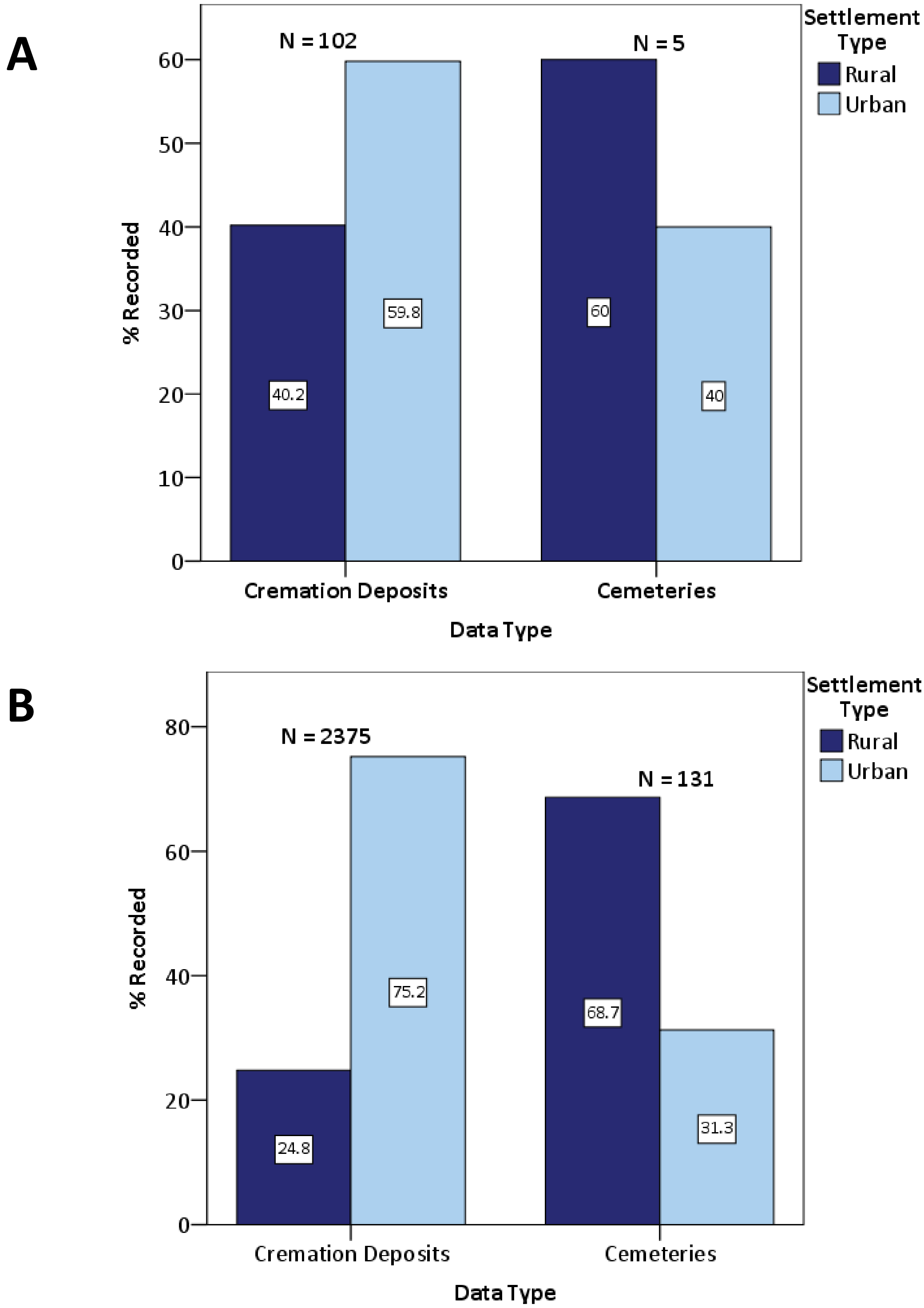


Figure 8.2 Percentage of cremation deposits and cemeteries according to settlement type. A) Pooled Data collected from primary investigation. B) Pooled data collected from secondary investigation.

8.1.3 Dominance of the Same Large Cemeteries

The survey conducted in this study has shown the significant impact of large, well-known cemeteries on examinations of Late Iron Age and Roman cremation practices in Britain. With the inclusion of 131 cemeteries dating from the Late Iron Age to the Late Roman periods, the majority of the data (66.1%, N = 1569 of 2375) derive from just thirteen large burial grounds. This meant that when examining trends according to region, time period or settlement type, the study sample was at times biased towards one or several cemeteries that were skewing the data. By identifying and temporarily removing these large cemeteries from the study sample, it was possible to examine the other cemeteries and establish to what extent the large ones are representative of burial practices from smaller sites. As a result, this study has demonstrated for the first time that the communities associated with these well-known burial grounds do not necessarily resemble those from the same geographical or temporal contexts, and any interpretations regarding cultural transitions need to be critically compared to smaller sites before it is used as a model of 'Romanisation'.

It has been common practice in Late Iron Age and Roman studies to reuse the same, well-known burial grounds such as King Harry Lane or Westhampnett, as primary case studies to examine cultural change (Millet, 1993; Haselgrove and Millet, 1997; Pearce, 1998; Fitzpatrick, 2000). While this approach encourages research progression and introduces new interpretations of well-studied sites, it skews the archaeological understanding of provincial society that is largely based on a handful of cemeteries (Pearce, 2008). As a result, other communities whose practices deviate from those of these large cemeteries remain overshadowed and unexplored (Fitzpatrick, 1991).

Some studies have tried to overcome this by examining burial grounds with a minimum number of burials (Davison, 2000; Watts, 2001). A similar approach could have been applied here. However, by not doing so this study has gained insight into smaller, more isolated communities that have previously been overlooked by other research. For instance, Davison (2000) in his examination of the male / female ratio in Romano-British cemeteries only included sites where a minimum of 30 sexed or possible sexed burials from both urban and rural cemeteries. The intention of which was to ascertain a sufficient study sample that was representative of that community. However, given the difficulties conducting sex assessment on burned human bone, this inevitably creates a bias towards well-preserved burial grounds, overlooking how and why these sites differ from smaller communities.

The following sections examine the dominant cemeteries identified by this study and discuss what can be inferred about cultural identifiers and 'Romanisation' when compared with smaller, neighbouring burial grounds.

8.1.3.1 Burial Type

King Harry Lane, St Albans, is a large inhumation and cremation burial ground situated adjacent to the Roman settlement of *Verulamium*. The settlement itself was an oppidum during the Late Iron Age (referred to as *Verulamion* in the literature (Niblett, 1999)), before becoming a *municipium* in the centuries following the Roman conquest (Stead and Rigby, 1989; Niblett, 1999). The site was active from the 1st century AD until the 3^{rd} or 4^{th} century AD. In this study, the site was recorded as two separate cemeteries, the large Late Iron Age burial ground consisting of 388 cremation deposits, and the much smaller Late Roman cemetery including 29 cremation burials. The effect of this large Late Iron Age burial ground on the combined data-set becomes particularly clear when considering burial type: for the South-East, 311 of the 532 identified cremation burials from this region were urned, making this the dominant type; however 96.8% (N = 301) of these cremation deposits came from King Harry Lane. Once removed from the study sample, it is clear that the majority of burials from other cemeteries within this region were in fact unurned, and that King Harry Lane displayed unusual practices for this area.

In their review of Iron Age *Verulamion*, Haselgrove and Millet (1997, p.292) suggest that the individuals buried at this site were migrants traveling to the oppidum. That this is why there was a drop in the number of goods placed within graves overtime at the cemetery. According to this hypothesis, the unusual prevalence of urned cremation burials was a reflection of migrating groups settling in *Verulamion* and introducing new burial practices to the region. However, would such a high number of migrants be expected? From examining the burial evidence, it is unlikely that the vast majority of individuals buried at *Verulamion* were not local. In his recent examination of grave goods from the King Harry Lane cemetery, Pitts (2017) suggests that local groups were imitating fashions from the continent. The findings from this thesis support Pitts' argument in that the majority of cremation deposits were placed in urns, imitating continental fashion, and further suggest that this community had a pro-Roman attitude towards death and burial, representing a distinct change in cultural practices. The smaller cemeteries in the region, however, appeared more resistant to change and continued to express Late Iron Age identities. King Harry Lane has been repeatedly examined in Late Iron Age burial studies because it is considered the largest, example of 'Aylesford' burials known from any cemetery in Late Iron Age Britain (Pearce, 1997). Researchers are therefore aware of how unusual this burial ground is within this context; however, until now no consideration has been given to how representative this burial ground is in the wider context of South-East Britain.

The Early Roman cemetery of Skeleton Green is located on the outskirts of the Roman town of Braughing (Hertfordshire). The site was a significant settlement in the Late Iron Age period and continued to prosper as a small Roman town after the conquest (Partridge, 1981). The cemetery was active from the 1st century AD to the 3rd or 4th century AD. Because the Roman town of Braughing was not classified as a *civitas*, *municipcium*, or *colonia* the cemetery was described here as 'minor urban'. In this investigation, Skeleton Green skewed the study sample for Early Roman minor urban cemeteries; of the 193 identified cremation deposits 102 were urned but 63.7% of these (N = 65) derived from Skeleton Green. When the site was temporarily removed from the sample, it became clear that the majority of minor urban cremation deposits (69.3%, N = 88) did not in fact include cinerary urns. It is not surprising that the minor urban settlements demonstrated a delayed response in taking up Roman practices, as small towns had less Roman contact compared to large urban complexes, such as *civitates.* However, it is interesting that Skeleton Green differs from this trend. Excavations within the last few years have shown that Braughing was a larger settlement than initial archaeological investigations suggested. In particular, the recent uncovering of an extensive cremation cemetery including hundreds of burials adjacent to the Roman town demonstrates the extent of the settlement's population (Fosberry, pers comm, 2016). As such, it is possible that Skeleton Green has been wrongly categorised as a minor urban settlement. From Partridge's (1981) monograph it is also clear that the cemetery is highly usual compared to other contemporary sites. For instance, a cluster of cremation burials with decorated wooden caskets was uncovered representing a distinct social group. It is possible that the use of wooden caskets as urns, rather than the ceramic vessels typically associated with burials from this time period suggest local innovations of Roman customs. The Roman Town of Braughing is part of six Late Iron Age and Roman settlements of Hertfordshire with links to London by road (Niblett, 1997). It is therefore likely that the individuals from Skeleton Green innovated new burial customs as a result of increased Roman contact, suggesting the development of new cultural identities as part of the process of 'Romanisation'. This is not to suggest that these new identities were 'Roman', but simply that they were distinguishable from the wider social context. To date, very little consideration has been given to this cemetery in contemporary literature, excluding the cemetery's excavation report (Partridge, 1981) and Fitzpatrick-Matthews' (2007) examination of small group identities from Roman Baldock. This is the first study to demonstrate that this is a large dominating cemetery that does not represent contemporary sites.

Yeomanry Drive North, Baldock is an extensive burial ground that is part of the Baldock cemetery complex in Hertfordshire. Baldock was a Late Iron Age oppida that is presumed to have taken on the rank of *vicus* after the Roman conquest (Fitzpatrick-Matthews, 2010). The cemetery was in used from the 1st century AD to the 4th century AD and practiced both inhumation and cremation. Compared to other Middle Roman, minor urban cemeteries, Yeomanry Drive North had an unusually high prevalence of unurned cremation burials that skew the study sample. A total of 313 unurned burials were identified in total, but 71.9% (N = 225) came from Yeomanry Drive North. When temporally removed from the investigation, it became clear that more cremation deposits (48.3%, N =14) were urned. This result has been discussed briefly by Fitzpatrick-Matthews (2007) who argues that this cemetery represented a distinct social group that did not adopt the innovation of using cinerary urns but persisted with Late Iron Age customs. He suggests that this is unlikely to represent a lack of wealth given the number of well-furnished cremation burials found at this site but indicates a local group that was continuing to express local identities. Williams (1999) points out that British communities may have initially used funerary practices to emphasise their distinctiveness from Roman groups. The results from Yeomanry Drive North support this statement in that this group were actively choosing burial rites that differed from contemporary minor urban settlements. This in turn suggests a distinct cultural identity that resembled Late Iron Age traditions. The excavation of Yeomanry Drive North remains largely unpublished, excluding the summary data provided by Fitzpatrick-Mathews and Burleigh's (2007), and Fitzpatrick-Matthews (2016). As such, contemporary literature has given little attention to this cemetery complex in the wider context of burial practices in Roman Britain. The only exception is Fitzpatrick-Matthews (2007) who emphasises how Yeomanry Drive North, along with Sale Drive East, Sale Drive West, and Sale Drive Doline (all of which are part of the large cemetery complex at Baldock), do not resemble the burial practices from other local cemeteries. The results presented here confirm Fitzpatrick-Matthews (2007) findings and demonstrate that the burial practices here are not representative of the wider context of minor urban cemeteries in Roman Britain.

Derby Racecourse, Little Chester is an inhumation and cremation cemetery attached to one of the three Roman towns found in *Derventio*. Little is known about the settlement in the Late Iron Age, however after the Roman conquest the site became a prominent Roman town and fort (Wheeler, 1985). The cemetery was active from the first half for the 2nd century AD and included a mausoleum and walled cemetery. During the meta-analysis, Derby Racecourse was found to have an uncommonly high number of unurned burials (N = 36) compared to other Early Roman cemeteries in the Midlands that was skewing the study sample. When removed, it was clear that 69.7% (N = 53) of the identified cremation deposits from the Midlands were urned. This is unusual considering the strong Roman military presence in the area (Wheeler, 1985). However, it is clear from Wheelers' (1985) excavation report that the lack of urned cremation burials was probably a reflection of post-depositional damage, which disturbed the cemetery complex and destroyed the cremation urns.

8.1.3.2 Brougham, Cumbria

Brougham, Cumbria is an extensive cemetery associated with the well-known Roman fort and settlement of Brougham. The cemetery was in use during the 3rd century AD and practiced both inhumation and cremation during this period. Interestingly, Brougham was the only burial ground in this study that had more pyre goods than grave goods. As, it was the only Late Roman minor urban burial ground found in the North-West, it made up the entire study sample. This result is surprising due to the destructive nature of cremation. Often, any items placed on the pyre rarely survived the cremation process (Marshall, 2011). Cool (2004) has commented on the elaborate nature of cremation at this cemetery pointing out that in several instances complete horse carcasses where placed on the pyre with the deceased, which is uncommon within the context of Roman Britain. Evidently, pyre display of the body and expression of individual identities was a key part of the cremation ritual at Brougham. Similar results were found by Thompson and colleagues (2016) in their examination of the cremation burials from five Romano-British military sites in the North of England. The recovery of green glass beads, and several unidentified metal objects, which were most likely jewellery, indicated the importance of bodily display and dress. The same is evident at Brougham, suggesting that Romano-British military sites were heavily influenced by Rome, and therefore cremation practices focused on expressions of personal, rather than communal, identities (Noy, 2000a).

8.1.4 Standardisation in Cremation Research

When this study compiled a database of cremation burials from Late Iron Age and Roman Britain, it became apparent that the available osteological data did not follow a standardised format. In particular, age data varied substantially between cemeteries, which meant that a new aging system had to be made specifically for this study. Further analysis showed that of the 67 (51.1% of 131) osteological reports examined here, age determination was the most common assessment method (Figure 8.3). However, examiners utilised different terminologies and categories to describe the age data collected (Table 8.1). For instance, even though most specialists used ‘Adult’ to describe an individual over 18 years, nine different age ranges were used, while a further seven were recorded to characterise ‘Infant’. In addition, several terms including ‘Young Human’, ‘Older Person’ and ‘Elderly’ were used to describe cremated individuals, but no chronological age range was provided (Table 8.1). This is the first study to review ageing categories and chronological age ranges in cremation research. Not only has this investigation demonstrated the urgency of this issue, but also confirmed how difficult it is to compare cremation data from different studies.

Rather than using different age categories based on unburned human remains to analyse cremation deposits, future research would benefit from employing simplified chronological age ranges that are more appropriate for cremated human remains. This study suggests that six universal age ranges should be used, including: >13 years; 14 – 18 years; 18-25; 25-45; 45+; Unknown. Descriptive terminologies of age groups are hindered by their different social, cultural connititions and therefore need to be avoided. The age ranges presented here acknowledge the key milestones in the human life cycle and provide a useful insight into age distributions in the past.

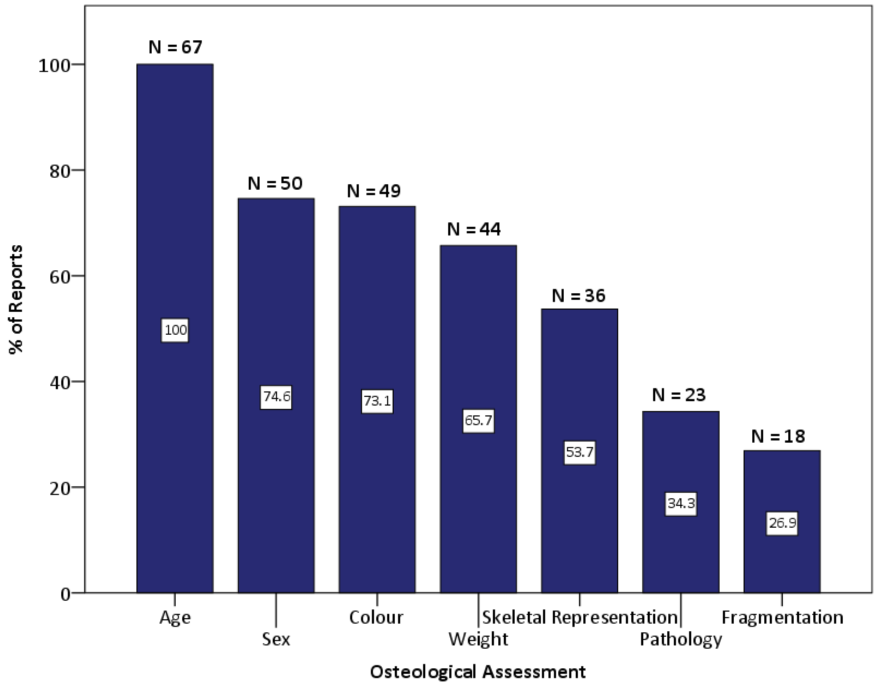


Figure 8.3 Percentage of reports according to osteological assessment.

Table 8.1 Age categories and ranges used in UK cremation reports, including examiners and publications.

Category	Age Range(s)	Examiner	Publication
Foetal	< 0 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	9 – 39 weeks	Jennifer Wood	Wood (2011)
Neonate	~0 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	Birth – 1 month	Mouli Start	Allen and Rylatt (2002)
	Birth – 5 months	Jennifer Wood	Wood (2011)
	< 6 months	Natasha Dodwell	Timby et al., (2007)
Infant	0 – 2 years	Sue Anderson	Orr (2010)
	3 – 4 years	Jacqueline McKinley	Birbeck (2001)
	0 – 1 year	Jonny Geber; Louise Loe	Powell et al., (2008)
	18 months – 2 years	Unknown	Shepherd (1988)
	1 – 11 months	Mouli Start	Allen and Rylatt (2002)
	6 months – 2 years	Jennifer Wood	Wood (2011)
	0 – 4 years	Natasha Dodwell	Timby et al., (2007)
Grown	Not Specified	Julie Curl	Orr (2005)
Juvenile	10 – 15 years	Sue Anderson	Orr (2010)
	15 – 23 years	Julie Curl	Orr (2005)
	13 – 17 years	Mouli Start	Allen and Rylatt (2002)
	< 15 years	Jennifer Wood	Wood (2011)
	5 – 12 years	Natasha Dodwell	Timby et al., (2007)
Adolescent	13 – 17 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	16 – 20 years	Jennifer Wood	Wood (2011)
	12 – 17 years	M. Harman	Wheeler (1985)
Sub– Adult	16 – 18 years	Sue Anderson	Orr (2010)
	13 – 18 years	Natasha Dodwell	Timby et al., (2007)
Immature	Sub-Adult, but age unknown	Ann Stirland	Stead and Rigby (1989)
Child	2 – 12 years	Jonny Geber; Louise Loe	Powell et al. (2008)
	< 12 years	M. Harman	Wheeler (1985)
	3 – 6 years	Jennifer Wood	Wood (2011)
Small Child	3 – 9 years	Sue Anderson	Orr (2010)
Young Child	2 – 5 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	1 – 6 years	Mouli Start	Allen and Rylatt (2002)
Young Human	Not Specified	Calvin Wells; G.W.I Hodgson	Jones (1977)
Older Child	6 – 12 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	7 – 12 years	Mouli Start	Allen and Rylatt (2002)
	7 – 15 years	Jennifer Wood	Wood (2011)

Adult	> 18 years	A Witkin; Jonny Geber; Louise Loe; Jacqueline McKinley	Brady (2006); Powell et al., (2008); Barber and Bowsher (2000)
	> 25 years	Ann Stirland	Stead and Rigby (1989)
Adult	23 – 40 years	Jacqueline McKinley	Stevens (2009)
	30 – 45 years	Francesca Boghi	Benfield (2007)
	> 30 years	Jacqueline McKinley	Birbeck (2001)
	18 – 45 years	Jacqueline McKinley	Birbeck (2001)
	at least 20 years	Unknown	Shepherd (1988)
	> 20 years	Unknown	Wilmott, (1993)
	> 17 years	M. Harman	Wheeler (1985)
Young Adult	18 – 25 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	17 – 25 years	M. Harman	Wheeler (1985)
	21 – 35 years	Jennifer Wood	Wood (2011)
	19 – 25 years	Natasha Dodwell	Timby et al., (2007)
Prime Adult	26 – 35 years	Jonny Geber; Louise Loe	Powell et al., (2008)
	26 – 45 years	Mouli Start	Allen and Rylatt (2002)
Aging Adult	> 35 years	M. Harman	Wheeler (1985)
Middle Adult	36 – 45 years	Jennifer Wood	Wood (2011)
	26 – 44 years	Natasha Dodwell	Timby et al., (2007)
Middle Aged Adult	35 – 50 years	Francesca Boghi	Benfield (2007)
Mature Adult	36 – 45 years	Jonny Geber; Louise Loe	Powell et al., (2008)
Mature / Older Adult	Not Specified	Jacqueline McKinley	Barber and Bowsher (2000)
Old Adult	45 – 60 years	Jennifer Wood	Wood (2011)
Older Mature	30 – 45 years	Jacqueline McKinley	Stevens (2009)
Older Adult	> 46 years	Jonny Geber; Louise Loe	Powell et al., (2008)
Older Person	Not Specified	Unknown	Wilmott (1993)
Elderly	Not Specified	Calvin Wells	Partridge (1981)
Senile	> 61 years	Jennifer Wood	Wood (2011)

It is well-established in UK bioarchaeological studies that cremation research lacks standardisation and a shared terminology (see Section 3.1) (Thompson, 2002; Quinn, et al., 2014; Gonçalves and Pires, 2017). As pointed out by Thompson (2002, p.55) this makes comparing results and experiments particularly difficult. A recent review of osteological reports examining cremated human remains by Gonçalves and Pires (2017, p.1685) concluded that if osteologists hope to investigate cross-regional themes and understand chronological, as well as geographical diversity of cremation practices, it is essential that they standardise their procedures.

Similar issues regarding standardised recording techniques have also been identified in the analysis of unburned human remains. For example, Falys and Lewis (2011) examined 200 articles from three leading journals that included the osteological assessment of unburned human remains. The intention of which was to assess the state of adult skeletal age-at-death estimations in biological anthropology. Their examination also found a lack of standardisation in the use of descriptive age categories, as well as the inappropriate use of some ageing methods. A total of eleven different non-numerical, age categories to describe adults were identified. Standardisation is clearly an issue in all fields of osteology, however in the context of burned human remains, it presents a more serious problem. Due to the destruction caused by extreme heat exposure, it is not always possible to ascertain basic osteological data, including age and sex. That is why it is imperative that the information retrieved is accurate and can be compared with other populations.

A further discovery from this review of standardisation in cremation research was that very few specialists attempt to age burned human remains that are under 18 years. Only a handful of cemeteries in the meta-analysis included non-adults. This is partially a result of demographic profiling, where not every cemetery includes individuals from all age groups. In addition, due to the taphonomic damage caused by cremation not all deposits of burned human remains will include skeletal features that will enable age assessment. However, the cemeteries of Brougham, Westhampnett, Yeomanry Drive North and London, Eastern Cemetery all show a prevalence of non-adults, and were analysed by the same osteologist (see section 8.2.5). Therefore, it is reasonable to suggest that other examiners who have less experience analysing cremated human bone may be reluctant to assign a chronological age range to an individual who is under 18 years of age. This may be due to a lack of confidence in handling and analysing burned human remains or an unfamiliarity with aging techniques when applied to cremated bone.

It is not within the scope of this thesis to resolve the problem of standardisation in cremation research. However, it is clear that the variety of age categories used by examiners to describe individuals, as well as the level of examiner bias does have serious ramifications on interpretations of cultural transitions and 'Romanisation' in the context of Late Iron Age and Roman Britain. It is hoped that this study has demonstrated the value of cremation data to cultural studies; if more effort was directed towards regulating the recording and analysing of burned human remains, its full potential could be realised. Recently, several studies have reviewed the current osteological methods used to analyse cremated human bone (Thompson, 2015a, p.2; Ellingham et al., 2015; Gonçalves and Pires, 2017). Next, scholars should focus on implementing the recommendations made by these publications in order to improve the quality of osteological data (see section 9.3).

8.2 Survey of Cremation Practices - 100BC to AD 410

8.2.1 Unurned and Urned Practices

This study has demonstrated that in the Late Iron Age for both the South-East and Midlands most cremation deposits were unurned (72.7%, N = 149 of 205). By the Early Roman period however, urned burials were more prevalent in both regions (64.9%, N = 243 of 358). It is widely held in Late Iron Age and Roman studies that this shift in burial type represents the spread of 'Roman' practices (Birbeck and Moore, 2004; Fitzpatrick, 2007; Timby, et al., 2007). However, Williams (2004) has recently challenged this assumption and suggests that this change in cremation practices does not represent the wholesale uptake of Roman customs, but a change in belief systems that focused on the selective remembering and forgetting of the dead. The results presented here challenge Williams' (2004) argument and show, at least in the context of the South-East and Midlands during the Early Roman period, a sudden and widespread shift in cremation practices directly following the Roman conquest. Even though it is clear from this investigation that urned burial practices were present in the Late Iron Age, and unurned burials were also deposited up until the Late Roman period, the fact remains that this cultural transition coincides with Roman occupation. Interestingly, the results of this study also confirmed that this shift from unurned to urned practices, was not homogenous and did vary according to cemetery, settlement type and type period representing different cultural responses to Roman occupation (see section 8.1.3.1).

8.2.2 Pyre Sites and Bustum Burials

The survey of cremation deposits from Britain found very few pyre sites (N = 18) in the Late Iron Age and Roman periods. Those identified were found exclusively in the South-East of the country at both rural and urban cemeteries. The prevalence of these features in the South-East is unlikely to represent a regional trend. Pyre sites would have been placed near to all cemeteries were cremation was practiced; this study has already demonstrated that burial grounds in the South-East have been better documented than other regions. As such, this result is a reflection of how this region has been more thoroughly investigated than the North and South-West of the country (see Section 8.1.1).

The elusive nature of these burial features has been discussed in depth by McKinley (2000; 2015b) who has argued that any convincing evidence of pyre sites in Roman Britain is relatively sparse. She goes on to describe how they are negative (below ground) features that are difficult to identify in the archaeological record. Experimental reconstructions of funerary pyres found that the heat generated would penetrate only 50-100mm into the ground. Consequently, this small amount of material would have been easily ploughed away and would not survive in the archaeological record (McKinley, 2015b).

This investigation supports McKinley's (2015b) argument for how difficult it is to identify these features, even when conducting a large scale meta-survey.

From the results presented here, it is reasonably to suggest that the majority of cremations were not performed within the walls of the cemetery, but elsewhere. Noy (2000a) points out that there is no reason for pyre sites to be near the tomb or grave because burned bone is easy to transport. He also suggests that *ustrina* in Latin literature refers to a spot other than the final resting place where the deceased was cremated; this could have been within the cemetery, or at a completely different site (Noy 2000b, p.186). Creighton and Fry (2016) have recently conducted a geomagnetic survey of the Roman town of Silchester, where clusters of 'hotspots' were identified outside of the town walls that represented thermal activity, which may be associated with pyres and commemorative activity. Further analysis needs to be conducted to confirm this theory and distinguish burial features from other types of firing including kilns and furnaces. Nonetheless, the results presented here teamed with the research conducted by Creighton and Fry (2016) demonstrate how cremation for most of the Late Iron Age and Roman periods was conducted outside of the cemetery; the application of advanced survey-techniques to confirm this theory is something future research should work towards (see section 9.3).

In this study, the decline in the number of pyre sites from the Late Iron Age to the Middle Roman period appeared to coincide with a rise in the number of bustum burials. Bustum burials were first recorded in the Middle Roman period at Major Urban sites in the South-East. By the Late Roman period they were also found in the North-West (Brougham) and at both rural and urban cemeteries in the south. Traditionally, bustum burials have been interpreted as a Roman military tradition associated with forts in the north of the province (Cool, 2004). This interpretation was later challenged by Boston and Marquez-Grant (2010) as it did not explain why they had also been found in civilian cemeteries in the south (Biddulph, 2006). This study supports this argument and has confirmed that bustum burials were not a custom exclusively practiced by the Roman army but were found across all settlement types by the end of Roman occupation. This is turned demonstrates that the uptake of Roman practices did not necessarily occur directly after the Roman conquest but continued throughout the Roman period. The fact that this particular burial practice coincides with the fall in the number of pyre sites suggests a change in cremation rituals at a time when cremation was being replaced by inhumations as the predominant burial rite (Pearce, 2016). The process of burning and burying the deceased in the same spot removes the process of collecting the remains and transporting them to the burial site. This could represent a fundamental change in ideological beliefs or demonstrate a more convenient way of disposing of the dead at a time when cremation was becoming less popular.

With regards to spatial distribution, bustums burials were not identified in the South-West, Midlands and North-East of the country in this study. Recently, Weekes (2008, p.149) has criticised the Latin translation of *bustum* and has argued that currently there is no convincing evidence for these types of burials in the UK. He states that they lack sufficient amounts of burned bone if the deceased was burned and buried *in situ.* While this study has demonstrated that, in fact, there is sufficient evidence for this burial custom in Britain, this may help explain why bustum burials are not more visible in regions where the archaeological data is comparatively poorer than the South-East. Similar to pyre sites, these deposits are difficult to identify in the archaeological record and could be mistaken for redeposited pyre debris laced with charcoal and fragments of burned human bone, or they may have been destroyed post-deposition as a result of plough damage.

8.2.3 Grave Goods and Pyre Goods

This study has confirmed that throughout the Late Iron Age until the end of Roman occupation, grave goods (present in 42.5% of all cremation deposits, N = 1010 of 2375) were more prevalent than pyre goods (15%, N = 356 of 2375) across all regions and settlement types. From a practical perspective, this result is hardly surprising given that pyre goods are subject to greater taphonomic alteration and more likely to be destroyed as a result of the cremation process. In other words, there is no guarantee that items placed on the body will survive after being burned. An experimental pyre burning by Marshall (2011) found that smaller items of bronze (typical of personal adornment and weaponry) that were placed on the body remained in the hottest part of the pyre, which reached temperatures of over 1000˚C. The results indicated that these bronze items were often destroyed by the fire and had a general survival rate of 18%. Even if pyre goods did survive the cremation process they may not have been collected with the bone for burial or identified within a burned bone assemblage; it is possible that such items may have been discarded because the firing would have caused the item to change shape and melt, resembling an extraneous fragment of slag. The only exception to this is the Late Roman cemetery of Brougham (North-West England), which has been argued here to represent an increased level of personal displayed indicative of Roman influence (see section 8.1.3.2).

This study has demonstrated that the prevalence of cremation deposits with grave goods peaked in the Late Iron Age in the South-East (from 80.7%) and Midlands (from 36.8%). Generally, by the Middle Roman period the number of cremations deposits with grave goods declined, while the number with pyre goods increased in the South-East and Midlands. However, grave goods remained more common than pyre goods. This pattern was consistent for all settlement types. Previous scholars have argued that the continued presence of grave and pyre goods in cremation burials in the Roman Period demonstrates a continuation of Late Iron Age traditions and beliefs (Wightman, 1985; Philpott, 1991;

Morris, 1992; Struck, 1995). More recently, Pearce (2015) has challenged this idea stating that the importance given to the continuation of Late Iron Age practices is misplaced. In his examination of grave good assemblages from cremation cemeteries in Britain and Northern Gaul, Pearce argues that the disappearance of hearth furniture, amphora, and weaponry from cremation burials during the Roman period showed that, while cremation remained the predominant funerary rite, the ritual involved changed due to Roman influence. While the types of grave and pyre goods were not recorded in this study, the results show clear evidence for continued Late Iron Age practices. However, the general increase in pyre goods also demonstrates a transition in cremation practices that evolved over the course of Roman occupation, rather than rapid change after the conquest.

An increase in pyre goods after the Late Iron Age suggests pyre display of the body became more important. Philpott (1991, 220-221) previously argued that the use of the pyre as a platform to display the body was confined to northern military sites (see Pearce, 1998). This study has demonstrated that, in fact, the trend towards pyre goods extended across all settlement types across southern and central regions. This shift towards personal display has been discussed more recently by Swift (2010) in her examination of bracelets from British and Continental Roman cremation and inhumation graves. She concluded that the increased deposition of dress accessories in burial contexts shows a growing popularity and availability of such items, as well as a new burial rite in which the body was fully dressed. Crummy and Eckardt (2003) in their examination of small objects used for grooming and self-representation showed how the Roman conquest was a catalyst for large-scale production of these types of items in Britain. Accounts of Roman cremation funerals also emphasise the importance of washing and dressing the deceased before they were placed on the pyre. The Romano-British cremations at Stansted Airport for instance included brooches that had evidently been retrieved from the pyre (Timby, et al., 2007). Similarly, several scorched glass beads were recovered from the cremation deposits at Strood Hall (Timby et al., 2007). Details of the pyre goods were not analysed in this current study and although the increase in percentage is small over time, it is possible that while grave and pyre goods continued, after the Conquest pyre goods became more frequent over time as people started to adopt Roman-style practices. In order to explore this theory further, future research should examine the type and function of items placed on the body during cremation compared to those placed in the grave on a large scale (see section 9.3).

8.2.4 Male vs. Female Cremation

This investigation has confirmed that for most of the Late Iron Age and Roman periods across all regions and settlement types, a larger proportion of male cremation deposits were identified. Before discussing these findings however, it is important to highlight the difficulties surrounding these types of data. As pointed out by Davison (2000), the distribution of males and females in the archaeological record is subject to the quality of the osteological data. Over the years methodological advances in the analysis of burned skeletal remains has improved analytical techniques, particularly regarding firing conditions; however, heat-induced shrinkage can result in statistically significant dimension changes in burned bone that can hinder osteological assessment (Thompson, 2002). In particular, the accuracy of sex determination from burned human remains is significantly reduced. In addition, this survey of cremation practices includes osteological reports dating from the 1950s. As such, older examinations are hindered by the application of outdated methods that would not meet the standards used today. Consequently, any interpretation must be directed by caution.

Several hypotheses have nevertheless been proposed by previous research to explain the prevalence of males in the Romano-British burial record, including widespread Roman military occupation following the conquest and female infanticide (Davison, 2000; Watts, 2001; 2005).

With regards to military occupation, it has been argued that the prevalence of males in Roman York, Cirencester, Gloucester and Colchester was a reflection of a large number of retired Roman legionaries (Wenham, 1968; Wacher, 1974; McWhirr, et al., 1982). However, this theory is not supported by the findings of this study. The cemeteries associated with Roman Forts, including Derby Racecourse, show a high prevalence of non-adults that is almost equal to the number of adults. As pointed out by Leach et al., (2010) both women and children would have accompanied military personnel on their expeditions across the empire, including to Britain. In addition, merchants and traders would have also followed the Roman Army to the province in search of new business, bringing with them their own families (Allason-Jones, 2004). Consequently, Roman military occupation would not have necessarily resulted in a higher prevalence of male cremation burials, but greater social diversity; this is supported by the results presented here.

The argument for female infanticide in Roman Britain made by Watts (2001; 2005) has not been well-received by contemporary research, and again is not supported by the findings in this study. This is because the results presented here show that women were subject to the same burial practices as men, and were therefore treated similarly by society, despite their being fewer females identified overall. The lack of identified females compare to males could be a reflection of insufficient sexing methods or the poor preservation of skeletal features for diagnostic assessment; the assumption that this represents female infanticide is farfetched. Critics have also pointed out there is no sufficient evidence to suggest that this practice was adopted by communities living in the province. In addition, Watts' interpretation of women in Roman Britain is heavily biased towards high-status individuals from Rome including Pomponia Graecine and Flavina Titania and is therefore not representative of Romano-British women (Drinkwater, 2008).

The prevalence of male individuals during the Late Iron Age and Roman periods has also been observed in similar studies examining both inhumation and cremation practices (Mays, 1995; Boylston, et al., 2000; Davison, 2000). For example, in his analysis of 2400 Romano-British adult inhumation burials, Mays (1995) calculated a sex ratio of 46:1 in favour of males. As such, this result represents a taphonomic bias towards males in the Romano-British burial record. In Davison’s (2000) revaluation of gender imbalances in Romano-British cemeteries, he points out the flaws in the sampling, analysis and interpretation of skeletal remains highlighting how fragmentary evidence combined with examiner bias may have created a distorted perception of Romano-British society. In relation to cremated human remains, Kurila (2015) examined the accuracy of sex assessment of 364 cremation deposits. The 157 individuals sexed were compared to their assigned gender based on the grave goods buried with them. For males, the accuracy of sex determination ranged between 52.5 – 85.5%, when females achieved an overall higher accuracy rate (85.5%). While the use of grave goods to examine sex and gender is highly debatable, Gonçalves (2011) also found that the sex allocation of modern cremated males was poor using osteometric techniques. However, in the context of this investigation, it is unlikely that the overriding dominance of males in the Romano-British burial record (both cremation and inhumation) is simply down to sample and examiner bias. Rather, it is more likely that more males were subject to archaeologically visible burial practices.

Interestingly, this investigation also found that in the South-East and Midlands during the Early Roman period, female cremation burials were more prevalent than males. This was a regional trend, as it differed significantly from the South-West where only males were recorded ($p = 0.006$). No difference was found according to settlement type. The Late Roman cemetery of Brougham (North-west), and the Middle Roman cemeteries of London, Eastern Cemetery, and Yeomanry Drive North (South-East), also had a higher proportion of females, unlike contemporaneous cemeteries from the same regions and settlement types. The osteological assessment for these populations however, was conducted by the same examiner who suggested that females are easier to identify from cremated human remains (McKinley, 1997, p.65). Even though this does explain why Brougham, Yeomanry Drive North and London, Eastern Cemetery had more female cremation deposits than males, it does not explain the prevalence of females identified in Early Roman Britain. This is because the cemeteries from this time period were analysed by different human bone specialists.

Consequently, the reason for this phenomenon is unclear as it does not have parallels in either Late Iron Age or Roman burial customs. It could possibly suggest a short-lived change in cremation practices whereby more women were burned and buried. It is possible that social mobility during and after the Roman conquest brought with it new ideas and customs, as well as an overall increase in the female population. This may explain why this trend occurred in regions that had greater contact with the Roman Empire (South-East and Midlands).

8.2.5 Age

Of the 1815 cremation deposits included in the survey of cremation practices in Britain, only 25.5% (N = 463) were under 18 years of age. In order to test for taphonomic bias against non-adult remains in the cremation process, Waterhouse (2013) burned fleshed pig limbs of different ages in outdoor wood fires and found that the lower density and higher organic content of younger bones resulted in significant bone breakdown compared to older individuals. Similarly, Holck (1997) found that the burned remains of neonates broke down more easily after they were buried. As such, cremation deposits of younger individuals may be less likely to survive in the archaeological record. The results presented here confirm that the survival rate of cremated non-adults in the archaeological record is very low, which has created a skewed perception of society in Late Iron Age and Roman Britain.

However, this study has highlighted that across all regions and settlement types, non-adults were subject to the same cremation practices as adults. This suggests that the age groups examined here were valued members of Late Iron Age and Romano-British society that were treated with formal funerary customs. These findings support contemporary research that has recently challenged the outdated perception that Romano-British society viewed non-adults as unimportance (including the supposed practice of infanticide) (Gowland, 2001; Pearce, 2001; Revells, 2005; Bonsall, 2013).

Gowland (2001) points out that the neglect of non-adults in this context has been largely a result of interpretation biases, specifically from an adult's perspective. In her combined examination of osteological evidence and grave goods of the non-adult burials from Lankhills cemetery in Winchester, she found that the proportion of younger individuals buried with items fluctuated over the 'childhood period'. She concluded that contrary to previous interpretations, non-adults were far more integrated into Romano-British society. Revell (2005) has explored this concept of childhood further by examining aspects of the Roman life course in different temporal and spatial contexts. Her analysis of epitaph inscriptions that recorded age at death from Italy, Spain and Britain found that attitudes towards different age groups varied across the Roman Empire. In particular, Britain has a peak in individuals aged from 0 to 10 years. Based on her results Revell concluded that in Britain there was evidence for the continuation of pre-Roman perceptions of age. While this study did not record the details of grave and pyre goods buried with non-adults, the findings do support this interpretation of childhood in this context. The distribution of non-adults alongside adults in Late Iron Age Britain shows that they were recognised by society as individuals; this seemingly continued until the Late Roman period across most of Britain.

Explaining the apparent 'anomaly' identified in this study at the cemeteries of Brougham (North-West, Westhampnett, Yeomanry Drive North and London Eastern Cemetery (South-East) where 14 to 18 year olds were more prevalent than individuals under 13 years is more complicated. The burned remains of pre-pubescent children are easier to identify in cremation assemblages because their bone size is very different from adults. However, the skeletal morphology of post-pubescent individuals that have not reached adulthood is less distinguishable. Unless there is clear evidence of epiphyseal fusion or dental eruption, it is difficult for an osteologist to confidently differentiate between the burned remains of adults and adolescents without conducting histological examinations (Cunha, et al., 2009). Therefore, it is not surprising that individuals under 13 years are generally more common than those between 14 and 18 in cremation contexts. The identified cemeteries are not linked by region, time period or settlement type. However, what they do share is the same specialist conducting the osteological analysis. The lack of standardisation in cremation research has been discussed at length in this thesis; the level of preference for individual age-categories is particularly pronounced (Table 8.1). It is clear that the methods used by the osteologist who analysed the skeletal material from these cemeteries shows a bias towards 14 to 18 year olds. This is not necessarily a false trend. Rather, this specialist may be finding individuals that are being mis-identified as 'unknown' by others who do not attempt to age cremated human remains that are under 18 years of age. This is the first study to identify an osteological bias in aged individuals (specifically 14 to 18 year olds) in Roman Britain, and demonstrates the impact it is having on interpretations of Late Iron Age and Roman provincial society.

8.3 Cremation Technology of Hertfordshire

8.3.1 Fuel Selection for Cremation

Unfortunately, when examining charcoal fragments recovered from cremation deposits it is not possible to distinguish wood fuel from the remains of wooden funerary artefacts placed on the pyre (Figueiral, et al., 2010). Even if there is clear evidence for woodworking or nails adhered to pieces of timber, this could represent pyre construction or the inclusion of wooden objects (Campbell, 2004). Here all charcoal fragments are considered to be the burned remains of funeral pyres; however, it is necessary to highlight the alternative possibility when considering the results.

Based on the charcoal identified at the five Hertfordshire cemeteries, it is clear that wood used for cremation was locally sourced from indigenous trees and shrubs; this is because all recorded taxa have also been found in the archaeobotanic data from the region (Gale, 1999; Burleigh and Fitzpatrick-

Matthews, 2010; Bonsall, et al., 2012). Sourcing local wood for cremation is a practice identified across Britain and the Continent (Gale, 1997; Campbell, 2004; Figueiral, et al., 2010; Deforce and Haneca, 2012), suggesting that fuel selection was guided by practicality, rather than ritual reasons.

Oak (*Quercus sp.*) was the most dominant taxon identified in 96.3% (N = 26 of 27) of the samples making it the primary wood type used to build pyres in Hertfordshire. This is not surprising as oak is a particularly good firewood because it has a high burning temperature (Gale and Cutler, 2000; Campbell, 2004; Günther, et al., 2012). Roman literary sources attribute oak (*Quercus sp.*) to the Celtic God Taranis, and the Roman God Jupiter. Oak (*Quercus sp.*) was also respected for its strength and longevity in antiquity (Gale, 1997, p.81). The presence of maloideae, a pomaceous fruit that is a subgroup of the Rose (*Rosaceae*) family, as well as the inclusion of other small tree or shrub types, such as hawthorn (*Crataegus monogyna*), fruit trees (*Prunus sp*), and hazel (*Corylus avellana*) indicates the use of tinder or pyre packing in order to help the larger pieces of timber catch fire (Figueiral, et al., 2010). These types of wood are usually found in hedgerows, woodland and scrub (bushes and shrubs) (Stace, 1997), and therefore produce smaller, more accessible twigs and branches. Experimental pyre burnings have employed the same approach using tinder packings to ensure the flash point (the lowest temperature at which vapours of a material ignite) is high enough to achieve combustion of the pyre structure (Jonuks and Konsa, 2007; Carroll and Smith, 2018). The results presented here support this method of pyre building in the context of Roman Britain.

The increased diversification of taxa found amongst the rural populations of Hertfordshire is not surprising. A similar study conducted by Figueiral and colleagues (2010) examining wood fuel from Gallo-Roman cremation deposits in the Languedoc Region in southern France identified at least 29 taxa in their rural assemblage, compared to the 22 types found at the urban cemeteries. In this study, a total of 9 taxa were identified at rural cemeteries compared to 6 from the combined minor and major urban sample. While some may argue that urban cremation deposits would include a larger selection of wood due to increased trade (Petts, 2003; Rippon, 2008; Creighton, pers comm, 2017), it is likely that towns had greater quantities of similar wood types for construction, woodworking, and domestic use (Hanson, 1978; Ulrich, 2007). As pointed out by McKinley (2015b) individuals conducting cremation funerals in rural contexts may have sourced fuel from local woodland resulting in a greater variety of species. This seems to be the case in Roman Hertfordshire.

In relation to comparisons between cemeteries, the significant difference in the number of identified oak (*Quercus sp.*) fragments between the urban cemeteries of Folly Lane and Wallington Road is a reflection of sample size. The assemblage from Wallington Road was very poor compared to other cemeteries examined here. This is because the volunteers that conducted the rescue excavation did not take any environmental samples. Grave and urn fills were only retained for a handful of cremation deposits. In addition, instead of taking environmental samples at the identified pyre site, volunteers handpicked a few large charcoal fragments during excavation (Burleigh and Fitzpatrick-Matthews, 2010). The significant prevalence of hazel twigwood (*Corylus avellane*) (N = 5), and alder (*Alnus glutinosa*) (N = 13) found at Spencer Park compared to all other cemeteries is also most likely a reflection of sampling bias, rather than specific cemetery practices. In other words, very few fragments were found at Spencer Park, where 100% of environmental sampling was conducted, compared to Folly Lane, Wallington Road and Cross Farm. A total of 18 fragments (Hazel twigwood: N = 5. Alder: N = 13) were recorded in the Spencer Park assemblage, which were not found anywhere else; this does not necessarily mean that they were not present at other sites. As pointed out by Gale (1997, p.79) taxa identified in environmental samples do not represent the complete range that would have been used, but only those that happen to be collected and relatively well preserved for identification. However, the significant quantity of maloideae (Pomaceous fruit) fragments (N = 249) (p = 0.003) at Spencer Park suggests that it was the primary wood type used for cremation, while for all other cemeteries examined here oak (*Quercus sp.*) was the predominant species used in pyre construction. This may represent a specific practice associated with this cemetery; this fuel burns hot and slowly, often producing a sweet smell making it well-suited for cremation funerals (Gale and Cutler, 2000; Campbell, 2004). However, it could also represent the collection of material from a different part of the pyre site (fragments from smaller tree types that have fallen through the pyre and accumulated in the centre) (Barnett, pers comm, 2018).

Fuel selection did not differ according to sex of the deceased, or social status based on the number of grave inclusions. This result is interesting, as Roman sources describing cremation funerals mention the selection of specific wood taxa for burning the bodies of famous men (Kreuz, 1992; Hope, 2007; Cerezo-Román, et al., 2017). However, this was clearly not the case for Roman Hertfordshire. Interestingly, a large proportion of oak (*Quercus sp.*) and twigwood fragments (N = 165) were found in a grave belonging to a 14 to 18 year old from Cross Farm, suggesting special treatment. In addition, significant amounts of oak (*Quercus sp.*) and ash (*Fraxinus excelsior*) twigwood, as well as shrub types including birch (*Betula*), hornbeam (*Carpinus betulus*) and hawthorn (*Crataegus monogyna*) were also found in the graves of those under 13 years of age. It is highly unlikely that twigwood was used to construct the mainframe of pyres, as these would have burned out prematurely, even when cremating younger individuals (Barnett, pers comm, 2018). Instead, this may represent ritual significance and/or the use of small wood types to pack smaller pyres for younger individuals. There is no mention of this practice in ancient sources (Hope, 2007; Cerezo-Román, et al., 2017), nor has it been reported by similar studies examining charcoal from Late Iron Age and Roman cremation deposits (Gale, 1997;

Figueiral, et al., 2010; Deforce and Haneca, 2012). However, McKinley (2015b, p.200) mentions that in relation to Romano-British cremation practices the pyre structure was not always adjusted to accommodate variation in body size based on the oxidisation of burned bone. Conversely, the evidence presented here suggests that at least in some cases bigger pyres were built to accommodate large individuals, and vice versa.

8.3.2 Burning Intensity

8.3.2.1 Oxidisation of Burned Bone

The individuals from Hertfordshire displayed the full spectrum of colour alteration, indicative of incomplete oxidisation. Bone colour ranging from brown to white has been observed in similar studies examining cremation deposits from Roman Britain (Boston and Marquez-Grant, 2010; McKinley, 2015b; Thompson, et al., 2016). McKinley (1997, p.66) describes how this level of diversity is 'normal' for cremated bone assemblages from this historical context and is a reflection of issues concerning oxygen supply, duration and temperature of the fire. The statistical analysis found that burned bone colour varied significantly between Cross Farm, Wallington Road and Folly Lane, as well as between urban and rural cemeteries. The individuals from Cross Farm, and rural cemeteries in general, displayed a higher degree of calcination with minimal diversity. In comparison, eight individuals from the urban cemeteries of Wallington Road and Folly Lane exhibited trabecular bone charring, alongside white colouration of the periosteal layer. This pattern of macroscopic change suggests exposure to high temperatures for shorter periods of time (Squires, et al., 2011); this could represent a difference in cremation technology. It is important to remember however, that the macroscopic colour of burned bone is influenced by several factors, including body position, weather conditions, and staining from the soil environment (Jonuks and Konsa, 2007; Carroll and Smith, 2018); as such, it is recommended to combine these data with results from further microscopic analyses to gain a better understanding of burning conditions.

8.3.2.2 Histology and Quantitative Petrography

The histological examinations conducted in this study utilising both quantitative and qualitative analyses showed that for the majority of cremation deposits from Hertfordshire high burning temperatures over 900°C were achieved. Unfortunately, there are currently no other histological examinations of Roman cremation deposits to compare these results to. Chronologically, the closest study conducted to date is by Squires et al., (2011), who identified substantial microscopic variation in the burned bone samples from the Anglo-Saxon cemetery of Elsham; temperatures ranged from 600°C to over 900°C, which was thought to indicate differences in social status. In other words, the cremation pyre of a high-status individual would have been more carefully tended, where more fuel and time was invested to achieve a higher quality burn. This does not appear to be the case in relation to Roman Hertfordshire as no significant differences were identified according to social status, age or sex. Instead, the variation in cremation temperature is more likely to reflect a difference in the way in which people were being cremated. The histological and quantitative petrographic examinations found a significant difference in burning temperature between Cross Farm and Wallington Road ($p = 0.008$), as well as between urban and rural cemeteries ($p = < 0.001$), matching the results examining macroscopic colour. In her examination of oxidisation from Romano-British cremation deposits, McKinley (2015b) proposes that at rural settlements the pyre would have been managed by family members or retainers who may have given more time and care to the practice. At urban centres, cremation funerals were conducted by professional *ustores* and it is likely that the quality of the cremation would have been subject to the amount paid for their services. This may explain why the rural cemeteries of Cross Farm, Spencer Park, and M1 Junction achieved consistently higher burning temperatures, compared to the urban cemeteries of Wallington Road and Folly Lane.

8.3.2.3 Crystallinity of Burned Bone

The results from the FTIR-ATR analysis showed that the majority of the cremation deposits from Hertfordshire clustered towards the higher end of the spectrum indicative of high burning intensity. A similar study examining crystallinity of Roman military cremation deposits along Hadrian's Wall found that the majority of individuals reached medium burning intensity (Thompson, et al., 2016). It is important to consider that the results from these two projects were processed at two separate institutions. In his review of heat-induced crystallinity change in bone, Thompson (2015b) draws attention to the many issues and inconsistencies in the methodology despite the increasing number of publications in this area. Currently, we do not fully understand the comparability of results between studies and institutions. As such, any interpretation must be made with caution.

It is possible that this difference between Hertfordshire and the North represents a difference in pyre technology between geographical regions and/or between military and civilian settlements. Hope (2003) points out that it was highly unlikely for the cremated remains of soldiers who died overseas to be returned to their families, unless they were of high-social standing. Often, individuals would have been cremated and their remains scattered close by (Carroll, 2009). The reduced burning intensity in military contexts may therefore be a sign that the cremation of a Roman solider in Britain was a quick and efficient affair. Thompson and colleagues (2016) found that burning intensity was generally consistent across different military sites. This is not surprising and represents a shared knowledge of cremation, characteristic of the Roman army. Phang (2008) in her examination of the Roman army describes how soldiers followed strict ideologies of discipline, spending peacetime honing their skills and learning new ones. This in turn resulted in a shared knowledge where cremation undertaken by the Roman army was standardised (Thompson, et al., 2016). However, the civilian centres from Hertfordshire examined here show greater fluctuation in burning temperatures, representing greater social diversity. This is also characteristic of the nature of civilian communities, specifically those from urban settlements. As pointed out by Eckardt (2010) after the Roman conquest a wide range of individuals settled in Britain from the Roman Empire. This brought new ideas, practices and customs into civilian communities, separate to those held by military communities (Phang, 2008). In the context of Roman Hertfordshire, Niblett (2001) highlights that the Roman towns within the area, such as *Verulamium* and Baldock, were in close proximity to London where most imported goods would have come from. This would have brought in traders, merchants and their families that would have introduced a variety of new cultural practices and customs from other regions, and overseas. This may have included professional *ustores*, where the quality of cremation was not standardised, but industrialised.

The crystallinity results showed that the majority of cremation deposits examined here achieved high burning temperatures (similar to evidence from bone colour, histology and quantitative petrography). However, no significant difference in crystallinity was identified between Wallington Road and Cross Farm, unlike all other microscopic and macroscopic proxies examined. A similar result where the FTIR-ATR data did not completely match the results achieved by other methods examining burning intensity was obtained by Squires et al., (2011); however, no explanation was offered as to what was causing the difference in the results obtained. Some have argued that this difference could be a result of different sampling techniques (Stiner et al., 2001); i.e FTIR-ATR samples were removed from the periosteal (outer) layer of bone, while the histological samples included the entire cross-section of the bone fragment, comprising of the periosteum, compact bone and spongy bone layers. However, Thompson et al., (2011) found no difference in crystallinity measured between samples taken from different areas of the same bone fragment. Sampling bias is therefore an unlikely explanation. It is not currently clear what is causing this result; further experimental research comparing these various modes of analysis is needed (see section 9.3).

From this examination of burning intensity combing both macroscopic and microscopic analyses, it seems that cremation in Roman Hertfordshire does, to some extent, resemble the customs described in Roman literary sources. In ancient Rome, a thoroughly burned body was considered ready for burial, while an incomplete cremation would have been shameful, and would have condemned the soul to roam restlessly for eternity (Noy, 2005; Cerezo-Román, et al., 2017; McKinley, 2015b). It is not clear what would have been considered an 'incomplete cremation'. In her examination of oxidisation from Romano-British cremation burials, McKinley (2015, p.199) points out that the term *ossilegium* (the process of collecting bones following cremation) suggests that the body of the deceased needed to be fired to the point where soft tissue was removed and only skeletal matter remained. This would have been considered ready for burial. While the results displayed significant variation between cemeteries and settlement types suggesting different cultural responses to Roman occupation, no evidence for a failed cremation was identified, indicated by partially cremated human remains (Noy, 2000b; McKinley, 2000).

8.3.3 Skeletal Representation

No significant difference in skeletal representation was found according to any of the variables examined in this study. As such, this investigation has demonstrated that in Roman Hertfordshire burned bone collected for burial was generally consistent for all cemeteries, settlement types and social groups. There is no evidence for the preferential collection of skeletal material, but instead the findings suggest that a sample of burned bone was collected randomly from the pyre debris. Accounts of cremation funerals from Rome do not specify the deliberate collection of specific skeletal elements following cremation. McKinley (2015b) points out that the Romans believed the soul left the body with the final breath. There was therefore no need to recover specific skeletal remains for burial (see Toynbee, 1971; Noy, 2005). She suggests elsewhere (McKinley, 2000) that the collection of burned bones included the random selection of fragments from across the body, which is supported by the results presented here suggesting the adoption of Roman cremation practices. Most of the identified bone (32.9%, 4593.6g of 13953.9g) from Hertfordshire were fragments from the lower limbs. This is not surprising as skeletal representation was quantified by examining the total weight of identified bone from each skeletal zone; the skeletal elements that make up the lower limbs (femur, tibia, fibula) constitute the heaviest bones in the body and are therefore well-represented in this sample from Hertfordshire. Similar results were also obtained at the Roman cemeteries of Hacheson, Suffolk (Blagg, et al., 2004), Marsh Leys, Bedfordshire (Luke and Preece, 2011), and The Bridles, Lincolnshire (Allen and Rylatt, 2002), indicating that this practice was not exclusive to Roman Hertfordshire.

8.3.4 Burned Bone Weight

The total weight of burned bone recovered from the cremation deposits of Hertfordshire varied from 1g to 2331.3g. Interestingly, no significant difference was found according to burial type suggesting that post-depositional damage was not a significant factor that influenced the preservation of burned bone. Ancient sources describing Roman cremation funerals are relatively vague when depicting how much skeletal material was collected for burial. This rite was usually undertaken by either the family members of the deceased or professional cremators, but no indication is given as to how much burned bone warranted a cremation burial (Cerezo-Románo, 2017). McKinley (2000, p.42) in her examination of Romano-British cremation practices points out that the inclusion of burned bone was not a pre-requisite. In the context of Prehistoric Britain, scholars have suggested that the variation in burned bone weight from cremation burials may be a result of other ceremonial activities. Brück (2006; 2014) in relation to Bronze Age burials suggests that female cremation deposits weighed substantially less than males because a proportion of their skeletal remains were distributed between family members, demonstrating how women were instrumental in forging intergroup alliances. In this current study, burned bone weight was significantly different between men and women ($p = 0.029$), where male cremation deposits had a higher median weight than females. This difference however is more likely a reflection of sexual dimorphism (Gonçalves, et al., 2015), and does not explain the significant difference in burned bone weight between individual cemeteries and settlement types. Drawing parallels from Bronze Age cremation practices in Orkney, McKinley (2000) suggests that in Roman Britain the burned bone collected from pyre sites may have been scattered in a separate location to the burial site representing further ritual practices. Unfortunately, there is no way to test this hypothesis in the context of Roman Hertfordshire.

Interestingly, burned bone weight varied significantly between rural and urban cemeteries ($p = 0.019$), whereby the rural cremation deposits were smaller. On an inter-cemetery basis, the difference in burned bone weight was also significant between Wallington Road (urban) and Spencer Park (rural) ($p = 0.041$), where the Wallington Road cremation deposits were heavier on average. This may well represent a difference in the cremation ritual. However, burned bone weight from archaeological contexts is subject to various taphonomic agents, including burning, burial, excavation and analysis. As such, it is not possible to establish what precisely caused this differentiation and may be a reflection of multiple influencing factors.

8.3.5 Burned Bone Fragmentation

The degree of burned bone fragmentation differs significantly according to settlement type, cemetery and age. No significant difference was found between urned and unurned burials suggesting that post-depositional damage was not an important factor that influenced the preservation of burned bone. In relation to age, a study by Waterhouse (2013) found that the lower density and higher organic content of bone from younger individuals resulted in greater fragmentation compared to older individuals. This supports the findings from this current study, where younger individuals showed greater bone breakage compared to those over 18 years of age.

Age-related differences do not, however, explain the difference in burned bone fragmentation according to settlement type and cemetery. Interestingly, several experimental studies have observed greater bone fragmentation when hot, brittle bone fragments were subjected to greater movement, including when the pyre was stirred or racked. Alunni et al., (2014) points out that bone destruction cannot be achieved by prolonged exposure to fire but requires mechanical stirring with a stick during cremation. Similar conclusions were also drawn by McKinley (1994) who observed that modern crematoria produced bone fragments that measured 250mm in size as a result of varying amounts of raking and moving of the remains.

In the context of this study, the processes of racking or stirring the pyre may explain this difference according to cemetery and settlement type. McKinley (2015b) in her review of cremation practices from Roman Britain suggests that cremations in rural areas were more likely to be undertaken by family members or their retainers, while towns would have had their own *ustores* or professional cremators. It is possible therefore that the families attending the pyre during the cremation funeral would have been more attentive and consistent in stirring the debris. In contrast, the professional *ustores* found at urban centres would have had to contend with a higher demand for the rite, which may have resulted in reduced pyre maintenance. Polfer (2000) points out that permanent pyre sites are more readily found in Roman urban settlements due to the large number of cremations performed per year; in comparison, he estimates that at rural sites only one cremation would be conducted every 10 months. This is supported by the results presented in this current study. It would therefore appear that this difference in cremation technology represents a dichotomy between these two settlement types. Cremation in Roman towns became industrialised following the introduction of professional cremators through increased contact with the continent. But interestingly, 'industrialisation' did not necessarily result in consistent outcomes, or a better quality of cremation.

8.3.6 Comparisons with Late Iron Age Data

Overall, very little difference was found between the Late Iron Age and Roman data from Hertfordshire. However, this is most likely a reflection of the extremely small Late Iron Age sample of only two individuals. These deposits were found to contain less burned bone and greater fragmentation than the Roman group. Burning intensity according to macroscopic and microscopic heat-induced changes were found to be generally consistent between the Late Iron Age and pooled Roman study sample, suggesting that similar temperatures were achieved and indicating a degree of continuity in cremation technology. Unfortunately, without a larger sample size, it is not possible to establish whether these results represent actual trends or are simply circumstantial.

8.4 Synthetic Discussion

This study has shown that cremation practices in Late Iron Age and Roman Britain were not fixed, but embodied various cultural responses to Roman occupation; most interestingly, these responses were not always homogenous, but were subject to both temporal and spatial variation. It is clear from the results presented here that 'Romanisation', at least in the context of cremation research, cannot be explained by a single universal paradigm. A similar stance has been argued by both James (2001) and Mattingly (2010), who state that employing such a system simplifies this complicated process and dismisses the many factors that had a part to play in the creation of provincial identities. The results from this study support this perception of British society during this period and demonstrates the simultaneous uptake of Roman-style fashions, the continuity of Late Iron Age practices, as well as the creation of new provincial identities.

The shift from predominantly unurned to urned cremation burials, as well as the general increase in pyre goods from the Late Iron Age to the Late Roman period does not simply demonstrate the uptake of Roman burial practices, but the evolution of cremation rituals in Britain. This in turn suggests an overarching move towards outwardly Roman identities. In his examination of funerary rituals in northwest Europe dating from the 1st century BC to the 3rd century AD, Pearce (2015, p.239) also emphasised that burial traditions evolved over time. However, in the same chapter, Pearce (2015) argues that the importance placed on continuity from the Late Iron Age in contemporary literature is misplaced, and states that this interpretation does not sufficiently consider the changes that occurred in cremation rituals. Nevertheless, Pearce's (2015) examination only considered the changing role of material goods in the cremation process and overlooks the other forms of evidence that have been examined in this present study. In this investigation, it is clear that some aspects of cremation also remained consistent from the Late Iron Age to the Late Roman period. For instance, the survey of osteological data from 2445 cremated individuals demonstrated that concepts of the life course, specifically social attitudes towards non-adults remained consistent from the Late Iron Age to the end of the Roman period for the few cemeteries that predate Roman occupation. This also highlights the continuity of Late Iron Age identities, where children remained an integral part of Romano-British society. In addition, the overall predominance of grave goods over pyre goods from pre-Roman Britain until the 5th century AD also demonstrates continuation from the Late Iron Age. This is not a surprising outcome and has been identified on the continent (Fitzpatrick, 2000; Cerezo-Román, et al., 2017), and discussed at length in Romano-British material cultural studies (Gardner, 2002; Mullen, 2007). However, scholars examining funerary data from Britain have been more black and white in their interpretations of provincial society, arguing for either the uptake of Roman traditions or the continuation of Late Iron Age ideals (Morris, 1992; Struck, 1995). This study has demonstrated that this is a rather simplified approach that is arguably reminiscent of outdated debates aimed at distinguishing Romans from natives (Pitts, 2017; Woolf, 1997). It is clear from this investigation that research examining burial data needs to overcome this to further the archaeological understanding of cultural transitions during this time period.

While conducting an in-depth analysis of cremation practices across Britain (excluding Wales) this study also found evidence to suggest the innovation of Roman cremation practices. This in turn indicates the negotiation of new cultural identities through increased contact with the continent. The Early Roman cemetery of Skeleton Green (Hertfordshire, South-East) included a cluster of casket burials, characterised as calcined bone deposits placed inside wooden containers. Further evidence for the innovation of Roman cremation practices was also found at the Middle Roman cemetery of Queens Road (Colchester, South-East), where several of the cremation depositions included ceramic lids that were used to cover the urns (Orr, 2010). At the Early Roman cemetery of Warren Farm (Bedfordshire) in the Midlands, one cremation deposit had a poppy-head beaker placed inside the cremation vessel (Dawson and Slowikowski, 1988). In their analysis of the Gallo-Roman cremation burials from Belgium, Cerezo-Román and colleagues (2017, p.176) also suggested that the individuals from Weyler and Houffalise (Luxemburg) found their own ways to adopt Roman cremation traditions. This is supported by the findings of this current study, where Romano-British communities adopted Roman practices but made them their own by adding their own signature style. In doing so, social identities transformed through cremation rituals inspired by increased contact with Rome.

This investigation has also confirmed that cultural change in provincial society was not limited to the period directly following the conquest, but happened throughout the 1st to the 4th centuries AD. Bustum burials did not appear in the burial record until the Middle Roman period, coinciding with a decline in pyre sites, which where always a rarity. This result confirms that cultural change was a gradual process that did not necessarily have an impact until several centuries after the conquest (Sweetman, 2007). So far, Romano-British burial studies have predominately used the spread of inhumation to discuss the concept of gradual or delayed 'Romanisation', where scholars have argued that burial practices did not become fully Romanised until this point (Wightman, 1985; Morris, 1992; Pearce, 2015). This study has demonstrated that, in fact, the process of delayed cultural change is also evident from the available cremation data.

A significant finding from the primary investigation of Hertfordshire, which has not been found elsewhere in contemporary research, is that burning intensity was not influenced by social stratification. This is contra McKinley (2015b, p.200) who inferred that incomplete oxidisation in the context of Roman towns is an indication of social status, suggesting that poorer individuals who could not afford sufficient amounts of firewood were less well cremated. The results presented in this study do not support this argument. In fact, they demonstrate that the quality of cremation was not influenced by social group, but rather suggest the 'industrialisation' of cremation that occurred in towns following the introduction of *ustores* after the Roman conquest. This is the first study to propose this concept in the context of Roman cremation burials.

The primary examination of Hertfordshire conducted in this thesis, combining archaeological, osteological and environmental analyses proved a successful approach to comprehensively reconstruct cremation funerals in Late Iron Age and Roman Britain. Similar multi-disciplinary approaches have been applied across north-western Europe to both identify distinct cultural practices, and the creation of new cultural identities through the process of 'Creolization' (Thompson, et al., 2016; Cerezo-Román, et al., 2017). The work presented in this study contributed to this body of research by showing how cremation technology was not always homogenous between cemeteries and settlement types in Roman Hertfordshire; this in turn demonstrated varying burial response to 'Romanisation'. Unfortunately, due to the limited sample used in this investigation, it was not possible to sufficiently examine transitions in cremation practices from the Late Iron Age to the Late Roman period. As only two Late Iron Age individuals could be located and sampled, any results ascertained are circumstantial. This same methodological approach should therefore be applied on a larger scale, examining cremation practices between different geographical regions (north and south), and settlement types (military and civilian) to expand on the results presented here; this will enable further insight into Late Iron Age and Romano-British society and how it responded to increased Roman contact.

This issue regarding the overall lack of Late Iron Age burial data was also prominent in the secondary investigation conducted on cremation practices in Britain (excluding Wales). It was only possible to examine cultural transitions from the Late Iron Age to the Early Roman period in the South-East and Midlands. This is not a representative sample, and invites inaccurate interpretations of provincial Roman society (Pearce, 2008). Following this review of burial data and standardisation in cremation research, this approach is not as useful for examining cultural transitions with Late Iron Age and Roman burial data in its current state. It would be better if more in depth investigations of individual cremation deposits were conducted.

As this study did not examine the function and type of material goods recovered from cremation deposits, it was not possible to comment on how these items transformed during the cremation process, and how this interacted with the transformation of the body. It is well established in contemporary research that objects are socially embedded; their meaning and function is not fixed, but changes depending on contextual and social dynamics (Hill, 2002; Pitts, 2014). There is evidence for the ritual destruction of grave goods within cremation contexts from Late Iron Age and Roman

Britain (Shepherd, 1988; Burleigh and Fitzpatrick-Matthews, 2010). By examining how these objects took on new meanings during the cremation funeral, it would be possible to investigate how cultural identities transformed during Roman occupation (Quinn, et al., 2014; Cerezo-Román, et al., 2017).

Overall, this examination of cremation practices in Late Iron Age and Roman Britain has demonstrated the complexity of cultural transitions during this period of British archaeology. The cultural responses to Roman occupation were not always homogenous, but varied across regions, time periods and individual cemeteries. Society was evidently a fluid concept that was characterised by the continuation of Late Iron Age traditions, the uptake of Roman customs, and the innovation of new cultural identities.

Chapter 9: Conclusions

9.1 Summary of Findings

9.1.1 Quantitative Petrography and Cremation Research

This study has outlined a novel method for preparing uniform thin-sections of burned bone that are all the same thickness. This technique will improve the comparability of results from different histological studies and encourage greater standardisation due to the higher quality of thin-sections produced, as well as the application of quantitative analysis. Its application to determine burning temperature has proved to be both reliable and highly accurate. The different stages of burning present narrower temperature ranges that provide a more detailed interpretation of burning conditions compared to contemporary studies. The results are consistent with those from other microscopic and macroscopic assessments, and when combine produce a holistic interpretation of cremation technology. It is therefore recommended that this method be used in conjunction with FTIR-ATR analysis, and macroscopic colour change.

The inter-observer pilot study found that quantitative petrography had a high percentage agreement between examiners. Both human bone and non-human bone specialists quickly understood the software dictionary and learnt how to navigate the software with relative ease. As such, this method could be used by anthropologists and archaeologists alike with minimal training.

9.1.2 Survey of Cremation Practices 100BC – 410AD

Investigating regionality in the context of Late Iron Age and Roman cremation practices in Britain was a challenging process due to the uneven distribution of data; the majority of cremation deposits came from the South-East of the country, however comparably fewer derived from the North and South-West. Consequently, it was not possible to obtain a holistic interpretation of these burial rites from the Late Iron Age to the Early Roman period. It was only possible to make comparisons between the South-East and Midlands. When possible, wider geographical comparisons were made. This lack of data highlights how the North and South-West are not as well studied or documented as the South-East and Midlands, but also that cremation was possibly not as popular, especially in the Late Iron Age. In the wider context of north-western Europe, the same varied distribution of Late Iron Age cremation burials it is evident in both France and Belgium (Fitzpatrick, 2000; Cerezo-Román, et al., 2017). A further parralle is that only a handful of well known pre-Roman cremation cemeteries, including Clemancy, Luxembourg, and Acy-Romance, French Ardennes, have been published (see Fitzpatrick, 2000, p.18). As such, there is no extensive comparative data in both Britain and the continent that can allow for a holistic interpretation of cremation practices during this transitional period.

Nonetheless, some interesting regional trends were identified in this study that could provide some insight into the nature of cultural transitions during this time period. The results have demonstrated that change was not restricted to the century directly following the Roman conquest. On the contrary, the uptake of Roman-styled practices occurred intermittently from the 1st century to the 3rd and 4th centuries AD across the country. The similarity in cremation practices identified in the South-East and Midlands in the Early Roman period shows that change was not exclusive to the South-East but had a larger regional impact. In addition, the prolonged continuity of older cremation rites, particularly in the South-West demonstrates how this phenomenon was not instant but was billowed in nature. Some regional changes in the South-East and Midlands were short-lived and did not take hold or spread in the following centuries. However, other aspects were regionally homogenous from the Late Iron Age to the Late Roman period.

While most cremation deposits examined in this study derived from urban cemeteries, data were recorded for all settlement types during the Late Iron Age to Early Roman transition, which allowed for more holistic interpretations of the study sample. Unlike regionality, very little variation was identified according to settlement type. Cremation practices were generally similar for rural, major and minor urban communities. This suggests a high level of interaction between settlements and challenges any notions of marginalisation, where those living on the outskirts of major settlements or urban complexes are removed from cultural change. There was, however, evidence for the continuation of Late Iron Age traditions at minor urban sites into the Middle Roman period, while rural and major urban settlements demonstrated a quicker uptake urned burial practices. This seeming resistance to Roman innovations is interesting and could reflect a difference in social dynamics and reduced contact with Rome.

Alongside the continuation of Late Iron Age practices and the uptake of Roman customs, evidence for cultural innovation was also identified, suggesting the creation of new identities. The use of wooden caskets as cinerary urns at Skeleton Green, rather than the usual ceramic vessels shows the development of new burial customs inspired by increased contact with the continent. This confirms that cultural change was not necessarily characterised by the uptake of Roman traditions, but the evolution of cremation practices over Roman occupation.

Another interesting outcome of this study is how large, dominating cemeteries were not always representative of the cremation rites practiced by smaller contemporary sites. Often, these burial grounds were outliers that were skewing the dataset resulting in trends that were not demonstrative of that particular region or settlement type. This is a significant finding for Late Iron Age and Roman studies that often use these large, well-known burial grounds as primary case studies to examine culture transitions. Not only does this emphasise the caution needed when interpreting these sites, but it also reiterates the level of inter-cemetery variation in this context.

For most of the Late Iron Age and Roman periods in Britain, cremation was a rite more commonly associated with males. Similar results have also been found regarding inhumation practices from the same time period, representing an overall bias in the burial record (Mays, 1995). Interestingly, in the Early Roman period a higher prevalence of female cremation deposits was found in the South-East and Midlands, across all settlement types. The reason for this trend is unclear, and could possibly suggest a short-lived change in practices whereby more women were burned and buried.

The majority of aged individuals across all regions and settlement types were over 18 years of age. This is to be expected given that fragile bones from younger individuals are less likely to survive cremation and burial, as well as the general bias towards adults in the burial record in Roman Britain. Non-adults also made up a small percentage of the demography from the Late Iron Age to the Late Roman period. While the results from this study highlighted issues with examiner biases, they also demonstrated continuity in perceptions of the life course from the Late Iron Age.

In this study, several new innovations in cremation practices have been identified suggesting the uptake of more outwardly Roman practices. The shift from predominantly unurned to urned burials could represent the introduction of a new belief system through a change in ritual practices. The fact that this custom varied according to region and settlement type highlights the complexity of this process showing fluctuating responses to Roman occupation.

The increased importance of the pyre in the centuries following the Roman conquest also represents a move towards Roman-styled cremation. The practicalities of cremation remained consistent from the Late Iron Age onwards, however the rituals involved may have changed over time. Unfortunately, as this study could not examine the type of pyre goods placed with the deceased on the pyre, it is not possible to comment on how pyre display evolved during the Roman period.

Overall, very few pyres sites and bustum burials were recorded in this study. Generally, these types of features are quite elusive in the burial record, and any regional variation is more likely a reflection of the poor quality of archaeological data in the North and South-West of the country. The increase in the number of bustum burials in the Middle and Late Roman periods in the North-West and South-East represents the adoption of continental cremation rites.

9.1.3 Cremation Technology in Hertfordshire

This study has demonstrated that cremation technology in Hertfordshire varied according to cemetery and settlement type. It is conceivable based on these results that rural communities demonstrated better pyre management evident from greater bone fragmentation, oxidization and burning temperatures. Urban cremations on the other hand did not reflect this same level of maintenance, which could be a result of the introduction of *ustores* (professional cremators) in Roman towns where cremation became industrialised and subject to demand. Interestingly, cremation was broadly similar according to sex, age and number of grave goods.

Fuel choice was practical, rather than ritually motivated. The greater number of species identified in rural assemblages suggests that wood was directly sourced from local woodlands. The higher proportion of twigwood in cremation deposits of non-adults suggests greater use of smaller wood types. No trends in skeletal representation were found; however, the amount the bone collected for burial varied substantially which could be a result of numerous taphonomic and ritual factors.

The burning intensity achieved in Hertfordshire was generally higher than that found at military cemeteries on the northern frontier, representing a difference in cremation technology between military and civilian communities. For soldiers that died overseas their remains were rarely sent back to their natal families. Instead, it is more likely that they were subject to cremation funerals characterised by standardised and efficient practices drawn from a shared knowledge. In comparison, individuals from civilian settlements, specifically those from Hertfordshire, displayed greater diversity.

Even though only two individuals from Hertfordshire dated to the Late Iron Age, they displayed similarities in burning intensity with the Roman sample. This suggests an element of continuity in cremation technology with the pre-Roman Iron Age. Interestingly, the Late Iron Age cremation deposits were comparatively smaller and more fragmented. However, it is not possible to comment of whether this presented a temporal trend in cremation practices without further investigation using a large sample size.

9.2 Contextualising Cremation in Late Iron Age and Roman Britain

This study has demonstrated that society during the Late Iron Age to Roman periods in Britain was a fluid concept characterised by the continuation of traditional ideals, the uptake of Roman customs, and the creation of new cultural indentities. Responses to Roman occupation and the introduction of a new culture was not always homogenous, but varied between regions, settlement types and cemeteries. This highlights how in this context 'Romanisation' was not characterised by the wholesale uptake of Roman culture. Concepts of death did, to some extent, change overtime where attitudes focused more on the individual.

9.3 Recommendations for Future Research

Studies examining cultural transitions in Late Iron Age and Roman Britain would benefit from focusing more on funerary data, specifically cremation deposits. As this rite was the predominant practice for large parts of this period, and with the recent advances in the field of cremation research, it is now possible to examine more research avenues, other than material culture.

Even though central and south-eastern Britain are heavily populated with Late Iron Age and Roman cremation burials, future research should focus on exploring the burial record from other geographical areas. This study has demonstrated that at present, it is not posssible to establish a holistic interperetation of this burial practice in Britain (excluding Wales) due to the lack of data from the north and south-west of the country. By collecting new data, as well as re-analysing known cemeteries, future studies would be able to examine cultural transitions and further explore 'Romanisation' on a cross-regional scale.

The results presented here demonstrate that cremation practices and cremation technology do vary between settlement types. However, at present, the majority of research and burial data dervies from urban settlements. Far fewer rural cremation cemeteries have been subject to post-exavation processing, analysis and publication. This has created a bias in archaeological perceptions of provincial Roman society. Future research should strive to resolve this issue concerning rural burial grounds to avert problems induced by comparatively small sample sizes.

A particularly interesting find from this investigation was how large, well-known cemeteries are not necessarily representative of smaller communities. The practices indentified at these burial grounds often differed from contemporary cemeteries from the same region. As such, it is recommended that future research examining these large burial complexes place the results in the wider, geographical context and establish how they compare to neighbouring cemeteries. By avoiding this assumption, future examiners will be able to identify any unusual trends that do not follow conventional practices and further identify different cultural groups.

Further effort should be made to conduct large-scale multi-disciplinary studies combining archaeological, osteological and archaeobotanical data. Such an approach has proven successful in this study in examining the many stages involved in a cremation funeral. Not only will this approach encourage collaborative projects between departments and institutions but will help advance the research field by tackling large research questions.

The overall lack of identified pyre sites in Britain (excluding Wales) found in this study suggests that cremation was not conducted within cemetery walls, but elsewhere. This has been further confirmed by Creighton and Fry (2016) by their geomagnetic survey of Roman Silchester. Future research should employ a similar approach to other settlements to identify any areas of pyre activity near cemetery boundaries. This could contribute to our understanding of the cremation process and establish any temporal or spatial differences.

More effort should be made to compare pyre and grave goods from cremation contexts, rather than focusing on items placed within the grave. Even though objects placed on the pyre cannot always be identified because they have melted as a result of the fire, a proportion of material does survive. This comparison will not only increase our understanding of the dressing of the body before cremation, but also help to further define the different stages of the cremation funeral and whether this evolves on a temporal/spatial basis.

The combined use of macroscopic and microscopic investigations of heat-induced changes in burned bone should be applied more widely in archaeological cremation studies. This will help to produce a more holistic interpretation of burning conditions in the past and allow for further comparisons between studies. Additional experimental work would also benefit from not only examining the replicability of results from different institutions, but also the replicability of results using these different methods, specifically histology and crystallinity.

Quantitative petrography is a statistically robust and efficient method for examining burned bone histology that could replace older, qualitative methods. Future research should use this technique more widely to examine cremated bone deposits from other geographical and chronological sites. Future research would also benefit from developing the osteometric application by measuring the size of microscopic features from burned bone samples of different ages, sexes and temperatures.

It is essential that future scholars in cremation research direct their attention towards addressing the lack of standardisation in the research field. The inability to compile large datasets and make comparisons between different studies limits the scope of research. By enforcing shared terminologies and analytical methods, research could further examine temporal and spatial themes that could greatly enhance our understanding of cremation in the past.

This investigation of cremation practices and cultural transitions in Late Iron Age and Roman Britain is significant for demonstrating the value of funerary data (cremation), and how it can contribute to our understanding of this transitional period. Not only has it shown the uptake of Roman innovations, but also the continuation of traditional Late Iron Age ideals and the creation of new cultural identities. Cremation was not always homogenous, but differed between different social grounps, settlement types and regions. In the context of 'Romanisation' these results have reiterated how complex cultural change was, and that it cannot be explained by a single paradigm. Society in Late Iron Age and Roman period was a fluid concept that embodied a pro-Roman attitude towards death, as well as a continuity of local identies. The primary investigation of Hertfordshire has highlighted the benefits of employing a multi-discplinary approach combing archaeological, osteological and environmental data. The application of both macoroscpic and microscopic techniques to reconstruction cremation technology can help distinguish between different cultural groups and identify varying responses to Roman occupation. In the context of cremation research, quantitative petrography is a novel method that has the potential to replace traditional histological methods and be used in combination with other techniques examining burning conditions. The new method for producing thin-sections will help standardise histological analyses and encourage comparative research. This investigation is also significant for highlighting the lack of standardisation in cremation research, particularly regarding the recording and analysing of burned human remains. These issues need to be addressed in order to facility future research investigating cremated human remains and what they can contribute to our understanding of cultural transitions in the burial record.

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Appendix 1: Primary Data from Hertfordshire: Cemeteries and Key References

Table A1.1 Cemeteries and key references of primary data from Hertfordshire.

Cemetery	Location	N Cremation Deposits	Publication
Wallington Road	Baldock, North-East Hertfordshire	46	Burleigh and Fitzpatrick-Matthews (2010)
Cross Farm	Harpenden, West Hertfordshire	31	1) West (1994) 2) Roberts (1996)
Folly Lane	St Albans, South-West Hertfordshire	15	Niblett (1999)
M1 Junction	Hemel Hempstead, South-West Hertfordshire	6	Stansbie et al. (2012)
Spencer Park	Hemel Hempstead, South-West	4	Foard (2008)

Table A1.2 Catalogue of data from primary investigation.

Cemetery	Burial Number	Time Period	Settlement Type	Sex	Age	Grave Goods	Burned Animal Bone	Colour(s)	Histology	FTIR-ATR	Quantitative Petrography
Wallington Road	16	Early Roman	Minor Urban	Male	18+	1	0	Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Wallington Road	17	Middle Roman	Minor Urban	Female	18+	1	0	Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	24	Middle Roman	Minor Urban	Female	18+	2	0	Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	26	Early Roman	Minor Urban	Male	18+	2	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	II (500-600˚C)
Wallington Road	28	Early Roman	Minor Urban	Unknown	18+	0	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	III (700-900˚C)
Wallington Road	29	Early Roman	Minor Urban	Unknown	14 - 18	0	0	Taupe; Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	32B	Early Roman	Minor Urban	Female	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	36	Early Roman	Minor Urban	Unknown	Unknown	0	0	Black; Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	III (700-900˚C)

Wallington Road	37	Early Roman	Minor Urban	Male	18+	1	0	Grey; Blue; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Wallington Road	38	Early Roman	Minor Urban	Female	18+	2	1	Brown; Black; Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	III (700-900˚C)
Wallington Road	39	Middle Roman	Minor Urban	Female	18+	4	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	41	Early Roman	Minor Urban	Male	18+	1	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	43	Early Roman	Minor Urban	Unknown	14 - 18	2	0	Taupe; Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	45	Early Roman	Minor Urban	Unknown	Unknown	0	0	Grey; Blue; White	Less Intensely Cremated (300-600C˚)	Middle (400-700˚C)	II (500-600˚C)
Wallington Road	54	Early Roman	Minor Urban	Male	18+	1	1	Grey; Blue; White	Less Intensely Cremated (300-600C˚)	Middle (400-700˚C)	II (500-600˚C)
Wallington Road	57	Early Roman	Minor Urban	Male	18+	3	0	Grey; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)

Wallington Road	58A	Early Roman	Minor Urban	Unknown	Unknown	3	0	Brown; Taupe; Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	60	Early Roman	Minor Urban	Male	18+	1	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	II (500-600˚C)
Wallington Road	71	Middle Roman	Minor Urban	Male	18+	2	0	Taupe; Grey; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Wallington Road	77	Early Roman	Minor Urban	Unknown	14 - 18	2	0	Taupe; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	84	Early Roman	Minor Urban	Male	18+	0	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	II (500-600˚C)
Wallington Road	85	Early Roman	Minor Urban	Unknown	Unknown	0	0	White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	86	Middle Roman	Minor Urban	Female	18+	2	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	II (500-600˚C)
Wallington Road	95	Middle Roman	Minor Urban	Female	18+	1	0	Grey; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Wallington Road	96	Middle Roman	Minor Urban	Unknown	18+	1	1	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	II (500-600˚C)

Wallington Road	99	Early Roman	Minor Urban	Female	18+	5	1	Taupe; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	108	Middle Roman	Minor Urban	Unknown	Unknown	1	0	Black; Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	109	Early Roman	Minor Urban	Unknown	Unknown	0	0	Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	110A	Late Iron Age	Minor Urban	Male	18+	1	1	Black; Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	113	Early Roman	Minor Urban	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	116	Late Roman	Minor Urban	Male	18+	1	2	Brown; Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	126	Early Roman	Minor Urban	Female	18+	2	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	III (700-900˚C)
Wallington Road	133	Early Roman	Minor Urban	Unknown	Unknown	2	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	136	Early Roman	Minor Urban	Male	18+	2	0	Grey; Blue; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)

Wallington Road	145	Middle Roman	Minor Urban	Female	18+	1	0	Taupe; Grey; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	III (700-900˚C)
Wallington Road	151	Early Roman	Minor Urban	Unknown	Unknown	1	0	Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	153	Early Roman	Minor Urban	Female	18+	2	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	157	Early Roman	Minor Urban	Female	18+	0	0	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	II (500-600˚C)
Wallington Road	160	Early Roman	Minor Urban	Male	18+	0	0	Brown; Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	165	Early Roman	Minor Urban	Male	18+	1	0	Taupe; Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	166	Early Roman	Minor Urban	Female	18+	1	0	Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	170	Early Roman	Minor Urban	Unknown	18+	2	0	Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Wallington Road	171	Early Roman	Minor Urban	Unknown	Unknown	0	0	Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)

Wallington Road	184	Early Roman	Minor Urban	Male	18+	2	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Wallington Road	186	Early Roman	Minor Urban	Unknown	Unknown	1	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	II (500-600˚C)
Wallington Road	190	Early Roman	Minor Urban	Female	18+	3	0	Taupe; Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Cross Farm	AAC.8.101	Early Roman	Rural	Unknown	18+	3	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAJ.6.103	Middle Roman	Rural	Female	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAB.17.103	Early Roman	Rural	Unknown	18+	5	0	Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Cross Farm	AAE.2.13.104	Early Roman	Rural	Unknown	< 13	2	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAE.12.3.104	Early Roman	Rural	Unknown	18+	2	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAF.2.105	Early Roman	Rural	Unknown	18+	3	0	Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)

Cross Farm	AAF.1.105	Early Roman	Rural	Female	18+	3	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAG.106	Middle Roman	Rural	Female	18+	3	0	Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAM.109	Middle Roman	Rural	Female	18+	1	0	Grey; White	Intensely Cremated (600-900C˚)	Middle (400-700˚C)	III (700-900˚C)
Cross Farm	AAN.10.110	Middle Roman	Rural	Male	18+	1	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAN.30.1.110	Middle Roman	Rural	Unknown	18+	1	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAP.31.111	Early Roman	Rural	Unknown	18+	4	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAP.19.111	Early Roman	Rural	Unknown	18+	4	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAV.112	Early Roman	Rural	Unknown	18+	3	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	AAY.22.113	Early Roman	Rural	Female	18+	1	0	Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)

Cross Farm	ABB.1.1 15	Early Roman	Rural	Male	14 - 18	2	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Cross Farm	ABD.117	Early Roman	Rural	Male	18+	3	0	Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Cross Farm	ABE.118	Middle Roman	Rural	Male	18+	0	0	Grey; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Cross Farm	ABG.36	Middle Roman	Rural	Male	18+	2	0	Taupe; Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	ABG.33. 119	Middle Roman	Rural	Unknown	18+	2	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	ABL.120 .38	Early Roman	Rural	Male	18+	2	0	White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Cross Farm	ABL.120	Early Roman	Rural	Male	18+	2	0	Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Cross Farm	ABF.34. 120.122	Middle Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	4	Early Roman	Rural	Female	18+	4	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)

Cross Farm	6	Middle Roman	Rural	Male	18+	2	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	7	Middle Roman	Rural	Male	18+	1	0	Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	206.008	Middle Roman	Rural	Unknown	18+	1	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	12	Middle Roman	Rural	Unknown	18+	2	0	Grey; Blue; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	17	Middle Roman	Rural	Unknown	18+	4	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	18	Middle Roman	Rural	Female	18+	1	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Cross Farm	214.203	Middle Roman	Rural	Unknown	14 - 18	3	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	1	Early Roman	Major Urban	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)
Folly Lane	2	Early Roman	Major Urban	Female	18+	3	0	Grey; White	Completely Cremated (900C˚+)	Middle (400-700˚C)	IV (1000-1100˚C)

Folly Lane	4	Early Roman	Major Urban	Male	18+	3	1	Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	7	Early Roman	Major Urban	Male	18+	2	0	Black; Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Folly Lane	8	Early Roman	Major Urban	Unknown	18+	0	0	Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	9	Early Roman	Major Urban	Unknown	18+	6	1	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	10	Early Roman	Major Urban	Unknown	18+	2	1	Taupe; Grey; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Folly Lane	11	Early Roman	Major Urban	Unknown	Unknown	1	0	Taupe; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	12	Late Roman	Major Urban	Unknown	18+	2	1	Taupe; Grey; Blue; White	Intensely Cremated (600-900C˚)	High (800-1000˚C)	III (700-900˚C)
Folly Lane	13	Late Roman	Major Urban	Male	18+	1	1	Brown; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	18	Early Roman	Major Urban	Male	18+	3	1	Black; Grey; Blue; White	Less Intensely Cremated (300-600C˚)	Middle (400-700˚C)	II (500-600˚C)

Folly Lane	21	Early Roman	Major Urban	Unknown	18+	8	2	Black; Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	22	Early Roman	Major Urban	Unknown	18+	0	0	Grey; White	Less Intensely Cremated (300-600C˚)	Middle (400-700˚C)	II (500-600˚C)
Folly Lane	24	Early Roman	Major Urban	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Folly Lane	29	Early Roman	Major Urban	Unknown	18+	0	2	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
M1 Junction	2013	Early Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
M1 Junction	3040	Late Iron Age	Rural	Unknown	Unknown	0	0	White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
M1 Junction	6291	Middle Roman	Rural	Unknown	18+	2	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
M1 Junction	6292	Middle Roman	Rural	Unknown	18+	2	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
M1 Junction	6295	Middle Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)

M1 Junction	6298	Middle Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Spencer Park	404	Early Roman	Rural	Male	18+	1	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Spencer Park	409	Early Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Spencer Park	410	Early Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)
Spencer Park	412	Early Roman	Rural	Unknown	18+	0	0	Grey; White	Completely Cremated (900C˚+)	High (800-1000˚C)	IV (1000-1100˚C)

Table A1.3 Catalogue of data from primary investigation continued.

Cemetery	Burial Number	Time Period	Settlement Type	Sex	Age	Weight(g)	10mm(g)	5mm(g)	2mm(g)	Skull(g)	Axial(g)	Upper Limb(g)	Lower Limb(g)
Wallington Road	16	Early Roman	Minor Urban	Male	18+	1210.63	778.9	46.23	385.5	49.9	74.6	130.7	58.6
Wallington Road	17	Middle Roman	Minor Urban	Female	18+	660.5	442	118.5	100	6.5	39.5	39.5	177.5
Wallington Road	24	Middle Roman	Minor Urban	Female	18+	670.9	549	44.1	77.8	60.5	60.6	45.5	210
Wallington Road	26	Early Roman	Minor Urban	Male	18+	2331.3	1158.3	397.5	775.5	208.9	83.5	141.5	364
Wallington Road	28	Early Roman	Minor Urban	Unknown	18+	362.6	154.7	84.4	123.5	15	51.2	14.5	59.9
Wallington Road	29	Early Roman	Minor Urban	Unknown	14 - 18	590	211	127.9	251.1	2	26.5	49.9	33.5
Wallington Road	32B	Early Roman	Minor Urban	Female	18+	434	143	91	200	22.5	4.5	44.5	16.5
Wallington Road	36	Early Roman	Minor Urban	Unknown	Unknown	298	86	87.7	124.3	2	6.1	29.6	32.5
Wallington Road	37	Early Roman	Minor Urban	Male	18+	814.2	446	127.4	240.8	78.6	104.3	65.3	47.7
Wallington Road	38	Early Roman	Minor Urban	Female	18+	982.1	416	249.6	316.5	43.2	62	60.7	81.2
Wallington Road	39	Middle Roman	Minor Urban	Female	18+	62.5	50	10.6	1.9	22.9	25.3	4.8	6.5
Wallington Road	41	Early Roman	Minor Urban	Male	18+	879	469	154.5	255.5	2	68	79.5	152.5

Wallington Road	43	Early Roman	Minor Urban	Unknown	14 - 18	776.9	244.7	149.5	382.7	58.4	25.1	43.6	41.3
Wallington Road	45	Early Roman	Minor Urban	Unknown	Unknown	238.1	69.7	62.1	106.3	0	19.3	15.3	26.3
Wallington Road	54	Early Roman	Minor Urban	Male	18+	229.5	27.5	36.5	165.5	3	2.5	11.5	3.5
Wallington Road	57	Early Roman	Minor Urban	Male	18+	880.98	457.08	146.7	277.2	19.5	67.2	105.7	117.98
Wallington Road	58A	Early Roman	Minor Urban	Unknown	Unknown	503.1	195.3	113.9	193.9	0	14.2	70.5	36.7
Wallington Road	60	Early Roman	Minor Urban	Male	18+	318	81.5	97.5	139	7.5	8	39.5	13.5
Wallington Road	71	Middle Roman	Minor Urban	Male	18+	276.1	107.8	67.2	101.1	24.4	25.5	27.7	9.9
Wallington Road	77	Early Roman	Minor Urban	Unknown	14 - 18	680.8	252.8	163	265	7	31.5	30.6	83.2
Wallington Road	84	Early Roman	Minor Urban	Male	18+	159.7	21.7	49.6	88.4	2.8	2.3	8.4	5.6
Wallington Road	85	Early Roman	Minor Urban	Unknown	Unknown	1.9	1.5	0.4		0	1.5	0	0
Wallington Road	86	Middle Roman	Minor Urban	Female	18+	835	436	145.5	253.5	13.5	26.5	39.5	107
Wallington Road	95	Middle Roman	Minor Urban	Female	18+	375.9	227	37.1	111.8	16	38.1	46.1	76.4
Wallington Road	96	Middle Roman	Minor Urban	Unknown	18+	809.5	424.2	189.1	196.2	12.3	41.3	48.3	200.6
Wallington Road	99	Early Roman	Minor Urban	Female	18+	1441.2	615.7	326	499.5	38.5	111	107	117

Wallington Road	108	Middle Roman	Minor Urban	Unknown	Unknown	332	99.5	104	128.5	1	7	40.5	14.5
Wallington Road	109	Early Roman	Minor Urban	Unknown	Unknown	11.2	3.3	3.9	4	0	1.5	2.9	0
Wallington Road	110A	Late Iron Age	Minor Urban	Male	18+	36.9	33.4	2.6	0.9	33.7	1.9	0	0
Wallington Road	113	Early Roman	Minor Urban	Unknown	18+	43.4	6.5	7.8	29.1	3.3	2.9	2.8	0
Wallington Road	116	Late Roman	Minor Urban	Male	18+	838	383.6	175	279.4	27.5	20.8	55.2	139.2
Wallington Road	126	Early Roman	Minor Urban	Female	18+	321	126.5	88	106.5	21	37.5	27	42.5
Wallington Road	133	Early Roman	Minor Urban	Unknown	Unknown	38.8	15.4	6.3	17.1	0	1.1	1.5	11.6
Wallington Road	136	Early Roman	Minor Urban	Male	18+	774.5	237.1	193.5	343.9	0	40.2	84.6	36.5
Wallington Road	145	Middle Roman	Minor Urban	Female	18+	314.5	98.5	90	126	22	3	26.5	2.5
Wallington Road	151	Early Roman	Minor Urban	Unknown	Unknown	460	67.5	158.5	234	7	9.1	49	14.1
Wallington Road	153	Early Roman	Minor Urban	Female	18+	160.4	14.6	36.4	109.4	15.1	2	1.8	4.3
Wallington Road	157	Early Roman	Minor Urban	Female	18+	685.1	175.2	164.4	345.5	29	35.6	46.3	28.6
Wallington Road	160	Early Roman	Minor Urban	Male	18+	1666.5	471.1	474.4	721	84.8	38.4	97.9	3.9

Wallington Road	165	Early Roman	Minor Urban	Male	18+	906	324.6	200.4	381	32.8	31.2	116.1	16.5
Wallington Road	166	Early Roman	Minor Urban	Female	18+	462.2	181.5	108.8	171.9	31.2	10	60.4	38.3
Wallington Road	170	Early Roman	Minor Urban	Unknown	18+	971.5	421.8	255.5	294.2	88.9	101.5	117.8	47.8
Wallington Road	171	Early Roman	Minor Urban	Unknown	Unknown	592.8	276.8	114	202	36.3	14.5	57	44
Wallington Road	184	Early Roman	Minor Urban	Male	18+	1606.5	577.6	373.4	655.5	47.6	14.1	19.7	30.9
Wallington Road	186	Early Roman	Minor Urban	Unknown	Unknown	486	214	73.5	198.5	7	21	21.5	75.5
Wallington Road	190	Early Roman	Minor Urban	Female	18+	942.8	484	198.7	260.1	98.5	75.4	68	28.3
Cross Farm	AAC.8.101	Early Roman	Rural	Unknown	18+	580	135.2	237.8	207	69.6	25.2	41.2	31.7
Cross Farm	AAJ.6.103	Middle Roman	Rural	Female	18+	251.7	133.9	73.6	44.2	21	7.7	65.5	37.5
Cross Farm	AAB.17.103	Early Roman	Rural	Unknown	18+	37.5	10.5	12.7	14.3	5.8	1.3	6.6	0
Cross Farm	AAE.2.13.104	Early Roman	Rural	Unknown	< 13	72.9	0	30.4	42.5	9	3	8.7	3.7
Cross Farm	AAE.12.3.104	Early Roman	Rural	Unknown	18+	295	81	88	126	8	11	5	45
Cross Farm	AAF.2.105	Early Roman	Rural	Unknown	18+	98.4	17.9	34.7	45.8	10.5	1.2	6.3	12.8
Cross Farm	AAF.1.105	Early Roman	Rural	Female	18+	128.7	28.7	46.1	53.9	2.7	4.4	10.6	20.5

Cross Farm	AAG.106	Middle Roman	Rural	Female	18+	292.5	66.5	109.5	116.5	34.5	0	3	9.5
Cross Farm	AAM.109	Middle Roman	Rural	Female	18+	329.5	104	108	117.5	22	18.5	38	21
Cross Farm	AAN.10.110	Middle Roman	Rural	Male	18+	531.3	178.7	208	144.6	25.2	15.3	48	83.4
Cross Farm	AAN.30.1.110	Middle Roman	Rural	Unknown	18+	65.7	14.5	25.3	25.9	0	0	1.8	17.6
Cross Farm	AAP.31.111	Early Roman	Rural	Unknown	18+	315.3	47.3	113.4	154.6	26.2	4.7	44.6	8.6
Cross Farm	AAP.19.111	Early Roman	Rural	Unknown	18+	164.3	38.6	59	66.7	5.9	8.4	16.9	17
Cross Farm	AAV.112	Early Roman	Rural	Unknown	18+	130.2	27.8	42.6	59.8	25.3	4.9	7.7	7
Cross Farm	AAY.22.113	Early Roman	Rural	Female	18+	112.6	14.6	38.4	59.6	9.5	1.4	4.9	13.2
Cross Farm	ABB.1.115	Early Roman	Rural	Male	14 - 18	885.2	322.3	263.6	299.3	35.2	97.3	48	64.2
Cross Farm	ABD.117	Early Roman	Rural	Male	18+	442.5	146	168.5	128	11	16.5	23	82
Cross Farm	ABE.118	Middle Roman	Rural	Male	18+	612.3	267.6	181.6	163.1	142.3	23.3	70	75.3
Cross Farm	ABG.36	Middle Roman	Rural	Male	18+	709.5	339.9	219	150.6	36.6	80.5	82.1	97.7
Cross Farm	ABG.33.119	Middle Roman	Rural	Unknown	18+	54.7	12.1	19.3	23.3	0	2.5	8.2	0
Cross Farm	ABL.120.38	Early Roman	Rural	Male	18+	231.9	107.4	60.5	64	0	22	50.4	30

Cross Farm	ABL.120	Early Roman	Rural	Male	18+	850	368.5	330	151.5	22.5	5.5	0	76
Cross Farm	ABF.34. 120.122	Middle Roman	Rural	Unknown	18+	11.4	4.1	5	2.3	0.7	0.7	5.3	0
Cross Farm	4	Early Roman	Rural	Female	18+	665.2	97.4	137.5	430.3	24.4	33.8	9.6	24.5
Cross Farm	6	Middle Roman	Rural	Male	18+	970.7	678.2	155.4	137.1	123.1	404.3	58.3	68.7
Cross Farm	7	Middle Roman	Rural	Male	18+	1276.7	266	264.7	746	0	14.5	93	94.9
Cross Farm	206.008	Middle Roman	Rural	Unknown	18+	136.3	22.6	52.3	61.4	18.9	6	1.8	2.8
Cross Farm	12	Middle Roman	Rural	Unknown	18+	1233.9	307.1	279.8	647	38.4	26.6	124	109.6
Cross Farm	17	Middle Roman	Rural	Unknown	18+	616.5	48.7	122.5	445.3	20.2	0	29.2	7.9
Cross Farm	18	Middle Roman	Rural	Female	18+	563.2	189	9.5	364.7	7	2.5	26.5	77
Cross Farm	214.203	Middle Roman	Rural	Unknown	14 - 18	1061.5	86	71.5	904	45	16	25	14.5
Folly Lane	1	Early Roman	Major Urban	Unknown	18+	376.5	174	104	98.5	20.5	61	16	24.5
Folly Lane	2	Early Roman	Major Urban	Female	18+	1649	785	568.5	295.5	73.5	191.5	50	128
Folly Lane	4	Early Roman	Major Urban	Male	18+	737.9	335.5	251.5	150.9	59	61.9	72.5	56.1
Folly Lane	7	Early Roman	Major Urban	Male	18+	1121.5	786.8	139.7	195	114.2	28.9	78.9	79.5

Folly Lane	8	Early Roman	Major Urban	Unknown	18+	297.3	132.3	90	75	0	18	26.3	46
Folly Lane	9	Early Roman	Major Urban	Unknown	18+	431.5	67.5	194	170	31.5	9	20	6
Folly Lane	10	Early Roman	Major Urban	Unknown	18+	100	74	16	10	11	10	15	30
Folly Lane	11	Early Roman	Major Urban	Unknown	Unknown	1	0	1		0	0.2	0	0.7
Folly Lane	12	Late Roman	Major Urban	Unknown	18+	281.1	196.1	35	50	2.3	79.5	17.6	84.7
Folly Lane	13	Late Roman	Major Urban	Male	18+	660.6	453.5	94.1	113	23.6	69	124	121
Folly Lane	18	Early Roman	Major Urban	Male	18+	746	311.3	278.7	156	36	91.4	36.1	70.5
Folly Lane	21	Early Roman	Major Urban	Unknown	18+	73.3	45	20.2	8.1	6.8	3.4	24.2	10.1
Folly Lane	22	Early Roman	Major Urban	Unknown	18+	311.6	94.1	103.2	114.3	10.8	20.7	34.8	29.7
Folly Lane	24	Early Roman	Major Urban	Unknown	18+	13.6	2.4	4.7	6.5	1.8	0.2	1.3	0
Folly Lane	29	Early Roman	Major Urban	Unknown	18+	14.9	8	5.9	1	1	4	4	2.9
M1 Junction	2013	Early Roman	Rural	Unknown	18+	9	1	6.8	1.2	0	1.9	2.8	1
M1 Junction	3040	Late Iron Age	Rural	Unknown	Unknown	1.1	1.1	0		0	0	1.1	0

M1 Junction	6291	Middle Roman	Rural	Unknown	18+	198.7	26.3	67.8	104.6	7.4	4.8	8.7	9.8
M1 Junction	6292	Middle Roman	Rural	Unknown	18+	15.7	3.9	8.4	3.4	0.2	1.6	1.4	3.7
M1 Junction	6295	Middle Roman	Rural	Unknown	18+	755.5	28	136.5	591	5	9.5	17	10.5
M1 Junction	6298	Middle Roman	Rural	Unknown	18+	15.7	3.9	8.4	3.4	0.2	1.6	1.4	3.7
Spencer Park	404	Early Roman	Rural	Male	18+	432.5	200.8	143.6	88.1	19.1	24.1	75.3	63
Spencer Park	409	Early Roman	Rural	Unknown	18+	1.9	0	0.9	1	0.2	0	0.3	0
Spencer Park	410	Early Roman	Rural	Unknown	18+	2	1	0.9	0.1	0	0	1.8	0
Spencer Park	412	Early Roman	Rural	Unknown	18+	9.3	0	3.7	5.6	0.5	0.1	1.6	0.2

Appendix 2: Secondary Data: Cemeteries and Key References

Table A2.1 Cemeteries and key references of secondary data.

Cemetery	Location	Region	N Cremation Deposits	Publication
Yeomanry Drive North	Baldock, Hertfordshire	South-East	395	Fitzpatrick-Matthews and Burleigh (2007)
King Harry Lane (Late Iron Age)	St Albans, Hertfordshire	South-East	388	Stead and Rigby (1989)
Walls Field	Baldock, Hertfordshire	South-East	316	Fitzpatrick-Matthews and Burleigh (2007)
Brougham	Penrith, Cumbria	North-West	205	Cool (2004)
Westhampnett (Late Iron Age)	Chichester, Sussex	South-East	164	Fitzpatrick (1997)
London, Eastern Cemetery	London	South-East	138	Barber and Bowsher (2000)
Skeleton Green	Puckeridge, Hertfordshire	South-East	97	Partridge (1981)
Derby Racecourse	Derby, Derbyshire	Midlands	91	Wheeler (1985)
Heaven's Walls	Litlington, Cambridgeshire	Midlands	80	Robinson and Going (2010)
1 Queens Road	Colchester, Essex	South-East	60	Orr (2010)
Trentholme Drive	York, Yorkshire	North-East	53	Wenham (1968)
Westhampnett (Early Roman)	Chichester, Sussex	South-East	31	Fitzpatrick (1997)
Lankhills	Winchester	South-East	30	Booth et al. (2010)
King Harry Lane (Late Roman)	St Albans, Hertfordshire	South-East	29	Stead and Rigby (1989)
Stansted Airport (Early Roman)	Stansted Mountfitchet, Essex	South-East	28	Havis (2004)
Strood Hall	Little Canfield, Essex	South-East	28	Timby et al. (2007)
London, Western Cemetery	London	South-East	28	Watson (2003)
The upper Walbrook Valley Cemetery	London	South-East	28	Harward, Powers and Watson (2015)
Icknield Way	Letchworth Garden City, Hertfordshire	South-East	27	Fitzpatrick-Matthews and Burleigh (2007)

A505 Baldock Bypass	Baldock, Hertfordshire	South-East	22	Philips (2009)
Wavendon Gate	Milton Keynes, Buckinghamshire	South-East	20	Williams, Hart and Williams (1996)
Walmer	Dover, Kent	South-East	20	Hoskins, Holman and Parfitt (2005)
Deverell Street	London	South-East	20	MacKinder (2014)
Hacheston	Hacheston, Suffolk	Midlands	19	Blagg, Plouviez and Tester (2004)
Guilden Morden	Guilden Morden, Cambridgeshire	Midlands	18	Letherbridge, (1936)
Saltwood Tunnel	Saltwood, Kent	South-East	18	McKinley, Riddler and Trevarthen (2006)
Mucking Cemetery IV	Mucking, Essex	South-East	18	Lucy and Evans (2016)
Stanway	Colchester, Essex	South-East	17	Crummy, et al., (2007)
Gill Mill	Ducklington and South Leigh, Oxfordshire	South-West	17	Booth and Simmonds (2011)
Mucking Cemetery II	Mucking, Essex	South-East	15	Lucy and Evans (2016)
Warren Farm	Deepdale, Sandy, Bedfordshire	Midlands	14	Dawson and Slowikoski (1988)
Mucking Cemetery VI	Mucking, Essex	South-East	13	Lucy and Evans (2016)
Sale Drive Doline	Baldock, Hertfordshire	South-East	13	Fitzpatrick-Matthews and Burleigh (2007)
Radley Barrow Hills	Oxon, Oxfordshire	South-West	12	Chambers and McAdam (2007)
Maskells Quarry	Harlington, Bedfordshire	Midlands	11	Dawson (2001)
Mucking Cemetery III	Mucking, Essex	South-East	11	Lucy and Evans (2016)
Marston Park	Marston Moretaine, Bedfordshire	Midlands	10	Newboult, Abrams and Turner (2010)
Land off Netherhall Road	Maryport, Cumbria	North-West	10	Kirby (2011)
Mucking Cemetery I	Mucking, Essex	South-East	10	Lucy and Evans (2016)
Mox Hill Farm	Bedford, Bedfordshire	Midlands	9	Zeepvat and Wilson (2002)
Birch Pit	Colchester, Essex	South-East	9	Benfield (2007)

Worton Rectory Farm	Cassington, Oxfordshire	South-West	9	Hey (1991)
Stansted Airport (Undated)	Stansted Mountfitchet, Essex	South-East	8	Havis (2004)
Denham	The Lea, Buckinghamshire	South-East	8	Coleman et al. (2004)
Marsh Leys (Late Iron Age)	Kempston, Bedfordshire	Midlands	8	Luke and Preece (2011)
Green End	Cambridge, Cambridgeshire	Midlands	8	Garrood (1937)
Clothal Road	Baldock, Hertfordshire	South-East	8	Fitzpatrick-Matthews and Burleigh (2007)
Stansted Airport (Late Iron Age)	Stansted Mountfitchet, Essex	South-East	7	Havis (2004)
Melandra Castle	Glossop, Derbyshire	Midlands	7	Webster (1967)
Brough under Stainmore	Brough under Stainmore, Cumbria	North-West	7	Jones (1977)
New Field	Brampton, Cumbria	North-West	7	Wilmott (1993)
Babraham Institute	Babraham, Cambridge	Midlands	7	Timberlake, Dodwell and Armour (2007)
California	Baldock, Hertfordshire	South-East	7	Fitzpatrick-Matthews and Burleigh (2007)
Watchfield	Shrivenham, Oxfordshire	South-West	6	Birbeck (2001)
Merly House	Colchester, Essex	South-East	6	Orr (2005)
Harrold Pit	Odell, Bedfordshire	Midlands	6	Dix (1980)
Jubilee Corner	Ulcombe, Kent	South-East	6	Aldridge (2005)
St Nicholas Yard	Whitehaven, Cumbria	North-West	6	Howard-Davies and Leah (1999)
Whittington Way	Bishop's Stortford, Hertfordshire	South-East	6	Williams and Heale (2008)
The little Wymondley Bypass	Hitchin, Hertfordshire	South-East	6	Hun (2001)
Ganstead to Asselby natural gas pipeline	Hull, Yorkshire	North-East	6	Wood (2011)
Offington Lane	Worthing, Sussex	South-East	5	Thorne (2009)
Watling Street	London	South-East	5	Mackinder (2000)

Mill Hill	Deal, Kent	South-East	5	Parfitt (1995)
Thames Valley Park	Reading, Berkshire	South-East	5	Smith, et al., (2010)
Latton Lands	Latton, Wiltshire	South-West	5	Powell, Laws and Brown (2008)
Salford Quarry	Salford, Bedfordshire	Midlands	5	Royston (1991)
Prickwillow Road	Ely, Cambridgshire	Midlands	5	Atkins and Mudd (2003)
Ben Bridge	Chew Valley, Somerset	South-West	4	Rahtz and Greenfield (1997)
Watercrook pipeline	Watercrook, Kent	North-West	4	Gibbson (1988)
Boys Hall Balancing Pond	Sevington, Kent	South-East	4	Oxford Archaeology (1999)
Kingsborough Farm	Eastchurch, Isle of Sheppey, Kent	South-East	3	Stevens (2009)
New House Farm	Headcorn, Kent	South-East	3	Aldridge (2010)
Fairfield Park Lower School	Stotfold, Bedfordshire	Midlands	3	Pilkinson, Barker and Oetgen (2013)
Parnwell	Peterborough, Cambridgeshire	Midlands	3	Webley (2007)
Imperial College London Sports Ground	London	South-East	3	Crockett (2001)
Chapel Lane	Dunston, Lincoln	Midlands	3	Palmer-Brown (1996)
Pineham North	Upton, Northamptonshire	Midlands	3	Carlyle (2005)
The Hutchison Site	Addenbrooke, Cambridgeshire	Midlands	3	Evans, Mackay and Webley (2004)
Arbury Road	Cambridge, Cambridgeshire	Midlands	3	Fell (1956)
Cambridge Villas	Godmanchester, Cambridgeshire	Midlands	3	Ivet (1955)
Howe House and Gravel Hill Farm	Cambridge, Cambridgeshire	Midlands	3	Liversidge (1977)
Mercia Road	Baldock, Hertfordshire	South-East	3	Fitzpatrick-Matthews (2016)
Brett Sands Pit	Charing, Kent	South-East	2	Philip (1992)
Abbotstone Field	Colchester, Essex	South-East	2	Pooley and Benfield (1991)
Herriotts Bridge	Chew Valley, Somerset	South-West	2	Rahtz and Greenfield (1997)
Stone Court Pit	Stone, Kent	South-East	2	Cotton and Richardson (1949)

Radwell Gravel Pits	Radwell, Bedfordshire	Midlands	2	Hall (1973)
Kingston Blount	Chinnor, Oxfordshire	South-West	2	Chamber (1976)
Marsh Leys (Early Roman)	Kempston, Bedfordshire	Midlands	2	Luke and Preece (2011)
Rothamsted Experimental Station	Harpenden, Hertfordshire	South-East	2	Lowther (1937)
Ivel Farm	Beck land south, Bedfordshire	Midlands	2	Thorpe (2003)
Milton Ham	Northampton, Northamptonshire	Midlands	2	Foard-Colby (2009)
Chichester Road	Bognor Regis, Sussex	South-East	2	Hammon and Preston (2005)
Wellington Quarry	Hereford, Herefordshire	Midlands	2	Edward (1990)
London Road	Bagshot, Surrey	South-East	2	Saunders (2005)
Bartlow Park	Cambridge, Cambridgeshire	Midlands	2	Beauchamp and Macaulay (2004)
Gravel Pitts	St Neots, Cambridgeshire	Midlands	2	Alexander (1993)
Queens Ediths	Cambridge, Cambridgeshire	Midlands	2	Liversidge (1997)
Mucking Cemetery V	Mucking, Essex	South-East	2	Lucy and Evans (2016)
West Thurrock	Thurrock, Essex	South-East	2	Andrews (2009)
Northumberland and Bottom	Gravesend, Kent	South-East	2	Askew and Booth (2006)
Cotswold Community	Upper Thames Valley, Gloucestershire	South-West	2	Smith et al. (2010)
Tutt Hill	Westwell, Kent	South-East	1	Brady (2006)
Bower Road	Smeeth, Kent	South-East	1	Diez (2006)
Whitchurch	Aylesbury, Buckinghamshire	South-East	1	Booth and Champness (2014)
Elms Farm	Humberstone, Leicestershire	Midlands	1	Charles, Parkinson and Foreman (2000)
Beancroft Road	Marston Moretaine, Bedfordshire	Midlands	1	Shotliff and Crick (1999)
King William IV site	Ewell, Surrey	South-East	1	Orton (1997*)*
Suddern Farm	Middle Wallop, Hampshire	South-East	1	Cunliffe and Poole (2000)

Millbridge	Hertford, Hertfordshire	South-East	1	Zeepvat (1994)
Enderby	Leicestershire	Midlands	1	Meek, Shore and Clay (2004)
Willington	Derby, Derbyshire	Midlands	1	Pinder (1984)
Dunstable	Bedfordshire	Midlands	1	Matthews (1981)
Central Criminal Court Extension	Warwick Square, London	South-East	1	Shepherd (1988)
Piercebridge	Darlington, County Durham	North-East	1	Cool and Mason (2008)
Souldern	High Street, Manor Farm, Oxfordshire	South-West	1	Moore (2010)
Norton Road	Stotfold, Bedfordshire	Midlands	1	Pilkinson et al. (2013)
Old Greens	Towcester, Northamptonshire	Midlands	1	Clarke (2010).
Gatcombe	Long Ashton, Somerset	South-West	1	Branigan (1997)
Fancott	Toddington, Bedfordshire	Midlands	1	Pollard (1991)
West Mersea	Colchester, Essex	South-East	1	Thompson (1981)
The Bridles	Barnetby, Lincolnshire	North-East	1	Allen and Rylatt (2002)
Barn Farm	Mancetter, Warwickshire	Midlands	1	Warwickshire (2018)
Grangford	March, Cambridgeshire	Midlands	1	Potter and Potter (1980)
Cherry Hinton	Cambridge, Cambridgeshire	Midlands	1	Pickstone and Mortimer (2012)
Brickhills Estate	Cambridge, Cambridgeshire	Midlands	1	Rudd (1968)
Stroud Roman Villa	Petersfield, Hampshire	South-East	1	Williams (1908)
Chichester Festival Theatre site	Chichester, Sussex	South-East	1	Thorne (2012)
Romany Rye	Hemel Hempstead, Hertfordshire	South-East	1	Saunders (2005)
Walton On Thames	Surrey	South-East	1	Hayman (2003)
Oak Street Head	Shrewsbury, Shropshire	Midlands	1	Hannaford (1992)
A69 Haltwhistle Bypass	Haltwhistle, Northumberland	North-East	1	Fraser and Speed (1969)

Hangmans Spinney to Gaynes Lodge Farm	Buckden, Cambridgeshire	Midlands	1	Craster, et al., (1965)
Meadow Lane North	Saint Ives Cambridgeshire	Midlands	1	Philips and Salway (1970)
Castle Hill	Cambridge, Cambridgeshire	Midlands	1	Garrood (1947)
Sibson	Peterborough, Cambridgeshire	Midlands	1	Fryer (1891)
Barley croft Farm	Cambridge, Cambridgeshire	Midlands	1	Tebbutt (1935)
Colne	Huntingdon, Cambridgeshire	Midlands	1	Tebutt (1929)
Emmanuel Knoll	Godmanchester, Cambridgeshire	Midlands	1	Ladds (1915)
Glatton	Peterborough, Cambridgeshire	Midlands	1	Garrood (1925)
Rectory Farm	Cambridge, Cambridgeshire	Midlands	1	Hey (1991)
Cantelupe Farm	Haslingfield, Cambridgeshire	Midlands	1	Liversidge (1977)
Oates Lane	Ely, Cambridgeshire	Midlands	1	Liversidge (1977)
Red Church Field	Linton, Cambridgeshire	Midlands	1	Liversidge (1977)
Harnhill	Cirecencester, Gloucestershire	South-West	1	Wright (2008)
Knobbs Farm	Somersham, Cambridgeshire	Midlands	1	Evans et al. (2013)
Welwyn burial	Welwyn Garden City, Hertfordshire	South-East	1	Stead and Rigby (1986)
Downlands	Stevenage, Hertfordshire	South-East	1	Fitzpatrick-Matthews and Burleigh (2007)
South Road Cemetery	Baldock, Hertfordshire	South-East	1	Fitzpatrick-Matthews and Burleigh (2007)

Table A2.2 Catalogue of data from secondary investigation.

Cemetery	Time Period	Region	Settlement Type	N Cremation Deposits	MNI	N Identified Burials	N Sexed	N Aged	N Grave Goods	N Pyre Goods	N Burned Animal Bone
Skeleton Green	Early Roman	South-East	Minor Urban	97	97	68	80	92	31	6	33
1 Queens Road	Middle Roman	South-East	Major Urban	60	64	49	26	42	47	11	2
Westhampnett(2)	Early Roman	South-East	Major Urban	31	34	31	12	32	26	9	3
Lankhills	Late Roman	South-East	Major Urban	30	31	25	13	31	6	6	14
King Harry Lane(2)	Late Roman	South-East	Major Urban	29	29	23	1	10	17	0	0
Stansted Airport(2)	Early Roman	South-East	Minor Urban	28	29	20	4	13	19	10	5
Strood Hall	Early Roman	South-East	Rural	28	28	28	18	28	20	5	12
Western Cemetery of London	Middle Roman	South-East	Major Urban	28	28	28	13	15	13	2	0
The Upper Walbrook Valley Cemetery	Middle Roman	South-East	Major Urban	28	31	28	4	26	1	2	7
Icknield Way	Roman	South-East	Minor Urban	27	27	27	6	22	0	0	4
A505 Baldock Bypass	Early Roman	South-East	Minor Urban	22	22	22	5	22	15	4	0

Wavendon Gate	Middle Roman	South-East	Rural	20	20	20	0	15	11	6	2
Walmer	Early Roman	South-East	Rural	20	20	0	0	0	12	0	0
Deverell Street	Early Roman	South-East	Major Urban	20	20	20	0	0	0	0	0
Hacheston	Early Roman	Midlands	Minor Urban	19	19	2	1	3	2	0	0
Guilden Morden	Early Roman	Midlands	Rural	18	18	4	0	0	3	0	0
Saltwood Tunnel	Early Roman	South-East	Rural	18	18	18	7	18	6	0	5
Mucking Cemetery IV	Middle Roman	South-East	Rural	18	21	18	9	19	13	0	1
Stanway	Late Iron Age	South-East	Major Urban	17	17	17	1	10	6	0	0
Mucking Cemetery II	Middle Roman	South-East	Rural	15	18	15	11	16	9	0	0
Warren Farm	Early Roman	Midlands	Rural	14	14	14	3	9	4	0	0
Mucking Cemetery VI	Middle Roman	South-East	Rural	13	14	10	2	13	8	1	0
Sale Drive Doline	Early Roman	South-East	Minor Urban	13	13	13	0	0	0	0	0
Maskells Quarry	Early Roman	Midlands	Rural	11	12	6	1	7	7	2	0
Mucking Cemetery III	Middle Roman	South-East	Rural	11	14	11	10	14	3	2	0

Marston Park	Roman	Midlands	Rural	10	10	9	0	0	0	0	0
Land off Netherhall Road	Middle Roman	North-West	Minor Urban	10	10	10	0	2	1	1	0
Mucking Cemetery I	Early Roman	South-East	Rural	10	12	10	5	12	6	0	0
Mox Hill Farm	Early Roman	Midlands	Rural	9	9	9	0	0	1	0	0
Birch Pit	Early Roman	South-East	Rural	9	9	7	0	9	0	1	0
Worton Rectory Farm	Early Roman	South-West	Rural	9	9	0	0	0	1	0	0
Stansted Airport(3)	Roman	South-East	Minor Urban	8	8	0	0	4	1	5	0
Denham	Late Roman	South-East	Rural	8	8	8	0	0	0	1	0
Marsh Leys	Late Iron Age	Midlands	Rural	8	8	8	2	2	2	0	0
Green End	Early Roman	Midlands	Minor Urban	8	8	0	0	0	5	0	0
Clothal Road	Early Roman	South-East	Minor Urban	8	8	8	1	8	0	0	0
Stansted Airport	Late Iron Age	South-East	Minor Urban	7	7	4	0	1	4	1	0
Melandra Castle	Early Roman	Midlands	Minor Urban	7	7	5	0	0	1	0	0
Brough Under Stainmore	Roman	North-West	Minor Urban	7	7	2	0	6	6	0	1

New field	Middle Roman	North-West	Minor Urban	7	7	7	0	0	3	1	0
Babraham Institute	Middle Roman	Midlands	Rural	7	7	7	2	7	2	2	4
California	Late Iron Age	South-East	Minor Urban	7	7	7	1	4	0	0	0
Watchfield	Middle Roman	South-West	Minor Urban	6	6	5	2	4	0	0	0
Merly House	Early Roman	South-East	Major Urban	6	6	5	1	1	3	1	0
Harrold Pit	Early Roman	Midlands	Rural	6	6	6	0	0	0	0	0
Jubilee Corner	Early Roman	South-East	Rural	6	6	2	1	6	0	2	0
St Nicholas Yard	Middle Roman	North-West	Rural	6	6	1	0	0	2	0	0
Whittington Way	Early Roman	South-East	Rural	6	6	0	0	0	1	0	0
The little Wymondley Bypass	Roman	South-East	Rural	6	6	6	0	0	2	0	0
Ganstead to Asselby natural gas pipeline	Early Roman	North-East	Minor Urban	6	6	6	0	0	0	0	0
Offington Lane	Middle Roman	South-East	Rural	5	6	5	1	6	5	0	4
Watling Street	Middle Roman	South-East	Major Urban	5	5	4	3	5	3	0	0

Mill Hill	Late Iron Age	South-East	Rural	5	5	5	2	4	3	0	2
Thames Valley Park	Roman	South-East	Rural	5	5	5	1	5	3	1	0
Latton Lands	Early Roman	South-West	Rural	5	5	5	1	3	1	0	0
Salford Quarry	Late Iron Age	Midlands	Rural	5	5	0	0	0	1	0	0
Prickwillow Road	Middle Roman	Midlands	Rural	5	5	5	2	5	1	2	0
Ben Bridge	Middle Roman	South-West	Rural	4	4	4	0	0	0	0	0
Watercrook pipline	Middle Roman	North-West	Minor Urban	4	4	4	0	0	0	0	0
Boys Hall Balancing Pond	Early Roman	South-East	Rural	4	4	4	0	0	3	0	0
Kingsborough Farm	Early Roman	South-East	Rural	3	3	3	2	3	0	0	1
New House Farm	Early Roman	South-East	Rural	3	3	1	1	2	3	1	0
Fairfield Park Lower School	Middle Roman	Midlands	Rural	3	3	3	0	0	1	0	0
Parnwell	Early Roman	Midlands	Rural	3	3	3	1	2	2	1	1
Imperial College London Sports Ground	Roman	South-East	Rural	3	3	0	0	0	0	0	0

Chapel Lane	Middle Roman	Midlands	Minor Urban	3	3	3	0	0	1	0	0
Pineham North	Early Roman	Midlands	Rural	3	3	1	0	3	2	1	0
The Hutchison Site	Early Roman	Midlands	Rural	3	3	3	0	0	1	0	0
Arbury Road	Early Roman	Midlands	Rural	3	3	3	0	0	2	0	0
Cambridge Villas	Early Roman	Midlands	Rural	3	3	3	1	1	3	1	0
Howe House and Gravel Hill Farm	Roman	Midlands	Rural	3	3	0	0	0	0	0	0
Mercia Road	Early Roman	South-East	Minor Urban	3	3	3	0	0	3	0	1
Brett Sands Pit	Early Roman	South-East	Rural	2	2	0	0	0	0	0	0
Abbotstone Field	Early Roman	South-East	Rural	2	2	2	0	0	0	1	0
Herriotts Bridge	Late Roman	South-West	Rural	2	2	2	0	0	0	0	1
Stone Court Pit	Early Roman	South-East	Rural	2	2	2	0	0	2	0	0
Radwell Gravel Pits	Late Roman	Midlands	Rural	2	2	2	0	0	1	0	0
Kingston Blount	Early Roman	South-West	Rural	2	2	2	1	2	1	1	0
Marsh Leys(2)	Early Roman	Midlands	Rural	2	2	2	1	1	0	0	0

Rothamsted Experimental Station	Early Roman	South-East	Rural	2	2	0	0	0	2	0	0
Ivel Farm	Late Iron Age	Midlands	Rural	2	2	1	0	0	2	0	0
Milton Ham	Middle Roman	Midlands	Rural	2	2	0	0	0	0	0	0
Chichester Road	Late Iron Age	South-East	Rural	2	2	2	0	1	0	0	1
Wellington Quarry	Early Roman	Midlands	Rural	2	2	2	0	0	0	0	0
London Road	Early Roman	South-East	Rural	2	2	2	0	0	1	1	0
Bartlow Park	Early Roman	Midlands	Rural	2	2	2	0	0	2	0	0
Gravel Pitts	Roman	Midlands	Rural	2	2	0	0	0	1	0	0
Queens Ediths	Roman	Midlands	Rural	2	2	2	0	0	1	0	0
Mucking Cemetery V	Early Roman	South-East	Rural	2	2	2	0	2	2	0	0
West Thurrock	Early Roman	South-East	Rural	2	2	2	0	0	1	0	0
Northumberland and Bottom	Middle Roman	South-East	Rural	2	2	2	1	0	0	0	0
Cotswold Community	Middle Roman	South-West	Rural	2	2	2	1	1	1	0	0
Tutt Hill	Early Roman	South-East	Rural	1	1	1	0	0	0	0	0

Bower Road	Early Roman	South-East	Rural	1	1	1	0	1	1	1	0
Whitchurch	Early Roman	South-East	Rural	1	1	1	0	0	1	0	0
Elms Farm	Late Iron Age	Midlands	Rural	1	1	1	0	1	0	0	0
Beancroft Road	Late Iron Age	Midlands	Rural	1	1	1	0	1	1	0	0
King William IV Site	Early Roman	South-East	Minor Urban	1	1	1	0	0	0	0	0
Sudden Farm	Early Roman	South-East	Rural	1	1	1	0	0	0	0	0
Millbridge	Early Roman	South-East	Rural	1	1	0	0	0	1	0	0
Enderby	Early Roman	Midlands	Rural	1	1	1	0	0	0	0	0
Willington	Early Roman	Midlands	Rural	1	1	1	0	1	0	0	0
Dunstable	Early Roman	Midlands	Minor Urban	1	1	1	0	0	0	0	0
Central Criminal Court Extension	Early Roman	South-East	Rural	1	2	1	0	2	1	1	0
Piercebridge	Early Roman	North-East	Minor Urban	1	1	1	1	1	0	0	0
Souldern	Early Roman	South-West	Rural	1	1	1	0	0	0	0	0
Norton Road	Late Iron Age	Midlands	Rural	1	1	0	0	0	1	0	0

Old Greens Norton Road	Early Roman	Midlands	Rural	1	1	0	0	0	0	0	0
Gatcombe	Middle Roman	South-West	Rural	1	1	1	0	0	1	0	0
Fancott	Early Roman	Midlands	Rural	1	1	1	0	0	1	0	0
West Mersea	Late Iron Age	South-East	Rural	1	1	1	0	1	1	0	0
The Bridles	Late Roman	North-East	Rural	1	1	1	0	1	0	0	0
Barn Farm	Early Roman	Midlands	Rural	1	1	0	0	1	1	0	0
Grandford	Early Roman	Midlands	Rural	1	1	1	0	0	0	0	0
Cherry Hinton	Late Iron Age	Midlands	Rural	1	1	1	0	1	0		0
Brickhills Estate	Early Roman	Midlands	Minor Urban	1	1	1	0	0	1	0	0
Stroud Roman Villa	Late Roman	South-East	Rural	1	1	1	0	0	1	0	0
Chichester Festival Theatre site	Late Roman	South-East	Major Urban	1	1	1	1	1	1	0	0
Romany Rye	Early Roman	South-East	Rural	1	1	1	0	0	0	0	0
Walton On Thames	Middle Roman	South-East	Rural	1	1	1	0	0	0	0	0

Oak Street Head	Early Roman	Midlands	Rural	1	1	1	0	0	0	0	0
A69 Haltwhistle Bypass	Early Roman	North-East	Rural	1	1	1	0	1	0	0	0
Hangmans Spinney to Gaynes Lodge Farm	Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Meadow Lane North	Roman	Midlands	Minor Urban	1	1	0	0	0	0	0	0
Castle Hill	Early Roman	Midlands	Rural	1	1	0	0	0	1	1	0
Sibson	Roman	Midlands	Rural	1	1	0	0	0	1	0	0
Barleycroft Farm	Early Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Colne	Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Emmanuel Knoll	Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Glatton	Roman	Midlands	Rural	1	1	1	0	0	0	0	0
Rectory Farm	Early Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Cantelupe Farm	Early Roman	Midlands	Rural	1	1	1	0	0	0	0	0
Oates Lane	Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Red Church Field	Early Roman	Midlands	Rural	1	1	1	0	0	1	0	0
Harnhill	Late Roman	South-West	Rural	1	1	1	1	1	0	1	1

Knobbs Farm	Middle Roman	Midlands	Rural	1	1	1	0	0	0	0	0
Welwyn burial	Late Iron Age	South-East	Major Urban	1	1	1	0	0	1	0	0
Downlands	Early Roman	South-East	Minor Urban	1	1	1	0	0	1	0	0
South Road Cemetery	Early Roman	South-East	Minor Urban	1	1	1	0	0	1	0	0
King Harry Lane	Late Iron Age	South-East	Major Urban	388	398	367	135	325	319	23	87
Eastern Cemetery	Middle Roman	South-East	Major Urban	138	143	127	55	129	41	33	13
Walls Field	Roman	South-East	Minor Urban	316	316	316	0	0	10	3	0
Westhampnett	Late Iron Age	South-East	Rural	164	168	156	33	135	144	3	37
Yeomanry Drive North	Middle Roman	South-East	Minor Urban	395	415	395	148	365	0	0	44
Gill Mill	Early Roman	South-West	Rural	17	17	17	3	13	3	0	0
Radley Barrow Hills	Middle Roman	South-West	Rural	12	12	12	1	12	1	0	0
Derby Racecourse	Early Roman	Midlands	Minor Urban	91	93	42	0	85	2	0	18
Heaven's Walls	Roman	Midlands	Rural	80	80	80	0	0	0	0	0
Trentholme Drive	Middle Roman	North-East	Major Urban	53	53	38	0	0	18	7	11

Brougham	Late Roman	North-West	Minor Urban	205	207	158	104	205	101	201	27

Appendix 3: Dominant Cemeteries from Secondary Data

Table A3.1 Distribution of Study Sample. Eleven dominant cemeteries.

Cemetery	N	% of Total	% Region	% Time Period	% Settlement Type
Yeomanry Drive North	395	13.9	22.5% of South-East sample.	45.7% of Middle Roman sample.	41.5% of Minor Urban sample.
King Harry Lane (LIA)	388	14.6	22.1% of South-East sample.	63.5% of Late Iron Age sample.	46.5% of Major Urban sample.
Brougham	205	7.1	88.4% of North-West sample.	73.2% of Late Roman sample.	21.5% of Minor Urban sample.
Westhampnett (LIA)	164	5.7	N/A.	26.8% of Late Iron Age sample.	27.9% of Rural sample.
London, Eastern Cemetery	138	4.8	N/A.	15.9% of Middle Roman sample.	16.5% of Major Urban sample.
Skeleton Green	97	3.4	N/A.	15.7% of Early Roman sample.	N/A.
Derby Racecourse	91	3.2	35% of Midlands sample.	14.7% Early Roman sample.	N/A.
Trentholme Drive	53	1.9	85.5% of North-East sample.	N/A.	N/A.
Gill Mill	17	0.6	27.4% of South-West sample.	N/A.	N/A.
Radley Barrow Hills	12	0.4	19.4% of South-West sample.	N/A.	N/A.
Worton Rectory Farm	9	0.3	14.5% of South-West sample.	N/A.	N/A.

Table A3.2 Distribution of sexed individuals. Eight dominant cemeteries.

Cemetery	N	% Total	% Region	% Time Period	% Settlement Type
Yeomanry Drive North	148	19.9	24.4% of South-East sample.	50.9% of Middle Roman sample.	42.7% of Minor Urban sample.
King Harry Lane (LIA)	135	18.2	22.2% of South-East sample.	77.6% of Late Iron Age sample.	50.9% of Major Urban sample.
Brougham	104	14	100% of North-West sample.	86.7% of Late Roman sample.	30% of Minor Urban sample.
Skeleton Green	80	10.8	13.2% of South-East sample.	53% of Early Roman sample.	23.1% of Minor Urban sample.
London, Eastern Cemetery	55	7.4	N/A.	18.9% of Middle Roman sample.	20.8% of Major Urban sample.
Westhampnett (LIA)	33	44.4	N/A.	19% of Late Iron Age sample.	26.6% of Rural sample.
Strood Hall	18	2.4	N/A.	11.9% of Early Roman sample.	14.5% of Rural sample.
Piercebridge	1	0.1	100% of North-East sample.	N/A.	N/A.

Table A3.3 Distribution of aged individuals. Eleven dominant cemeteries.

Cemetery	N	% Total	% Region	% Time Period	% Settlement Type
Yeomanry Drive North	365	19.7	25.4% of South-East sample.	52.4% of Middle Roman sample.	45.3% of Minor Urban sample.
King Harry Lane (LIA)	325	17.5	22.6% of South-East sample.	66.9% of Late Iron Age sample.	51.8% of Major Urban sample.
Brougham	205	11.1	99% of North-West sample.	82.3% of Late Roman sample.	25.5% of Minor Urban sample.
London, Eastern Cemetery	129	7	N/A.	18.5% of Middle Roman sample.	20.6% of Major Urban sample.
Westhampentt (LIA)	135	7.3	N/A.	27.8% of Late Iron Age sample.	35.2% of Rural sample.
Skeleton Green	92	5	N/A.	24% of Early-Roman sample.	N/A.
Derby Racecourse	85	4.6	65.4% of the Midlands sample.	22.1% of Early Roman sample.	N/A.
Lankhills	31	1.7		12.4% of Late Roman sample.	N/A.
Gill Mill	13	0.7	36.1% of South-West sample.	N/A.	N/A.
Radley Barrow Hill	12	0.6	33.3% of South-West Sample	N/A.	N/A.
Watchfield	4	0.2	11.1% of South-West sample.	N/A.	N/A.

Table A3.4 Distribution of identified burials. Twelve dominant cemeteries.

Cemetery	N	% Total	% Region	% Time Period	% Settlement Type
Yeomanry Drive North	395	15.8	24.5% of South-East Sample.	48.4% of Middle Roman sample.	50.1% of Minor Urban sample.
King Harry Lane (LIA)	367	14.7	22.8% of South-East sample.	64.2% of Late Iron Age sample.	48% of Major Urban sample.
Brougham	161	6.3	89.4% of the North-West sample	72.5% of Late Roman sample.	20.1% of the Minor Urban sample.
Westhampnett (LIA)	156	6.2	N/A.	27.3% of Late Iron Age sample.	31.8% of Rural sample.
London, Eastern Cemetery	127	5.1	N/A.	15.6% of Middle Roman sample.	16.6% of Major Urban sample.
Skeleton Green	68	2.7	N/A.	15.7% of Early Roman sample.	N/A.
Derby Racecourse	42	1.7	27.8% of the Midlands sample.	N/A.	N/A.
Trentholme Drive	38	1.5	80.9% of the North-East sample.	N/A.	N/A.
Lankhills	25	1	N/A.	11.3% of Late Roman sample.	N/A.
Gill Mill	17	0.6	32.7% of South-West sample.	N/A.	N/A.
Radley Barrow Hills	12	0.5	23.1% of South-West sample.	N/A.	N/A.
Ganstead	6	0.2	12.8% of North-East sample.	N/A.	N/A.

Table A3.5 Distribution of cremation deposits with grave goods. Ten dominant cemeteries.

Cemetery	N	% Total	% Region	% Time Period	% Settlement Type
King Harry Lane (LIA)	319	31.6	38.9% of South-East sample.	65.8% of Late Iron Age sample.	63.5% of Major Urban sample.
Westhampnett (LIA)	144	14.3	17.6% of South-East sample.	29.7% of Late Iron Age sample.	45.4% of Rural sample.
Brougham	101	10	94.4% of North-West sample.	79.5% of Late Roman sample.	52.9% of Minor Urban sample.
Queens Road	47	4.7	N/A.	25.3% of Middle Roman sample.	N/A.
London, Eastern Cemetery	41	4.1	N/A.	22% of Middle Roman sample.	N/A.
Skeleton Green	31	3.1	N/A.	14.6% of Early Roman sample.	16.2% of Minor Urban sample.
Westhampnett (ER)	26	2.6	N/A.	12.3% of Early Roman sample.	N/A.
Trentholme Drive	18	1.8	100% of North-East sample.	N/A.	N/A.
King Harry Lane (LR)	17	1.7	N/A.	13.4% of Late Roman sample.	N/A.
Gill Mill	3	0.3	33.3% of South-West sample.	N/A.	N/A.

Table A3.6 Distribution of cremation deposits with pyre goods. Eleven dominant cemeteries.

Cemetery	N	% Total	% Region	% Time Period	% Settlement Type
Brougham	201	56.5	99% of North-West sample.	96.2% of Late Roman sample.	89.7% of Minor Urban sample.
London, Eastern Cemetery	33	9.3	24.6% of South-East sample.	47.1% of Middle Roman sample.	35.1% of Major Urban sample.
King Harry Lane (LIA)	23	6.5	17.2% of South-East sample.	85.2% of Late Iron Age sample.	24.5% of Major Urban sample.
Queens Road	11	3.1	N/A.	15.7% of Middle Roman sample.	11.7% of Major Urban sample.
Stansted Airport (ER)	10	2.8	N/A.	20% of Early Roman sample.	N/A.
Westhampnett (ER)	9	2.5	N/A.	18% of Early Roman sample.	N/A.
Trentholme Drive	7	2	100% of North-East sample.	N/A.	N/A.
Skeleton Green	6	1.7	N/A.	12% of Early Roman sample.	N/A.
Wavendon Gate	6	1.7	N/A.	N/A.	15.8% of Rural sample.
Strood Hall	5	1.4	N/A.	N/A.	13.2% of Rural sample.
Westhampnett (LIA)	3	0.8	N/A.	11.1% of Late Iron Age.	N/A.

Appendix 4: Statistical Analysis of Secondary Data

Table A4.1 Test statistics of One-Way ANOVA. Male / female ration according to region Early Roman period.

Region(I)	Region(J)	Mean Difference	Standard. Error	Sig.	Lower Bound	Upper Bound
Midlands	North-East	0.24730	0.25415	0.765	-0.4214	0.9160
	South-East	-0.00420	0.10299	1.000	-0.2752	0.2668
	South-West	-0.68603	0.20257	0.006	-1.2190	-.1531
South-East	North-East	0.25150	0.25259	0.752	-0.4131	0.9161
	Midlands	0.00420	0.10299	1.000	-0.2668	0.2752
	South-West	-0.68183	0.20061	0.006	-1.2096	-.1540
South-West	North-East	0.93333	0.30697	0.017	0.1257	1.7410
	Midlands	0.68603	0.20257	0.006	0.1531	1.2190
	South-East	0.68183	0.20061	0.006	0.1540	1.2096

Table A4.2 Test statistics of One-Way ANOVA. Male / female ration according to settlement types Early Roman period.

Settlement Type	N	Subset for alpha = 0.05
Major Urban	2	-0.6665
Minor Urban	6	-0.2792
Rural	14	-0.0432
Sig.		0.559

Appendix 5: Inter-Observer Pilot Study Results

Table A5.1 Results of Inter-observer pilot study of 30 cremation deposits from Hertfordshire. *O = original assessment. N = New assessment.

Site		MNI		Sex		Age	
	N	O	N	O	N	O	N
Wallington Road	1	1	1	-	-	-	-
	2	1	1	-	-	Older Child	Older Child
	3	1	1	Male	Male	Young Adult	Old Adult
	4	1	1	Female	Female	Older Adult	Older Adult
	5	1	1	-	-	Older Child	Older Child
	6	1	1	-	-	Adult	Adult
	7	1	1	-	-	Adult	Adult
	8	1	1	-	-	-	-
	9	1	1	-	-	Adult	Adult
	10	1	1	Male	Male	Young Adult	Young Adult
%		**100%**		**100%**		**90%**	
Cross Farm	1	1	1	-	Female??	30+ years	30+ years
	2	1	1	Male??	Male??	Adult	Adult
	3	1	1	Male?	Male?	Young Adult	Young Adult
	4	1	1	-	-	Adult	Adult
	5	1	1	Female?	Female?	Adult	Adult
	6	1	1	-	-	Adult	Adult
	7	1	1	-	Male??	Adult	Adult
	8	1	1	-	-	6 months – 1 year	6 months – 1 year
	9	1	1	-	-	Adult	-
	10	1	1	Female??	Female??	Adult	Adult
%		**100%**		**80%**		**90%**	

Table A5.2 Results of Inter-observer pilot study of 30 cremation deposits from Hertfordshire continued. *O = original assessment. N = New assessment.

Site	MNI			Sex		Age	
	N	*O	*N	*O	*N	*O	*N
Folly Lane	1	1	1	-	-	Adult	Adult
	2	1	1	-	-	Young Adult	Young Adult
	3	1	1	-	-	Adult	Adult
	4	1	1	Male?	Male?	Middle Adult	Middle Adult
	5	1	1	-	-	Middle/old	Middle/old
	6	1	1	-	-	-	Child
	7	1	1	-	-	Middle Adult	Middle Adult
	8	1	1	-	-	Adult	Adult
	9	1	1	-	Male??	Adult	Adult
	10	1	1	Male	Male	Middle Adult	Middle Adult
%	**100%**			**90%**		**90%**	
M1 Junction	1	1	1	-	-	Adult	Adult
	2	1	1	-	-	-	-
	3	1	1	-	-	Adult	Adult
	4	1	1	-	-	Adult	Adult
	5	1	1	-	-	Adult	Adult
	6	1	1	-	-	Adult	Adult
%	**100%**			**100%**		**100%**	

Appendix 6: Statistical Analysis of Primary Data

Table A6.1 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for fragmentation and burial type.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	95	123.976	0.000
Burial Type	2	95	0.541	0.584
Fragmentation	2	190	13.563	0.000
Burial Type * Fragmentation	4	190	2.040	0.090

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	14357.06228
Intercept (Variance)	17996.94147

Table A6.2 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for fragmentation and sex.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	46	121.529	0.000
Sex	1	46	2.842	0.099
Fragmentation	2	92	15.540	0.000
Sex * Fragmentation	2	92	0.509	0.603

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	18528.69967
Intercept (Variance)	16790.21084

Table A6.3 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for fragmentation and number of grave goods.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	69	116.342	0.000
Number of grave goods	2	69	0.201	0.811
Fragmentation	2	138	12.369	0.000
Number of grave goods * Fragmentation	4	138	1.259	0.289

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	17620.80836
Intercept (Variance)	17605.65832

Table A6.4 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for skeletal representation and burial type.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	95	101.007	0.000
Burial type	2	95	0.475	0.624
Skeletal Representation	3	285	7.604	0.000
Burial type *Skeletal Representation	6	285	0.362	0.902

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	1096.696776
Intercept (Variance)	924.311195

Table A6.5 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for skeletal representation and settlement type.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	96	107.325	0.000
Settlement type	1	96	5.951	0.017
Skeletal Representation	3	288	7.754	0.000
Settlement type *Skeletal Representation	3	288	1.611	0.187

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	1075.499085
Intercept (Variance)	859.055218

Table A6.6 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for skeletal representation and cemetery.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	93	108.223	0.000
Cemetery	4	93	2.451	0.051
Skeletal Representation	3	279	7.667	0.000
Cemetery*Skeletal Representation	12	279	0.880	0.568

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	1087.669710
Intercept (Variance)	846.654963

Table A6.7 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for skeletal representation and sex.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	46	91.021	0.000
Sex	1	46	3.115	0.084
Skeletal Representation	3	138	4.073	0.008
Sex*Skeletal Representation	3	138	0.127	0.944

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	1854.281391
Intercept (Variance)	964.382651

Table A6.8 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for skeletal representation and age.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	84	95.199	0.000
Age	2	84	0.361	0.698
Skeletal Representation	3	252	6.087	0.001
Age*Skeletal Representation	6	252	0.044	1.000

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	1219.548713
Intercept (Variance)	985.226376

Table A6.9 Test statistics of linear mixed model. Fixed effects of Type 1 tests and covariance parameters of model for skeletal representation and the number of grave goods.

Type I Tests of Fixed Effects				
Source	**Numerator df**	**Denominator df**	**F**	**Sig.**
Intercept (Individuals from Hertfordshire	1	69	89.304	0.000
Number of Grave Goods	2	69	0.414	0.663
Skeletal Representation	3	207	7.213	0.000
Number of Grave Goods*Skeletal Representation	6	207	0.653	0.688

Estimates of Covariance Parameters	
Parameter	**Estimates**
Residual	1364.810999
Intercept (Variance)	1035.062204

Table A6.10 Test statistics of One-Way ANOVA. Maloideae, cherry type (*Prunus sp.*), oak (*Quercus sp.*), and unidentified according to sex. * Statistically Significant.

Species	**Groups**	**Sum of Squares**	**d.f.**	**Mean Square**	**F**	**Sig,**
Maloideae	Between Groups	105.800	1	105.800	0.195	0.688
Prunus sp.	Between Groups	0.450	1	0.450	0.200	0.685
Quercus sp.	Between Groups	110.450	1	110.450	0.053	0.832
Unidentified	Between Groups	0.800	1	0.800	1.200	0.353

Table A6.11 Test statistics of One-Way ANOVA. Birch (*Betulaceae sp.*), hornbeam (*Carpinus betulus*), beech (*Fagus sylvatica*), ash (*Fraxinus excelsior)* Roundwood and twigwood, maloideae (Pomaceous fruits), hawthorn (*Pomoideae c.f crataegus*), cherry types (*Prunus sp.*), oak (*Quercus sp.*) roundwood and twigwood, and unidentified roundwood and twigwood according to the number of grave goods. * Statistically Significant.

Species	Groups	Sum of Squares	d.f.	Mean Square	F	Sig,
Betulaceae sp.	Between Groups	0.133	2	0.067	1.000	0.397
Carpinus betulus	Between Groups	0.178	2	0.089	0.300	0.746
Fagus sylvatica	Between Groups	0.133	2	0.067	1.000	0.397
Fraxinus excelsior roundwood	Between Groups	16.133	2	8.067	1.000	0.397
Fraxinus excelsior twigwood	Between Groups	2.178	2	1.089	0.300	0.746
Maloideae	Between Groups	126.533	2	63.267	0.353	0.710
Pomoideae cf. crataegus	Between Groups	0.044	2	0.022	0.300	0.746
Prunus sp.	Between Groups	0.400	2	0.200	0.300	0.746
Quercus sp. roundwood	Between Groups	3366.533	2	1683.267	0.603	0.563
Quercus sp. twigwood	Between Groups	1089.378	2	544.689	0.295	0.750
Unidentified roundwood	Between Groups	12.933	2	6.467	2.519	0.122
Unidentified twigwood	Between Groups	3.600	2	1.800	0.300	0.746

Appendix 7: Quantitative Petrography Inter-Observer Study

Participant consent sheet: Quantitative Petrography

Research Project: Burning by numbers: The use of quantitative petrography in the analysis of heat-induced alteration in burned bone

I have read and understood the Research Study Information Sheet.	**X**
I have been given the opportunity to ask questions about the research study.	**X**
I agree to take part in the research study. Taking part in the research study will include analysing burned bone thin-sections using Quantitative Petrography under the supervision of the lead researcher. The results will then be used to examine inter-observer reliability.	**X**
I understand that my personal details e.g. name will not be revealed to people outside the research team.	**X**
I understand that the results will be anonymised, and that data will be archived securely.	**X**
I understand that my taking part is voluntary; I can withdraw from the study at any time with no consequences, and I will not be asked any questions about why I no longer want to take part.	**X**
In case I decide to withdraw *after* the interview has taken place, I understand that I will need to inform Emily Carroll before December 31st 2018, so that all the information I have provided can be removed from any research outputs. I understand that if I withdraw after December 31st 2018, it will not be possible to guarantee that the information I have provided will be removed from the final project report.	**X**

Sascha Valme

_______________________________ _____________________________ 16/11/2018

Name of Participant Signature Date

16/11/2018

Emily Carroll

_______________________________ _____________________________ __________

Name of Researcher Signature Date

Your contact person for this research study is

Emily Carroll, Department of Archaeology,

University of Reading, READING, RG6 6AB

Email: e.l.carroll@pgr.reading.ac.uk; Telephone:

Participant consent sheet: Quantitative Petrography

Research Project: Burning by numbers: The use of quantitative petrography in the analysis of heat-induced alteration in burned bone

I have read and understood the Research Study Information Sheet.	**X**
I have been given the opportunity to ask questions about the research study.	**X**
I agree to take part in the research study. Taking part in the research study will include analysing burned bone thin-sections using Quantitative Petrography under the supervision of the lead researcher. The results will then be used to examine inter-observer reliability.	**X**
I understand that my personal details e.g. name will not be revealed to people outside the research team.	**X**
I understand that the results will be anonymised, and that data will be archived securely.	**X**
I understand that my taking part is voluntary; I can withdraw from the study at any time with no consequences, and I will not be asked any questions about why I no longer want to take part.	**X**
In case I decide to withdraw *after* the interview has taken place, I understand that I will need to inform Emily Carroll before December 31st 2018, so that all the information I have provided can be removed from any research outputs. I understand that if I withdraw after December 31st 2018, it will not be possible to guarantee that the information I have provided will be removed from the final project report.	**X**

____Sophia Mills_____________ 09-11-2018

Name of Participant Signature Date

Emily Carroll 16/11/2018

_____________________________ _____________________________ _____________

Name of Researcher Signature Date

Your contact person for this research study is

Emily Carroll, Department of Archaeology,

University of Reading, READING, RG6 6AB

Email: e.l.carroll@pgr.reading.ac.uk; Telephone:

Participant consent sheet: Quantitative Petrography

Research Project: Burning by numbers: The use of quantitative petrography in the analysis of heat-induced alteration in burned bone

I have read and understood the Research Study Information Sheet.	✓
I have been given the opportunity to ask questions about the research study.	✓
I agree to take part in the research study. Taking part in the research study will include analysing burned bone thin-sections using Quantitative Petrography under the supervision of the lead researcher. The results will then be used to examine inter-observer reliability.	✓
I understand that my personal details e.g. name will not be revealed to people outside the research team.	✓
I understand that the results will be anonymised, and that data will be archived securely.	✓
I understand that my taking part is voluntary; I can withdraw from the study at any time with no consequences, and I will not be asked any questions about why I no longer want to take part.	✓
In case I decide to withdraw *after* the interview has taken place, I understand that I will need to inform Emily Carroll before December 31st 2018, so that all the information I have provided can be removed from any research outputs. I understand that if I withdraw after December 31st 2018, it will not be possible to guarantee that the information I have provided will be removed from the final project report.	✓

Jennifer Austen

_____________________________ _____________________________ 16/11/2018

Name of Participant Signature Date

16/11/2018

Emily Carroll

_____________________________ _____________________________ _____________

Name of Researcher Signature Date

Your contact person for this research study is

Emily Carroll, Department of Archaeology,

University of Reading, READING, RG6 6AB

Email: e.l.carroll@pgr.reading.ac.uk; Telephone:

Participant consent sheet: Quantitative Petrography

Research Project: Burning by numbers: The use of quantitative petrography in the analysis of heat-induced alteration in burned bone

I have read and understood the Research Study Information Sheet.	√
I have been given the opportunity to ask questions about the research study.	√
I agree to take part in the research study. Taking part in the research study will include analysing burned bone thin-sections using Quantitative Petrography under the supervision of the lead researcher. The results will then be used to examine inter-observer reliability.	√
I understand that my personal details e.g. name will not be revealed to people outside the research team.	√
I understand that the results will be anonymised, and that data will be archived securely.	√
I understand that my taking part is voluntary; I can withdraw from the study at any time with no consequences, and I will not be asked any questions about why I no longer want to take part.	√
In case I decide to withdraw *after* the interview has taken place, I understand that I will need to inform Emily Carroll before December 31st 2018, so that all the information I have provided can be removed from any research outputs. I understand that if I withdraw after December 31st 2018, it will not be possible to guarantee that the information I have provided will be removed from the final project report.	√

Paul Flintoft 16/11/2018

______________________________ ______________________________ ______

Name of Participant Signature Date

16/11/2018

Emily Carroll

______________________________ ______________________________ __________

Name of Researcher Signature Date

Your contact person for this research study is

Emily Carroll, Department of Archaeology,
University of Reading, READING, RG6 6AB
Email: e.l.carroll@pgr.reading.ac.uk; Telephon

Participant consent sheet: Quantitative Petrography

Research Project: Burning by numbers: The use of quantitative petrography in the analysis of heat-induced alteration in burned bone

I have read and understood the Research Study Information Sheet.	**X**
I have been given the opportunity to ask questions about the research study.	**X**
I agree to take part in the research study. Taking part in the research study will include analysing burned bone thin-sections using Quantitative Petrography under the supervision of the lead researcher. The results will then be used to examine inter-observer reliability.	**X**
I understand that my personal details e.g. name will not be revealed to people outside the research team.	**X**
I understand that the results will be anonymised, and that data will be archived securely.	**X**
I understand that my taking part is voluntary; I can withdraw from the study at any time with no consequences, and I will not be asked any questions about why I no longer want to take part.	**X**
In case I decide to withdraw *after* the interview has taken place, I understand that I will need to inform Emily Carroll before December 31st 2018, so that all the information I have provided can be removed from any research outputs. I understand that if I withdraw after December 31st 2018, it will not be possible to guarantee that the information I have provided will be removed from the final project report.	**X**

Carolina Rangel De Lima   Carolina Rangel De Lima   16/11/2018

_______________________________   _______________________________   _________

Name of Participant   Signature   Date

Emily Carroll   16/11/2018

_______________________________   _______________________________   _________

Name of Researcher   Signature   Date

Your contact person for this research study is
Emily Carroll, Department of Archaeology,
University of Reading, READING, RG6 6AB
Email: e.l.carroll@pgr.reading.ac.uk; Telephone:

Head of School Dr Nick P Branch **School Environmental Science of Archaeology, Geography and**

Wager Building Whiteknights
PO Box 227
Reading RG6 6 AB

Phone : +44 (0) 118 378 6102
Email: *n.p.branch@reading.ac.uk*

8 November 2018

Dear Emily

SREC Application SREC2018/04 (Emily Carroll)
Title: Burning by numbers: The use of quantitative petrography in the analysis of heat-induced alteration in burned bone

Your ethics application was considered and approved by Chairs action on 20th October.

The Chair appreciated your comprehensive and detailed application materials and considerations. Your application has been approved to proceed.

With best wishes for your research.

Yours sincerely

pp Professor N Branch
SAGES Research Ethics Committee

Appendix 8: Publications Arising from Thesis - Submitted

Title: Burning by numbers: The use of quantitative petrography in the analysis of Heat-Induced alteration in burnt bone.

First Author: Emily Carroll.

Second Author: Dr Kirsty Squires.

Abstract

In the past, experimental research into the histomorphological examination of burned human bone has led to the creation of a criterion for assessing burning intensity, which can be used to infer firing conditions in both archaeological and forensic contexts. Current methods visually compare the microscopic alterations in burned bone with modern standards fired at known temperatures and durations. Despite the benefits of this approach, it is hindered by the use of qualitative analysis that are subject to the expertise and consistency of the examiner. This paper reviews the application of histomorphometry in previous burned bone studies, presents a new protocol for producing burned bone thin-sections, and introduces quantitative petrography as an alternative, statistical method for categorising burning intensity. Initially, burning intensity categories were devised by burning 11 modern pig (*Sus scrofa*) femora at 100˚C increments from 100˚C to 1100˚C in an industrial furnace. These samples were then subjected to thin-section analysis using quantitative petrography. A K-means cluster analysis identified the presence of four categories of burning intensity based on the quantified heat-induced changes. To test the validity of this method, thin-sections of archaeological bone from the early Anglo-Saxon cemetery at Elsham (North Lincolnshire; n = 16) and the Roman cemetery of Folly Lane (St Albans, Hertfordshire; n = 15) were examined. A discriminate function analysis was performed to separate the archaeological samples into the categories produced by the modern proxies. Over half of the Roman samples from Folly Lane (n = 10, 66.7%) achieved temperatures over 1000˚C. However, the Anglo-Saxon samples from Elsham showed greater diversity with only six (37.5%) reaching temperatures in excess of 1000˚C. Generally, these results were consistent with those produced using more traditional qualitative methods, demonstrating that they are reliable. An inter-observer study successfully demonstrated the repeatability of the new method proposed in this research by both anthropologists and non-anthropologists. The novel technique employed in this research aims to encourage the standardisation of histomorphological examination of burned bone and presents a statistically robust method for establishing burning intensity.

Keywords

Burned Bone; Histomorphometry; Quantitative Petrography; Bioarchaeology; Forensic Anthropology.

1. Introduction

Burned human bone is frequently found in forensic and archaeological contexts. The analysis of these remains is imperative to any investigation as they can assist in the creation of a biological profile (e.g. age, sex, and stature estimation) of the deceased, the events leading up to an individual's death, as well as the manner of burning and burning conditions achieved. Alongside other avenues of research, studies have experimented with the use of histomorphometry, and its value in analysing the microscopic heat-induced (H-I) alterations in burned bone (Hanson and Cain 2007; Squires et al. 2011; Castillo et al. 2013).

Research examining the histomorphological changes of cremated bone stems back to the 1970s. Herrmann (1977) observed that between 700˚C-800˚C the organic component of bone became fully cremated and the hydroxyapatite fused, which caused the bone to shrink. This stage of the burning process was identified as the "critical level" (Herrmann 1977, 101). At this time, it was believed that histomorphological examinations could only be achieved once bone was fully cremated, and that incompletely burned bone displayed no morphological differences at the microscopic level (Bradtmiller and Buikstra 1984). However, it could be argued that this was most likely a reflection of the sampling methods employed and limited experience in the production of thin-sections when this type of research was still in its infancy.

Over the years these initial histomorphological observations have developed greatly thanks to the application of strict laboratory procedures and thorough methodological approaches. Researchers now have a better understanding of the nature of heat-induced changes in burned bone at the microscopic level, although there are discrepancies between a number of studies (Ellingham et al. 2015). Table 1 summarises the histological observations of burned bone published over the last 80 years. Forbes (1941), Nelson (1992), and Hummel and Schutkowski (1993) found that the size of osteons decreased when exposed to increased temperatures, however this was contradicted by Bradtmiller and Buikstra (1984), Cattaneo et al. (1999), and Absolonova et al. (2013) who found that osteon size grew when subject to higher burning temperatures. However, when considering the preservation of bone microstructure, the majority of researchers agree that by 800°C the homogeneity of bone's matrix has largely disappeared (Herrmann 1977; Brain 1993; Castillo et al. 2013). More recently, Squires et al. (2011) and Wolf et al. (2017) have noted that between 600-900°C and 750-850°C respectively, bone microstructure is still preserved and can be used to conduct age assessment. Of the studies that discuss both histomorphology and burned bone colouration, the majority concur that bone darkening or carbonisation is present at temperatures between 300˚C-800°C (Herrmann 1977; Squires et al. 2011). In Brain's (1993) study, it was observed that this change occurs at 500°C at which point the carbon component of bone oxidises, inducing a pale pigmentation.

Temperature	Observation	Reference
Increase in temperature	Decrease in osteon size.	Forbes (1941)
<700°C-800°C >700°C-800°C	Carbon colouration. Organic matter cremated. Crystals fused.	Herrmann (1977)
600°C	Microstructure preserved. Increase in osteon size.	Bradtmiller and Buikstra (1984)
Increase in temperature	Decrease in osteon size. Increase in Haversian canal diameter.	Nelson (1992)
200°C 300°C 400°C 500°C 600°C 700°C 800°C	Carbon in lacunae. Microstructure preserved. Lamellar is carbon. Cracks spreading from Haversian canals. Cracks continue to develop. Carbon has oxidised, producing pale colour. Microstructure visible. Cracks spread across surface area. Matrix shrunk. Microstructure disappeared. Fusion of crystals.	Brain (1993)
Increase in temperature	Decrease in osteon size.	Hummel and Schutkowski (1993)
<800°C <1000°C	Osteons shrink. Significant changes in microstructure.	Cattaneo et al. (1999)
Unheated - 470°C 380°C-482°C 590°C 482°C-620°C 462°C-705°C	All histological structures are visible. Carbon Accumulating. Cracking emanating from Haversian canals. Accumulation of carbon in is minimal. No cracking. Histological structure has disappeared. Carbon deposits extensive. Cracks spreading from Haversian canals. Carbon deposits still occur. Cracks spreading outwards from the Haversian canals.	Hanson and Cain (2007)
300°C-600°C 600°C-900°C >900°C	Preservation of microstructure, organic material with some crystal fusion. Dark in colour. Less microstructure and >50% organic material. Hydroxyapatite fusion. No microstructure. Complete hydroxyapatite fusion.	Squires et al. (2011)
600°C 700°C 800°C	Microstructure was similar to unburned bone. Osteon and Haversian canals shrink. Osteon and Haversian canals shrink further.	Absolonová et al. (2013)
100°C-300°C 400°C-600°C	Collagen deformation. Vitreous crystalline formations. Crystalline polymers.	Castillo et al. (2013)

700°C-800°C >900°C	Rounded and cubical crystals. Loss of homogeneity. Granular surface.	
750°C -850°C	Inorganic bone structures are in good condition.	Wolf et al. (2017)

Table 3: Microscopic changes in burned bone according to contemporary research.

Since the latter years of the 20th century, researchers have examined bone microstructure to determine the origins of burned remains and to establish a criterion for distinguishing animal from human remains (Cattaneo et al. 1999). Due to the fragmentary nature of burned bone, the ability to separate animal from human is hindered by the lack of identifiable features. Osteometric analyses that focused upon osteon size and Haversian canal parameters were found to correctly distinguish non-human (six pigs, six sheep, five cows, one cat, one dog, and one horse) from human remains at a rate of 79% when fired in an industrial furnace at 800˚C-1200˚C (ibid.). More recently, decision tree analysis has been applied to differentiate human and non-human (one badger, one dog, one sheep, and two pigs) bone fired at 700˚C in a bench top furnace. Histomorphometric examinations were able to successfully distinguish human from animal bone at an accuracy rate of 96% (Simmons et al. 2016). Future research into this area would benefit from experimenting with more varied temperature increments and bone preservation (fleshed vs. defleshed remains).

Over the course of the last decade, histomorphological studies have focused on the creation of standardised stages that categorise microscopic alterations according to firing temperature. Squires et al. (2011) provided a three-stage classification of cremated bone ranging from 300˚C to temperatures in excess of 900˚C. The categorisation outlined in this research thoroughly describe the morphological changes from each temperature grouping. This was furthered by Castillo et al. (2013) who described four stages of thermal decomposition based on the mineral composition of bone with firing temperatures ranging from 100°C to 1100°C. In both instances, the qualitative assessment of bone microstructure was employed, and the different categories proposed were determined using visual assessment.

Qualitative analyses can be problematic as they are based on the examiners experience. Unfamiliarity with bone microstructure and the changes that can occur as a result of extreme heat exposure can result in inaccurate interpretations of burning conditions. Additionally, differential sampling methods, namely thin-section production and the examination of various skeletal elements, were used in each of the aforementioned studies, making a comparison of the results problematic. One author faced difficulties when producing thin-sections cut to <1mm due to the friable nature of the archaeological material (Squires et al. 2011), while the other made observations from samples measuring 3mm in thickness (Castillo et al. 2013). These methodological differences complicate replicability of results and obscures the visual assessment of bone's structural matrix. With this in mind, the aims of the present research are three-fold. Firstly, this paper will present a new method for producing burnt bone thin sections, consistently cut at 40µ. The authors will then propose a new method for quantifying the H-I microscopic changes in burned bone using quantitative petrography; this approach aims to increase the accuracy of determining the burning conditions of bone and reduce inter-observer bias. Finally, this new methodology will be used to compare burning intensity of cremated remains from the Roman cemetery of Folly Lane (St Albans, Hertfordshire) and the Anglo-Saxon cemetery of Elsham (Lincolnshire). This will provide greater insight into the cremation technologies of these two historical contexts and how they changed over time.

2. Materials and Methods

2.1 Thin-section production of modern animal bone

Before archaeological burned bone could be examined, it was imperative that the authors created thin-sections of bone heated to known temperatures and durations as this would inform the burning categories that were to be used throughout the course of this research. Eleven sections of pig femur measuring 2cm long were burnt in an industrial furnace at controlled temperatures ranging from 100˚C to 1100˚C (in 100˚C increments) for 45 minutes, following the methodology employed by Thompson, Islam and Bonniere (2013). These samples were then placed in ice cube trays and covered in a solution of Epoxy Resin RX77IC/NC and HY951 Hardener at a ratio of 10:1. The samples were evacuated in a large glass desiccator to remove the oxygen before being placed in an oven overnight set at 60˚C to allow the resin to harden. The solid blocks were cut in half using a WOKO cutter to expose the cross section of the bone, and polished using a motorised hand grinder with 800 grit paper. The polished surface of each sample block was then mounted onto a glass slide, measuring 76mm x 26mm x 1.2mm – 1.4mm, with a mixture of RT151-BU-256 resin and RT151-BU-250G hardener at a ratio of 4:1. Once mounted, the blocks were left to set under a pressure plate overnight. At this stage it is vital that the surface of the block has been polished to a flat surface. This avoids the risk of the glass slide cracking due to the uneven distribution of pressure. Once set, the excess resin block was cut from the glass slide using a LOGITRIM saw, leaving *c*.1mm of sample to polish. Each thin section was then polished to 40µ using a LOGITECH. This machine is used for precision polishing and is often employed in the production of pottery thin-sections as it can be programmed to remove microns from the surface of samples. It is imperative to measure the thickness of the thin-section, including the glass slide, with a micrometer as this will ensure the researcher programmes LOGITECH to the correct calibration. Figure 1 shows the stages of thin section production in line with the methodology outlined above.

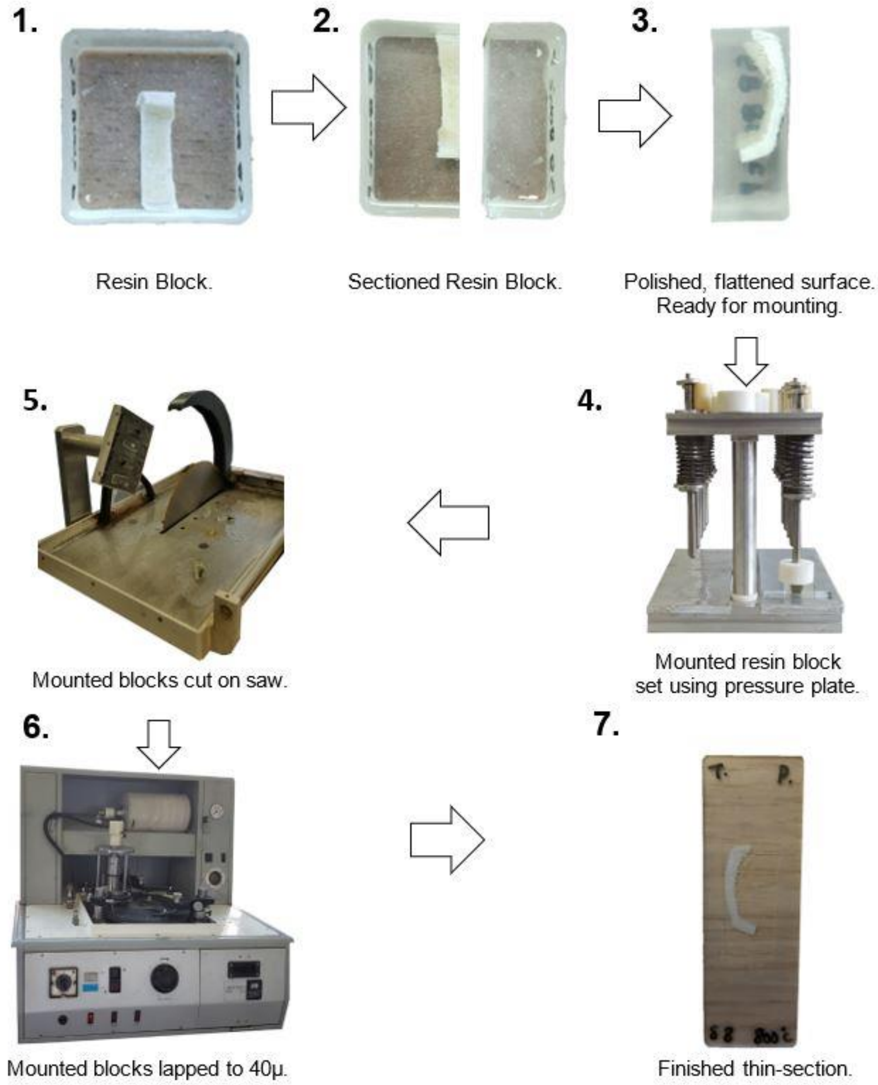


Figure 1: Flow diagram of burned bone thin section production.

2.2 Sites

Thin-sections from two archaeological sites were employed to establish whether the quantitative petrographic methodology, described in section 2.1 of this article, could successfully be used to categorise archaeological burned bone. All human bone was handled in accordance with the British Association for Biological Anthropology and Osteoarchaeology code of ethics (2010a) and code of practice (2010b). A research proposal and disclaimer form were submitted to North Lincolnshire Museum. Permission to examine the Elsham thin-sections was granted from this institution and permission to sample the burned bone from Folly Lane was given by the curator of the Verulamium Museum (St Albans). Ethical approval to conduct all elements of this project (i.e. histomorphological analysis and the interobserver study; section 2.5) was granted by the Staffordshire University ethics committee. All bone and resultant thin-sections were returned to the appropriate museum following analyses.

2.2.1 Folly Lane, St Albans, Hertfordshire

The Romano-British samples examined in this paper come from the cemetery of Folly Lane, in St Albans, Hertfordshire (Figure 2). Fifteen bone samples were taken from 14 adult cremation burials and one juvenile/adult recovered from the burial complex. The site was first discovered in 1991 as a result of a series of archaeological projects set out to survey the area (Niblett 1999). While 22 cremation burials from this cemetery were recovered and subject to anthropological assessment (Mays and Steele 1999), no consideration was given to the heat-induced alterations in the burned bone.

The 15 archaeological samples from Folly Lane, Hertfordshire were produced using the same method described above (section 2.1). These samples were cut and polished to a thickness of 40µ. Initial assessment of the macroscopic colour of each sample was recorded following the gradient form used by Thompson et al. (2016) and Munro et al. (2007). Further histological examinations, according to the descriptions outlined by Squires et al. (2011), established that these individuals were subject to temperatures ranging from 600°C to 900°C.

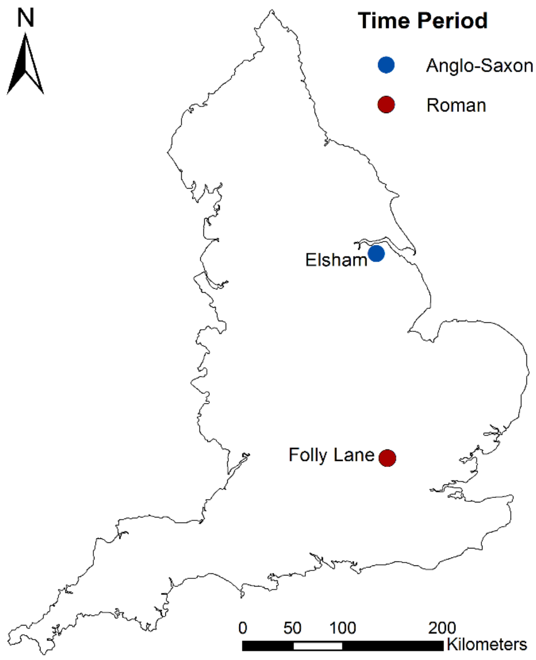


Figure 2: Map of Folly Lane (St Albans, Hertfordshire) and Elsham (North Lincolnshire).

2.2.2 Elsham, Lincolnshire

The early Anglo-Saxon samples used in this study derived from the cemetery of Elsham, North Lincolnshire (Figure 2). A total of 16 bone samples were chosen at random and comprised of 12 adults, two adolescent individuals, and two children. The cemetery was excavated between 1975 and 1976 and yielded 569 cremated bone deposits (Squires 2011). Previous anthropological assessment, including a qualitative-based histomorphological examination, concluded that cremation pyres at this site typically reached temperatures between 600°C to 900°C under oxidising conditions (Squires et al. 2011).

In total, 16 thin-sections from the early Anglo-Saxon cemetery of Elsham (North Lincolnshire). These thin-sections were prepared by Kirsty Squires as part of her PhD research (Squires 2011). Further methodological details can be found in Squires et al. (2011), though it is worth noting here that colour was recorded using Munsell (2000) colour charts. In the first instance, these samples were recorded using qualitative methods, namely the colour of each bone was assessed and a written description of the bone microstructure was produced. The 16 thin-sections from Elsham were created using a microtome and were cut to 60µ, 75µ, or 100µ due to issues pertaining to the integrity of the cremated bone. The variable thickness of these thin sections is problematic as they are inconsistent and could affect the results of intra- and inter-site studies of these bones. However, the authors decided not to cut more thin-sections of bone from the Elsham assemblage on this occasion as it was possible to obtain information from the pre-existing thin-sections. It is therefore recommended that the thin-section preparation guidelines presented in this paper (section 2.1) are used in future research that involves the examination of bone histomorphometry.

2.3 Quantitative petrography

Quantitative petrography has traditionally been applied in geology to examine the composition of rocks and soils by counting the organic inclusions. More recently, it has been used in archaeological studies to count inclusions in pottery fragments and ceramic building material to establish how materials were sourced and made (Machin 2017; Sutton 2017). In this study, quantification of the microscopic H-I alterations in burnt bone was achieved using the PETROG motorised stepping stage and 2018 PETROG software provided by Conwy Valley Systems Limited. The setup involves attaching the PETROG motorised stepping stage (a metal frame in which the thin-section is secured and moved along via a motor) to the platform of a Leica DM EP microscope with a Leica DF 295 camera. The 2018 PETROG software loaded on the associated computer displays a live video stream of the microscopic view of the mounted thin-section. The software is used to set the area of interest (the sample area under examination), and program the step count (the number of times the thin-section is moved). In this study, 300 steps were recorded for each thin-section examined to ensure a representative analysis of the surface area. The stepping stage systematically moves the thin-section. With each step the cross hairs on the live video stream land on a H-I feature. The operator then selects the identified feature from the software dictionary (Table 2), developed from the criteria provided by Squires et al. (2011). The data can then be exported to a Microsoft Excel spreadsheet for quantification and SPSS for statistical analysis.

Heat-Induced alteration	**Description**
Hydroxyapatite crystal fusion	The hydroxyapatite crystals that form within the bone matrix fuse.
Organic material	The preservation of bones organic component.
Haversian system – well defined	The preservation of Haversian systems that are not deformed or misshaped.
Haversian system – poorly defined	The preservation of Haversian systems that are no longer clearly defined and have become misshaped.
Volkmann's Canal – well defined	The preservation of Volkmann's canals that are not deformed or misshaped.
Volkmann's canal – poorly defined	The preservation of Volkmann's canals that are no longer clearly defined and have become misshaped.
Osteon – well defined	The preservation of osteons that are not deformed or misshaped.
Osteon – poorly defined	The preservation of Volkmann's canals that are no longer clearly defined and have become misshaped.
Canaliculi – well defined	The preservation of canaliculi that are not deformed or misshaped.
Canaliculi – poorly defined	The preservation of canaliculi that are no longer clearly defined and have become misshaped.

Table 2: Dictionary of Heat-Induced changes (adapted from Squires et al. 2011).

2.4 Statistical analysis

The petrographic data from the eleven modern thin-section was imported to IBM SPSS Statistics 24. A K means cluster analysis was performed to statistically group the H-I alterations recorded. This test was used as it is an unsupervised way of grouping unlabelled data and is more appropriate than a hierarchical cluster or a two-step cluster because it is better suited for large data sets (Kaur and Kaur 2013). A discriminate function analysis was subsequently performed on the petrographic data collected for the archaeological thin-sections from Folly Lane and Elsham using the categories produced by the K means cluster analysis. This test statistically assigned each sample to a burning category based on the H-I alteration recorded. It was chosen because it is effective in predicting category membership according to a set of variables (Jain 2010).

2.5 Inter-observer study

An inter-observer study was also carried out as part of this research to establish whether quantitative petrography could be employed to analyse burned remains by anthropologists and non-anthropologists. Five participants were recruited for the purpose of this study: three anthropologists and two non-anthropologists. Each of the anthropologists had undertaken postgraduate studies specialising in human bone and possessed one to four years' experience of working with human skeletal remains. The two non-anthropologists had studied archaeology at undergraduate level and had both worked in commercial archaeology. None of the participants had used quantitative petrography before. Each were shown how the method worked and were provided with an information sheet describing the microscopic structure of bone and the H-I changes. Each participant was required to analyse two archaeological thin-sections: sample EL75HL (Elsham) and Burial 2 (Folly Lane). These thin-sections were chosen for analysis as they display substantially different heat-induced microscopic changes. This would ensure that the examiners fully understood the effects of heating on the microstructure of burned bone and test the reliability of this method using dissimilar samples. The lead author was present during the study to answer any questions the participants may have; however, care was taken to ensure that any answer given did not influence the results of the study.

3. Results

3.1 Categories of burning intensity using modern standards

The K means cluster analysis identified four burning intensity groups based on the quantities of H-I alterations of the 11 porcine femora samples examined in this study (Table 3). These results are consistent with findings provided by other publications (Squires et al. 2011; Castillo et al. 2013), which indicates that the data are reliable.

Category I: Between 100˚C-400˚C the microstructure of the bone is well preserved; Haversian systems are consistently circular, with no malformation and smaller features including Volkmann's canals, osteons and canaliculi are relatively un-altered. Between 48.3% and 53.6% of the sample area consists of organic material, while the remainder is comprised of well-defined micro-features.

Category II: The depletion of organic material and the fusion of hydroxyapatite crystals becomes more frequent at temperatures between 500˚C-600˚C. At this stage, micro-features are still identifiable, but they are less well-preserved and show signs of deterioration, whereby 14.7% and 18.3% of the sample area displaying poorly defined microstructures.

Category III: The degeneration of microscopic features and the increase in hydroxyapatite fusion becomes more apparent in temperatures ranging between 700˚C-900˚C. All organic material within the sample area has decomposed and 49%-59.6% of the microscopic composition is fused.

Category IV: For temperatures in excess of 1000˚C, a minimum of 86.3% of the sample area displays complete hydroxyapatite fusion, evident from the lack of discernible osteons, Volkmann's canals, and canaliculi. A few misshaped Haversian systems still remain, comprising up to 14% of the sample area.

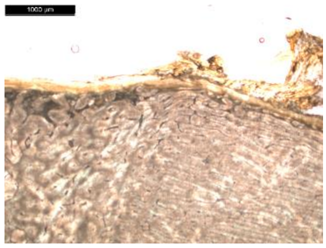
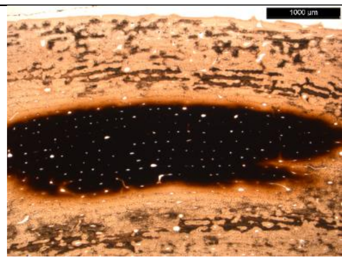
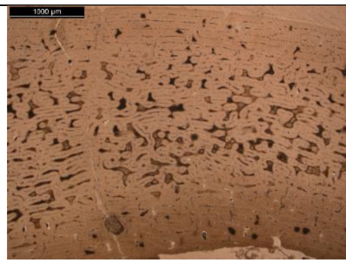
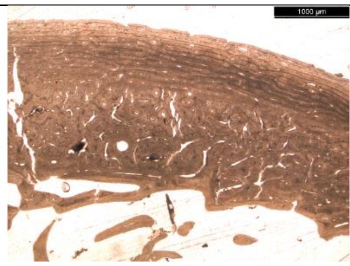
Category	Temperature	Micrograph
I	100˚C-400˚C	
II	500˚C-600˚C	
III	700˚C-900°C	
IV	1000˚C-1100°C	

Table 3: Burning categories identified from K means cluster test from the modern pig samples.

3.2 Discriminant function analysis using archaeological samples

A discriminant function analysis was performed on 31 archaeological thin-sections to statistically predict the stage of burning intensity based on the quantification of the microscopic changes. The colour of each burnt bone fragment was recorded (using the methods outlined in sections 2.2) and visual examination utilising the method outlined by Squires et al. (2011) was performed to compare the quantitative petrography results with contemporary, qualitative methods (Table 4).

Fourteen (93.3%) samples from Folly Lane are fully calcined displaying white colouration, which is known from previous research to represent intense burning temperatures in excess of 700˚C (Ellingham et al. 2015). According to Squires et al.'s (2011) method the lack of well-defined microstructure and complete hydroxyapatite fusion suggests that ten of the bone samples are 'Completely Cremated', indicative of temperatures in excess of 900˚C. These results match the categories assigned using quantitative petrography, affiliated with temperatures between 1000˚C and 1100˚C. Folly Lane Burials 7, 10, 12, 18, and 22 produced the only samples that did not demonstrate high burning temperatures. In particular, burial 18 was fully carbonised, which was indicated by the black and brown colouration and suggestive of incomplete oxidisation (Ellingham et al. 2015). The high preservation of organic material and defined microstructure within the sample area most accurately correlates with 'Less Intensely Cremated' indicative of temperatures between 300˚C-600˚C (Squires et al. 2011). This is consistent with the 90% organic material calculated using quantitative PETROG, representing a lower temperature bracket of 500˚C-600˚C. The results ascertained from the macroscopic colour assessment of each sample, Squires et al.'s (2011) histomorphological method, and the current Quantitative PETROG method are consistent, indicating that quantitative petrography is a reliable method that is quick and highly accurate.

A total of 14 (88%) samples from Elsham exhibited some white colouration; however, EL75CR, EL75GA, EL75HL, EL76EI, EL75PF, and EL75PM(b), showed both white and black colouration, which suggests incomplete oxidisation where higher temperatures were archived for shorter time periods. On a microscopic level, the majority of samples (n = 11, 78.6%) displayed very few micro-features including Volkmann's Canals or organic material. These observations fell within the 'Intensely Cremated' category according to Squires et al. (2011) indicative of temperatures between 600°C to 900°C. Similar results were ascertained using quantitative petrography, whereby the remaining microstructure was poorly defined indicative of temperatures between 700°C and 900°C (Category III). Six (37.5%) Anglo-Saxon samples exhibited almost complete hydroxyapatite fusion, which is characteristic of temperatures over 900°C according to both methods applied here. Overall, the cremated individuals from Anglo-Saxon Elsham displayed a greater variety of burning intensities, compared to the Roman samples from Folly Lane where most of the burials reached temperatures over 1000°C (n = 10, 66.7%).

Sample no.	Fragment colour	Squires et al. (2011) classification	Quantitative petrography category	Sex	Age Group
Folly Lane Burial 1	White; light grey	Completely Cremated	IV	Unknown	Middle Adult
Folly Lane Burial 2	White; grey	Completely Cremated	IV	Female?	Young/Middle Adult
Folly Lane Burial 4	White; Taupe; light grey	Completely Cremated	IV	Male?	Adult
Folly Lane Burial 7	White; Dark greyish blue; taupe; black;	Intensely Cremated	III	Male?	Middle Adult
Folly Lane Burial 8	White; grey	Completely Cremated	IV	Unknown	Adult
Folly Lane Burial 9	White; light grey	Completely Cremated	IV	Unknown	Young Adult
Folly Lane Burial 10	White; dark grey; taupe	Intensely Cremated	III	Unknown	Adult
Folly Lane Burial 11	White; dark grey; taupe	Completely Cremated	IV	Unknown	Unknown
Folly Lane Burial 12	White; greyish blue; taupe	Intensely Cremated	III	Unknown	Middle/Old Adult
Folly Lane Burial 13	White; brown; light grey	Completely Cremated	IV	Male	Middle/Old Adult
Folly Lane Burial 18	Black; brown	Less Intensely Cremated	II	Male	Young/Middle Adult
Folly Lane Burial 21	White; darkish grey; black	Completely Cremated	IV	Unknown	Juvenile/Adult
Folly Lane Burial 22	White; light grey	Less Intensely Cremated	II	Unknown	Young Adult
Folly Lane Burial 24	White; light grey	Completely Cremated	IV	Unknown	Middle/Old Adult
Folly Lane Burial 29	White; light grey	Completely Cremated	IV	Unknown	Juvenile/Adult
EL75AM	White; very dark bluish grey	Completely Cremated	III	Unknown	Older Mature Adult
EL75AO	White	Completely Cremated	III	Unknown	Younger Mature Adult
EL75BK	White	Completely Cremated	IV	Unknown	Child
EL75BQ	White	Completely Cremated	IV	Unknown	Adolescent

EL75BY	White; bluish grey	Intensely Cremated	IV	Unknown	Child
EL75CA	White	Completely Cremated	IV	Female	Younger Mature Adult
EL75CR	White; black	Intensely Cremated	II	Unknown	Younger Adult/Younger Mature Adult
EL75GA	White; black	Intensely Cremated	III	Unknown	Adult
EL75HL	White; black	Intensely Cremated	II	Unknown	Younger Mature Adult/Older Mature Adult
EL75PF	Dark bluish grey; black	Intensely Cremated	III	Male	Older Mature Adult
EL75PM(b)	White; bluish grey; dark bluish grey; black	Intensely Cremated	II	Male?	Older Mature Adult
EL76EI	Bluish grey; black	Completely Cremated	II	Indeterminate	Younger Adult/Younger Mature Adult
EL76EQ	White; light grey	Completely Cremated	IV	Unknown	Adolescent
EL76MQ	White	Completely Cremated	IV	Male	Younger Mature Adult
EL76NA	White; light bluish grey	Intensely Cremated	II	Unknown	Adult
EL76NN	White; light bluish grey	Intensely Cremated	III	Male	Younger Mature Adult

Table 4: Archaeological burned bone thin-sections from Folly Lane and Elsham.

3.3 Inter-observer study

Of the five examiners included in this study, four of the participants produced the same results, yielding an agreement level of 80% with observations made by the authors of this paper (Table 5). Only one of the examiners (2nd Anthropologist) produced results that did not match those of the author. The reason for the misclassification was simply a result of the examiner repeatedly selecting the wrong option from the dictionary of heat-induced alterations by accident. This is because the two options are placed next to each other in the lists of options. Overall, the results demonstrate that quantitative petrography is a highly reliable method that overcomes inter-observer biases.

Examiner	Sample	Original category (by the authors)	New Category (by the participants)	Agreement (%)
1st Anthropologist	1	IV (1000°C-1100°C)	IV (1000°C-1100°C)	100%
	2	II (500°C-600°C)	II (500°C-600°C)	
2nd Anthropologist	1	IV (1000°C-1100°C)	III (700°C-900°C)	50%
	2	II (500°C-600°C)	II (500°C-600°C)	
3rd Anthropologist	1	IV (1000°C-1100°C)	IV (1000°C-1100°C)	100%
	2	II (500°C-600°C)	II (500°C-600°C)	
1st Non-Anthropologist	1	IV (1000°C-1100°C)	IV (1000°C-1100°C)	100%
	2	II (500°C-600°C)	II (500°C-600°C)	
2nd Non-Anthropologist	1	IV (1000°C-1100°C)	IV (1000°C-1100°C)	100%
	2	II (500°C-600°C)	II (500°C-600°C)	

Table 5: Results from inter-observer pilot study.

4 Discussion

4.1 Thin-section preparation

Creating thin-sections of modern and archaeologically burnt bone is challenging. In the past, researchers have struggled to produce consistently flat thin-sections that are all the same thickness, without breaking or damaging the sample, or grinding the sample by hand (Hanson and Cain 2007; Squires et al. 2011; Simmons, Goodburn and Singhrao 2016). The method recommended in this paper helps to overcome some of these issues and encourages a standardised approach that will facilitate further comparative research on both an intra- and inter-site level.

As bone is a porous material, the process of impregnating a fragment in resin often leads to air pockets or bubbles that can obscure the appearance of the sample area when examined under a microscope. This study highlights that evacuating the resin mixture before and after it is poured over the bone fragment helps to remove all the oxygen before the resin has set. This removes any air pockets from the resin block, which produces a consistent sample area that is not obscured by any air bubbles. To date, this approach has yet to be applied in other studies producing thin sections of burned bone (Cattaneo et al. 1999; Hanson and Cain 2007; Squires et al. 2011; Simmons, Goodburn, and Singhrao 2016). However, it has been successfully applied to the analysis of other porous materials, including soils, metals, and ceramics (Granger 1967; Jongerius and Heintzberger 1975).

Previous studies that have explored the histomorphology of burned bone employed a microtome (Holden, Phakey, and Clement 1995; Squires et al. 2011; Castillo et al. 2013; Schotsmans et al. 2014), which is a tool used to cut burnt bone thin sections (e.g. Squires et al. 2011). This technique can be problematic when used to section resin blocks, often resulting in the slice breaking due to the friable nature of the burnt bone and producing an uneven sample area that is hard to accurately examine under a microscope (ibid.). An alternative to this approach involves grinding or polishing the resin block mounted to the glass slide (Cattaneo et al. 1999; Simmons, Goodburn, and Singhrao 2016), which can be a time-consuming process when conducted by hand (Simmons, Goodburn, and Singhrao 2016). To make the process more efficient, this study employed a LOGITECH, which is a lapping machine with automated plate flatness control that reduces a bone sample to a pre-programmed thickness. This not only guarantees the same thickness across the entire sample area, but also removes the risk of breaking the sample. Other studies examining bone histology have also used this lapping technique to process large numbers of samples (Holden, Phakey and Clement 1995; Cattaneo et al. 1999).

Despite the clear benefits of this new approach, it is time consuming. On average, a batch of twelve samples takes a minimum of five days to produce. In addition, the numerous machines used in this procedure are specialist pieces of equipment that are not readily found and do require expert training. The quantitative PETROG software and equipment used in this study was provided by Conwy Valley Systems Limited. The software's design is flexible and can be applied not only to the analysis of burned bone, but other modern and ancient materials including ceramics, building materials, and soil samples. It is therefore an invaluable addition to any multi-disciplinary department or laboratory. It is also compatible with Windows operating systems and can be used on most desktops. The programme exports the collected data into a spreadsheet from which statistical analysis can be carried out, e.g. imported into SPSS or R. The automated stepping stage is also compatible with most microscopes and can be assembled easily. However, this set-up is another example of specialist equipment that is not widely available at present.

Pigs are often used in forensic research as human proxies, as their body size, fat distribution, and bone microstructure are, to some extent similar to that of humans (Schotsmans et al. 2014); however, it is important to acknowledged that the results achieved may not be fully true of human bone (Thompson 2002). The samples analysed in this study comprised sections of porcine femora which were burnt in an industrial furnace. Studies have found that the distribution of fatty tissue on a body can impact the resultant H-I changes (Dehaan 2015). For example, Dehaan (2015, 9-10) explains that fat is the best fuel in the body for burning, though the effects of heating on this material depends on its thickness and its thermal properties, as well as the duration of the fire. This author also observed that it takes around 30-60 minutes for the core temperature of a human torso to rise in temperature when exposed to a normal room fire, which is longer than other areas of the body (ibid.). In the present study, the animal bone samples used were partially defleshed (soft tissue removed) before firing which would have had an impact on the resultant microscopic heat-induced alterations. Future research would benefit from using complete bodies and taking multiple samples from different parts of the body.

4.2. Quantitative vs. qualitative analysis

Quantitative petrography is a valuable technique for examining heat-induced changes in burned bone from both forensic and archaeological contexts. This new approach compliments the results ascertained by previous histological research (Squires et al. 2011; Absolonová et al. 2013; Castillo et al. 2013) and those derived from the examination of macroscopic colour (Ullinger and Sheridan 2015), as well as crystallinity (Thompson, Islam and Bonniere 2013); it is therefore encouraged that this approach is used in combination with other techniques for a holistic interpretation of the data.

The new categorising system concerning microscopic changes in burned bone presented in this study has generated narrower temperature ranges than those established in contemporary research (Squires et al. 2011). This results in a more accurate interpretation of the material. The K means cluster statistical analysis identified significant groups amongst the modern animal bone samples burned between 100°C-1100°C degrees that most studies had only previously been established using visual assessment (Hanson and Cain 2007; Squires et al. 2011; Castillo et al. 2013). A similar statistical approach was successfully used by Absolonová et al. (2013) to compare the microscopic dimensions of bone shrinkage between human unburned bone with samples fired at 700°C, 800°C, and 1000°C. This study found that the greatest changes in burned bone microstructure occurred around 800°C.

Based on the standards devised from the porcine samples employed in this research, it was observed that minimal microscopic alteration takes place at temperatures between 100°C and 400°C, which is understandable considering that these temperatures are used in cooking and do not result in skeletonisation. At this stage, petrographic analysis found that between 48.3% and 53.6% of the sample area consisted of organic material, which includes carbon and collagen (Ellignham et al. 2015), while the remainder constitutes well preserved micro features such as Volkmann's canals and canaliculi. This is to be expected and represents the dehydration stage of burnt bones transformation whereby hydroxyl-bonds start to break up resulting in the loss of water (Ellingham et al. 2015). Between 500˚C-600˚C, the sample area demonstrates depleted microscopic definition, whereby between 14.7% and 18.3% of the sample area constitutes poorly defined features including Haversian systems and Volkmann's canals. Previous research has established that this represents the decomposition and removal of carbon and collagen within the bone's matrix (Hanson and Cain 2007; Squires et al. 2011). By 700˚C all organic material is removed from the sample area due to pyrolisation. Haversian systems are the only discernible micro feature remaining, and their form has become misshapen due to the decomposition of bone's organic component and fusion of hydroxyapatite, which constitutes 49%-59.6% of the sample area. By 1000°C 86.3% of the sample area is completely fused, representing the melting and coalescing of the crystal matrix (Ellingham et al. 2015).

The results ascertained from this study demonstrate the value of quantitative petrography in the analysis of burnt human remains and show that it should be applied more widely in this field alongside other modes of analysis; future research would benefit exploring its potential more vigorous. For instance, using the measuring application to conduct a metric assessment of the microscopic features in burnt bone to identify how the size of these features change during the transformation process.

4.3 Roman and Anglo-Saxon cremation technologies

Given the accuracy of quantitative histomorphological analysis, the burning categories and observations presented in this paper will be used to gain an insight into the cremation process in the past. Additionally, it will allow anthropologists and archaeologists to further understand how and why cremation technologies changed over time. The following section of this paper will present a brief case study exploring the changing pyre technologies in Roman Britain and Anglo-Saxon England based on the results generated in this experimental work.

As noted in section 3.2, it was observed that the Anglo-Saxon samples from Elsham displayed greater burning intensity variability compared to those from the Roman site of Folly Lane. Whilst this could indeed be attributable to sampling strategy by the authors, there may be other factors at play that could account for these observations. Jacqueline McKinley (2008) has noted that, in a study of 60 Romano-British sites, the majority of cremated bone deposits were white in colour, indicating oxidising conditions and an efficient cremation process. Unfortunately, the author does not specify the percentage of deposits that constitute "majority" of deposits examined, nor does she employ histomorphometric analyses. There are occasions where colour does not always correlate with microscopic structure, thus the sole use of macroscopic observations to infer burning conditions must be interpreted with caution (Squires et al. 2011). McKinley (2008) suggests that Roman remains that were not completely oxidised on the pyre is the result of practical factors, for example individuals with larger body masses, which would have required more resources to cremate, and under-sized pyres whereby the amount of fuel was standardised and not based on the size of the deceased (ibid.). It is also worth highlighting that McKinley (2008) observed that the oxidation of military cremations on the Northern Frontier showed greater efficiency than cremation in rural areas. Again, only colour of bone was used to reach these conclusions. Thompson et al. (2016) used macroscopic observations and FTIR-ATR to assess burning intensity of Romano-British military sites in northern Britain and concluded that remains were not fully oxidised; suggesting that the sole aim of military cremations was to combust the body (possibly due to time constraints and other practical factors) and not completely cremate it, whereby greater calcination (i.e. the bones turning white) would occur. Hope (2003) points out that it was highly unlikely for the cremated remains of soldiers who died overseas to be returned to their families, unless they were of high social standing. Often, individuals would have been cremated immediately and their remains scattered close by (Carroll 2009). According to Pliny (Pliny *Naturalis Historia* VII, 54) cremating bodies removed the risk of them being dug up and desecrated (Hope 2003). As such, cremation in military contexts would have been rapid and relatively unceremonious. Sampling strategy may explain the disparate results observed by McKinley (2008) and Thompson et al. (2016), although it does demonstrate the need for more technical forms of analysis in the analysis of regarding burned remains from archaeological sites, including quantitative histomorphological analysis.

In contrast to the overall high efficiency observed at Folly Lane, variable burning intensities, more akin to those seen at the Roman Northern Frontiers, are observed from Elsham. Evidence of variable degrees of oxidation on the cremation pyre have not only been observed elsewhere from early Anglo-Saxon England, but also from contemporary sites in Germany (Squires 2016). Here, these Late Roman Iron Age (c. AD 180-400) to Migration Period (c. AD 400-550/600) cremation deposits show similarities in terms of the colour and large fragment sizes, indicative of minimal intentional disturbance of the pyre (e.g. tending to encourage oxidising conditions) (McKinley 1994; Squires 2016). However, it is worth noting that none of these sites, with the exception of Elsham, have been subjected to histomorphological analyses as a means of understanding burning efficiency. In contrast to the Roman period (Thompson et al. 2016), the form of pyre constructions from early Anglo-Saxon England is unknown. The use of differential pyre structures during this period (e.g. see Wells 1960; McKinley 1994) could also account for more variable cremation, particularly, if under-pyre scoops or pits were not employed.

Differential cremation practices between the Romano-British and their contemporaries from Germany, as well as those from Migration period Germany and early Anglo-Saxon England could indicate differential traditions in the western and eastern Roman provinces. These may have been influenced by a combination of ideological beliefs, social structure, for example the use of professional *ustores* in Roman Britain (McKinley 2008), and the ability to overcome practical hurdles faced by cremation practicing groups, such as time constraints, weather and seasonality, lack of storage facilities for bodies, and the provision of animal offerings on the pyre (Squires 2015, 2017). In such cases, the primary aim of a cremation may have been to solely render the body down to bone as opposed to achieving complete "calcination", which may have been reserved for certain members of society, who could afford greater resources and energy at the funeral.

Despite the more variable nature of cremation during the early Anglo-Saxon period, there is no evidence for failed cremations during this period. In contrast, there is both archaeological evidence (McKinley 2000, 2008) and literary accounts from the Roman period (Noy 2000) that refer to the remains of charred and partially cremated remains which was intentional, rather than a failed cremation due to practical factors. These curtailed cremations were conducted as a means of insulting and dishonouring the dead (ibid.). Whilst no failed Roman cremations were observed in this study, the application of histomorphometric methods to analyse the remains of so-called failed cremations would be insightful. It would also be interesting to compare how the microstructure of such remains compares to those of 'Less Intensely Cremated' bones from both the Roman and early Anglo-Saxon periods.

5 Conclusion

This paper has outlined a novel method for preparing uniform thin-sections of burned bone. The utilisation of this technique in future research will improve comparability between the results of both qualitative and quantitative histomorphological studies. This article has also proposed a new quantitative method to determine burning intensity based on H-I changes in heat modified bone. The use of the PETROG software proved to be reliable, quick, and highly accurate when recording the level of heat-induced changes of burned bone samples. These results were subjected to discriminant function analysis to predict burning intensity stages of archaeological samples from Folly Lane and Elsham and corresponded to the qualitative histomorphological method outlined by Squires et al. (2011) and the use of colour to assess burning intensity, though there are, on occasions, anomalies with the latter, which would benefit from further investigation. The use of the newly proposed quantitative methodology is also user friendly, as demonstrated by the success rate of the inter-observer study. Both human bone and non-human bone specialists quickly understood the software dictionary and learnt how to navigate the software with relative ease. This highlights that quantitative histomorphological analysis could be used by anthropologists and archaeologists alike with minimal training. Evidently, this particular format helps to ensure standardisation in analysis, and minimises inter-observer bias.

This is first study to directly compare pyre technology from the Roman and early Anglo-Saxon period using histomorphometry. Whilst, only a brief case study using 31 thin-sections is provided, it has raised an interesting distinction between the two periods in relation to pyre technology. Overall, remains from the Roman site at Folly Lane experience greater calcination than those from the early Anglo-Saxon cemetery at Elsham, which displayed greater variability in terms of burning intensity of skeletal remains. Of course, sampling strategy could come into play here, although similar macroscopic observations made in other studies have noted analogous findings. The lack of professional *ustores* in the early Anglo-Saxon period, differential ideological beliefs, cremation traditions which may have originated from their Germanic homelands, and difficulties in overcoming practical challenges could all account for the greater variability seen in the cremations from the later period. Given recent developments in qualitative and quantitative histomorphology and the use of FTIR-ATR to understand burning conditions, it would be insightful to employ these methods with a larger sample size to explore how and why pyre technology varied both temporally and geographically, as opposed to solely basing our understanding of past cremation practices on the colour of burned remains. The proposed method for producing consistent thin-sections of burned bone and the new quantitative method discussed in this paper, will make histomorphological analysis more accessible to practitioners in archaeology and forensic science, as well as increase the accuracy of the results generated by such studies.

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Appendix 9: Charcoal

Table A9.1 Tree and Shrub taxa represented. *Evergreen types.

Family	Sub-Family	Genus/Species	Common Name
Aquifoliaceae	N/A	*Llex aquifolium*	Holly*
Betulaceae	N/A	*Alnus glutinosa*	Common alder
	N/A	*Betula pendula/ pubescens*	Silver/downy birch
	N/A	*Corylus avellane*	Hazel
	N/A	*Carpinus Betulus*	Hornbeam
Fagaceae	N/A	Fagus sylvatica	Beech
	N/A	Quercus sp. (robur/petrea)	Oak
Rosaceae	Maloideae (formerly Pomoideae)	(Maloideae)	Pomaceous fruits, e.g. Apple, Pear, Whitebeam, Hawthorn
		Eg Crataegus type	Hawthorn
	Amygdaloideae (formerly Prunoideae)	*Prunus* sp. undiff.	Cherry type, e.g. Bird cherry, Blackthorn
		Prunus spinosa	Blackthorn
Ulmaceae	N/A	*Ulmus* sp.	Elm
Oleaceae	N/A	*Fraxinus excelsior*	Ash

Table A9.2 Catalogue of individual charcoal descriptions.

Cemetery	Sample	Time Period	Settlement Type	Sex	Age	N Grave Goods	Excavator Description	Charcoal Description
Cross Farm	04/202	Early Roman	Rural	Female	18 +	4	The cremation burial was heavily disturbed by plough damage. A furrow had been cut into the feature, which had mixed the contents with both the underlying natural and overlying topsoil.	One sample was analysed from this context. The charcoal from this sample was relatively sparse, consisting primarily of small fragments that were >2mm in size and badly preserved, making identification difficult. The majority of the material (97%) was oak roundwood (*Quercus Sp.*) cut at 3 years, while a few fragments of Maloideae (3%) were also identified. 62% of the assemblage displayed vitrification, which is archived through the firing of wood at extremely high temperatures.
Cross Farm	214/023	Middle Roman	Rural	Unknown	14 – 18	3	A deposit consisting of three vessels and an urn that had been badly crushed, resulting in some of the urn fill becoming incorporated into the backfill of the grave.	Charcoal was examined from two samples. Both of the samples examined were not charcoal rich and consisted of poorly preserved fragments that were >4mm in size. 75 – 83% of the assemblage consisted of oak twigwood, while small quantities of

								Maloideae (5 - 6%), ash twigwood (*Fraxinus excelsior)* (3.5%) and unidentified twigwood (4.5%) were also recorded. 6% of the assemblage displayed vitrification.
Folly Lane	3	Early Roman	Major Urban	Unknown ; Unknown	< 13; 18 +	4	A mix of cremated bone and charcoal was found in the southern end of the burial pit. The context was considerably charcoal rich, especially compared to other cremation burials from the same site.	One sample was analysed from this context. The charcoal was well preserved measuring <4mm in size. Of the 200 fragments examined, 89% was young roundwood oak cut at 1 year. Traces of common hornbeam (*Carpinus betulus)* (1%), Pomoideae (*Pomoideae cf. Crataegus*) (<1%), and Maloideae (8.5%) were also recorded all cut at 1 year. 36% of the fragments within the assemblage displayed vitrification and a further 2% exhibited shrinkage, which occurs when damp wood is burnt at high temperatures.
Folly Lane	4	Early Roman	Major Urban	Male	+ 18		A cremation burial placed centrally within the pit, which consisted of a clean	One sample was analysed from this context. As expected from the excavator's description, the presence of charcoal within the

						3	fill with little charcoal.	sample was meagre. Fragments measured >2mm in size, which made identification difficult. Modern grass was also recovered, demonstrating contamination of the assemblage. 98.2% of the sample consisted of oak roundwood, while the remaining 2% was identified as Maloideae roundwood. Of the 56 fragments identified, 25% displayed vitrification.
Folly Lane	6	Early Roman	Major Urban	Unknown	Unknown	3	The deposit was a truncated burial pit, where the urn was placed in the centre with burnt bone deposited in the base	One sample was analysed from this context. A considerable amount of grass was recovered from the sample caused by modern contamination from the soil B horizon. The charcoal recovered from the sample was very poor and consisted mostly of fragments measuring >2mm in size. The assemblage was dominated by oak roundwood (85%) mostly cut at 1 year and a small quantity of Maloideae (11%). Interestingly, Elm (*Ulmus sp.)* made up 2% of the assemblage and was not

								identified in any other cremation deposit from Folly Lane. 11% of the 100 fragments examined displayed vitrification.
Folly Lane	9	Early Roman	Major Urban	Unknown	18 +	6	The burnt human bone was placed in the centre of a circular pit.	One sample was analysed from this context. A considerable amount of grass was recovered from the sample presumably from the soil B horizon. The little charcoal recovered was poorly preserved and measured <2mm in size, making identification difficult. The identifiable assemblage comprised oak, which is unusual compared to the other cremation burials from Folly Lane. The majority of the material was roundwood cut at 1-2 years, apart from a single fragment of twigwood identified. Of the 100 fragments examined, 76% displayed vitrification.
Folly Lane	13	Late Roman	Major Urban	Male	18 +		The deposit was described by excavators as a rectangular pit where	One sample was analysed from this context. The >2mm assemblage consisted of four taxa, the most abundant being

						1	the urn containing the burnt bone and charcoal was placed in the west corner	oak roundwood (85%). A small quantity of ash roundwood (11%) was identified, alongside a few fragments of Maloideae (3%). A single piece of birch (*Betulaceae sp.*) was recovered, and was not found in any other burial from this cemetery. Of the 101 fragments examined, 11% displayed vitrification.
Folly Lane	18	Early Roman	Major Urban	Male	18 +	3	The urn fill from this deposit had spilled from the container and mixed in with the backfill of the grave.	One sample was analysed from this context. An adequate amount of charcoal was recovered showing moderate preservation, with fragments measuring <2mm in size. Surprisingly, the entire sample consisted of oak roundwood except for one fragment that could not be identified. Of the 150 fragments examined, 25% displayed vitrification.
Folly Lane	20	Early Roman	Major Urban	Unknown	18 +		The deposit consisted of a pit, where the burnt material was placed within the base of a flagon	One sample was analysed from this context. The quality of the sample was poor. Grass and insect shells were recovered, which is not uncommon for this cemetery and derives presumably from the soil B

						3		horizon. The charcoal was sparse and small, much measuring <2mm. Similar to other burials from Folly Lane, the identified assemblage was dominated by oak roundwood (91%), with a few fragments of Maloideae (5%) as well as some unidentifiable fragments (4%). Of the 100 fragments examined, 11% displayed vitrification.
Folly Lane	22	Early Roman	Major Urban	Unknown	18 +	0	The burnt bone was placed in the centre of the burial pit with considerable amounts of charcoal mixed in to the grave fill.	One sample was analysed from this context. A sufficient amount of charcoal was recovered, but a fragment of coal and modern grass demonstrate contamination. The latter presumably from the soil B horizon. The fragments were poorly preserved and measured <2mm in size, making identification difficult. 88.5% of the assemblage consisted of young oak roundwood cut at 1 year, while traces of Maloideae (10%) and cherry type (*Prunus sp.*) (1%) were also identified. Of the 104

								fragments of charcoal examined, 35% displayed vitrification.
Folly Lane	24	Early Roman	Major Urban	Unknown	18 +	0	A deposit of cremated bone within the centre of the burial pit mixed in with charcoal.	One sample was analysed from this context. The preservation of the material was adequate, much of it >4mm in size. The majority of the assemblage consisted of oak roundwood (94%), while 3% was identified as Maloideae; only 1 fragment could not be identified. Of the 100 fragments examined, 26% displayed vitrification.
M1 Junction	3040	Late Iron Age	Rural	Unknown	Unknown	0	This feature consisted of dark greyish brown silty clay, 40% of which was charcoal.	One sample was analysed from this context. Based on this account it is unsurprisingly that sufficient amounts of charred wood was recovered from the sample. The material displayed a high level of preservation with fragments measuring <4mm in size. 54.9% of the assemblage comprised oak roundwood cut at 4 years, while 38.2% was identified as maloideae. Traces of holly (*Ilex aquifolium*) roundwood (2.9%) and hazel (*Corylus avellana*) (2.9%)

								roundwood were also identified. Iron staining was found in 1.8% of the oak assemblage, indicative of Fe objects within the deposit. Of the 102 fragments examined, 2% displayed vitrifraction.
M1 Junction	6291	Middle Roman	Rural	Unknown	18 +	2	A deposit consisting of burnt bone with some clay, silt and charcoal.	One sample was analysed from this context. The little charcoal recovered from the sample displayed poor preservation, with fragments measuring >2mm in size. An abundance of grass was also found, indicative of modern contamination presumably from the soil B horizon. 88% of the assemblage was comprised of young oak roundwood, while the remaining 12% was Maloideae. No evidence for vitrification was identified in this sample.
M1 Junction	6292	Middle Roman	Rural	Unknown	18 +	2	A cremation pit consisting of silty clay and charcoal flecks. The urn fill had spilled from the vessel and had become mixed	One sample was analysed from this context. The sample was surprisingly rich with charcoal considering the excavators description, however the fragments were small measuring <2mm in size. Grass

							into the backfill of the grave.	was also found within the flot, believed to be modern taxa presumably from the soil B horizon. 92% of the assemblage (100 fragments in total) was identified as oak roundwood cut at 4 years, while 7% was recorded as Maloideae roundwood. A single fragment of young beech *(Fagus sylvatica)* roundwood cut at 1 year was also found and was not identified in any other burial from this cemetery. No vitrification was identified.
M1 Junction	6295	Middle Roman	Rural	Unknown	18 +	0	The deposit consisted of cremated bone and little pyre material.	One sample was analysed from this context. Little charcoal was found and the sample was heavily contaminated with modern grass presumably from the soil B horizon. The fragments examined were poorly persevered measuring >2mm in size. 97% of the assemblage consisted of oak roundwood cut between 1-3 years, while the remaining 2% was identified as birch (*Betula pubescens*) roundwood cut at 1

								year. Of the 100 fragments examined, 89% displayed vitrification.
M1 Junction	6298	Middle Roman	Rural	Unknown	18 +	0	The feature was an urned cremation burial consisting of silty clay with occasional flecks of charcoal and cremated bone. The urn reportedly toppled over in situ resulting in some of the contents to become mixed into the grave fill.	One sample was analysed from this context. A considerable amount of well-preserved charcoal was recovered from the sample, with fragments measuring <2mm in size. 83% of the assemblage consisted of roundwood oak cut at 1 year, while the remaining 16% was Maloideae cut at 1 year. Of the 101 fragments examined, 84% displayed vitrification.
Spencer Park	410	Early Roman	Rural	Unknown	18 +	0	The deposit consists of the fill of a burial pit comprised of light, dark silty clay with inclusions of pot, bone and tile.	One sample was analysed from this context. The sample itself consisted of a moderate amount of charcoal of varying sizes, ranging from >2mm to <4 mm. A total of six different tree species were identified, which higher than the other burials from this site. 67% of the assemblage was identified as young Maloideae roundwood cut at 1-2 years, while 18% was recorded as young roundwood

								oak. Traces of blackthorn (*Prunus cf spinosa*) (2%) cut at 1 year, hazel twigwood (2%), and alder (*Alnus glutinosa*) (7%) were also present. A single fragment of coal was identified in this sample, indicative of contamination from modern industrial activity. No evidence for vitrification was identified.
Spencer Park	404	Early Roman	Rural	Male	18 +	1	The deposit consisted of a light grey fill with inclusions of pottery and burnt bone.	One sample was analysed from this context. An adequate amount of well-preserved charcoal was recovered, measuring <4mm in size. Half of the assemblage consisted of oak roundwood cut between 1-3 years, while the remaining 49% was identified as Maloideae cut between 1-3 years; 1 fragment could not be identified. No evidence for vitrification was found in this sample.
Spencer Park	409	Early Roman	Rural	Unknown	18 +		The deposit is described as the fill of a burial pit; no further information is provided.	One sample was analysed from this context. The condition of the material was poor and the fragments were markedly small, measuring >2mm in size.

						0		79% of the assemblage was identified as Maloideae roundwood cut at 4 years, and 9% was recorded as hazel twigwood. A pith of an unidentified tree was also found. Of the 33 fragments examined 76% demonstrated vitrification, while 55% was reflective; this is also indicative of very high burning temperatures. Iron staining was found in 15% of the assemblage, indicating the inclusion of Fe objects within the deposit.
Spencer Park	411	Early Roman	Rural	Unknown	18 +	0	No information is provided by the excavator describing the deposit.	One sample was analysed from this context. Charcoal was abundant in this sample and considerably well preserved, ranging from <2mm to >4mm in size. Some fragments did appear to be rounded, suggesting transportation e.g. in water or by rolling, although this may be an artefact of processing. 47% of the assemblage consisted of Maloideae roundwood cut at 3-

								6 years, while 40% was identified as oak roundwood. Traces of cherry type (10%) and alder (3.5%) were also identified. Out of the 167 fragments examined from this sample 8% displayed vitrification, and 1% exhibited iron staining.
Wallington Road	ITB/BC	Undated	Minor Urban	Unknown	Unknown	0	This feature was initially interpreted by excavators as a burial when it was discovered in 1969. It was not until the 1980s during further excavation that it was reinterpreted as a pyre site associated with Wallington Road cemetery.	One sample was analysed from this context. The sample itself consisted of just five large charcoal pieces >4mm handpicked from the spread of pyre debris during excavation. All were identified as oak roundwood cut at 4 years. Four were vitrified.
Wallington Road	38	Early Roman	Minor Urban	Unknown	Unknown	3	This deposit derives from a disturbed burial that was partially truncated.	The sample comprised of a mix of mollusc shell, pottery and very little charcoal that was poorly preserved. The assemblage consisted of just two <2mm charcoal fragments identified as oak roundwood.

								50% of the assemblage were vitrified.
Wallington Road	47	Middle Roman	Minor Urban	Unknown	Unknown	2	A disturbed burial group, where the contents had been scattered and damaged by a mechanical excavator	One sample was analysed from this context. The sample consisted of sand, mollusc shells and very few fragments of poorly preserved charcoal measuring <2mm in size. A total of five oak roundwood fragments were identified. 40% of the 5 fragments examined displayed vitrification.
Wallington Road	93	Early Roman	Minor Urban	Male	18 +	3	An undisturbed burial group within a sub-circular pit, where the urn was placed west of the centre.	One sample was analysed from this context The sample was adequately preserved consisting of a moderate amount of charcoal measuring 2-4mm in size. 87% of the assemblage consisted of young oak roundwood cut at 1-2 years, and 8% was identified as Maloideae. A small quantity of cherry type roundwood was also present. Out of the 100 fragments examined, 11% displayed vitrification.
Wallington Road	118	Early Roman	Minor Urban	Unknown	Unknown		A disturbed burial group, where most of the contents had	One sample was analysed from this context. The sample was comprised of very little

						0	been ploughed away by modern construction work.	charcoal that was poorly preserved and measured >2mm in size. A total of 15 fragments of oak roundwood were identified. Of the entire assemblage, 7% displayed vitrification.
Wallington Road	188	Early Roman	Minor Urban	Female	18 +	1	A undisturbed burial group consisting of several vessels.	One sample was analysed from this context. The sample included very few fragments of charcoal that were poorly preserved and measured >2mm in size. A total of 21 fragments of oak roundwood cut at 1 year were identified. 10% of this assemblage displayed vitrification.

Appendix 10: Data

See disk for catalogue of cemeteries from survey of Britain, catalogue of individual cremation deposits from Hertfordshire, burned bone thin-section micrographs, quantitative petrographic and FTIR-ATR data.