Textile fibre preservation and statistical variation in burials:Clothing evidence in Anglo-Saxon and Roman inhumations

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Abstract

This research challenges the archaeological record in at least three ways. Through the enquiry of thirteen selected case studies, namely four Roman cemeteries and nine Anglo-Saxon cemeteries, it reviews textile remains and grave objects associated with clothing and personal equipment. Firstly, this analysis evaluates the degree of variation between different populations through cultural traits, using for the first time the statistical formula elaborated by Penrose to discern different populations by some biological traits.

Secondly, this research considers cultural and non-cultural factors, which may preserve textile in different forms. Some mechanisms of preservation for textile are already investigated by experimental studies. This subject is affected by its intrinsic incomplete condition, textiles occur less than other materials in the archaeological record. However, the archaeological reports often show a lack of interest that makes this subject even more inconclusive. It seems important that a full understanding of preservative mechanisms of textiles can improve the archaeological reconstructions. This aspect is also linked with the ERC InterArChive project that works for an ideal sampling strategy in burial contexts and for detecting organic remains in soil.

Finally, the research questions the extent of the influence of taphonomic factors in making archaeological inferences based on the analyses of organic materials like textiles. In order to do so, it has taken research data on over 3862 inhumation graves and 3100 grave objects. These data are archived in a digital database, produced for this purpose. In addition, some SEM studies, carried out by the author, are also presented, in order to discuss the mechanisms of organic textile preservation.

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Author's Declaration

I hereby declare that this thesis is a record of the research study carried out in the Department of Archaeology at the University of York during the period from March 2011 to March 2016. The thesis is original in content and all sources are acknowledged as references. The work in this thesis has not been previously submitted for award at this or any other institution.

Chapter 1: Archaeological background. Broad theories and specific models in late Roman and early Anglo-Saxon transition

This chapter outlines death and burial as a subject of archaeological interest. It starts from a broader theoretical perspective of recent approaches and then goes into details of the archaeological context that concern this thesis. It will define the chronological context of the Late Roman and Anglo-Saxon periods. Finally, it explores the main problems and results of studies on Late Roman and Anglo-Saxon cemeteries and funeral customs.

1.1 Who cares about death? A brief overview

Generally, death is not a pleasant topic to discuss, but it is always a fascination for humanity, because it is not possible to explore completely the opposite concept of life. In Western countries, current social behaviour does not give importance to fate or try to avoid this thought during daily activities. Conversely, anyone is aware of the inevitability of death. It is a natural step like birth, growth and senescence, which defines the existence of a living being. Currently, it is known that every type of living being must follow the steps of birth, growth, senescence and death, even if the death may occur at any time during life for different reasons. Incidentally, in the peculiar case of *Turritopsis nutricola*, a type of jellyfish, this animal is able revert its life process from the adult form back to the sexually immature form. This is the only known case of a living being avoiding the fatal step.

Sometimes it can be technically difficult to define precisely when a person is dead. A few centuries ago, when the heart stopped beating, it was considered the end. Today, medical technologies are able to stimulate the activities of heart, lungs and brain to maintain life in a person otherwise viewed as dead. Additionally, organ transplantation may allow survival not only in recipients but also donors in a certain way. Medical progress generates some ethical issues concerning boundaries of death and life.

Death is a significant event. It is undeniable and often we are personally forced to deal with it. Not only are subjective emotions involved, science and religion have confronted the realities of fate and several disciplines have a great involvement in 'death studies'. Therefore, different features of death have been studied and analysed for the most diverse reasons. Firstly, the health sciences and life sciences are interested, mainly on material aspects linked to the corpse, such as the preservation, decay and final disposal. Obviously, medicine has a strong role in this subject; a considerable part of a doctors' work is dedicated to delay our appointment with death. More specifically, pathology and forensic pathology are the branches of medicine, which seek the causes of the final step (Dolinak, Matshes and Lew 2005). Demographic studies have interests in the growth of average life expectancy and the reasons for death, because they want to understand and explain differences and changes (Ouellette and Bourbeau 2011).

Metaphysical explanations about the human end are common. Numerous religions have expressed the existence of afterlife, which provide a sense of hope and an answer about a possible purpose for death (Rosen 2008). Some religious beliefs affirm the presence of the human soul, which is immortal and not corrupted. Consequently, believers are comforted that death is not the final end. Another field, which deals with death, is psychology. Psychologists have analysed the reasons for the denial, suffering, anxiety and fear of death, and they have tried to provide a layman's view and also explanations (Becker 1973). Additionally, social psychology has produced researches to show how the dead may affect a community (Bradbury 1999).

Besides this, the social and historical sciences have considered funeral customs and practices in different cultures and places. For instance, Ariès has discussed changes of attitude towards death in fundamental sociological and historical works (1967; 1976; 1983), beginning with the Middle Ages until last century. The author describes how European and Western cultures have transformed perceptions of death and the dead by the use of various literary examples and historical documents. The study of the French historian is still basic in social studies of Death. However, it is doubted by some critics for the absence of contrasting facts to his theories or not providing other interpretations about the facts he has produced. Particularly, the holistic results of Aries have not been accepted, because of the lack of specificity in the examined contexts (Whaley 1981a). Anthropological contributions to this field are numerous. At the end of the seventies of last century there were complaints about the quantity of anthropological surveys (e.g. Goody 1962; Metcalf and Huntington 1979; Bartel 1982). Anthropologists and ethnologists have produced several remarkable contributions and they have often influenced and been influenced by archaeological studies.

1.2 The recent archaeological background

1.2.1 The processual archaeology approach

A recent publication edited by Tarlow and Nilsson-Stutz (2013) is an updated and essential starting point to discuss the history of the development and principal interests of the "Archaeology of Death and Burial". Here, this review is limited to a few points on the recent and major theoretical developments and I refer to this text for broader and further discussion.

The archaeology of death and burial is a theme with a long tradition of studies (Chapman and Randsborg 1981; Stout 2013; Richard 2013). Over the last 40 years the archaeological debate on interpretations of mortuary practises has become extremely dynamic (Chapman and Randsborg

1981; McHugh 1999; Chapman 2013; Kus 2013). The approaches may be divided into two main streams: the New Archaeology (Binford and Binford 1968; Binford 1972) and Post-processual archaeology (Hodder 1982).

The former studies in funerary contexts have concerned mostly seriation and typologies of artefacts in order to rebuild chronologies (e.g. Petrie 1899; Petrie and Mace 1899), and to understand the social and religious aspects of past cultures (e.g. Childe 1925; 1929 and 1956). At the beginning of the 1970s, processual archaeology tried to find new interpretations about past cultures (Trigger 2006). The New archaeologists were disappointed with the previous archaeological approaches on burials. Binford and Saxe have described alternative approaches to understanding mortuary contexts (Binford 1971; Saxe 1971). Binford study was deliberately small-scale, but it is worth reviewing. He selected a sample of 40 societies to analyse the mortuary practises and understand social information derived from those practises. The burial is influenced by two main social factors: the *social persona* of the dead and the structure and dimensions of the social unit with status obligations to the deceased (Binford 1971). The concept of social persona was formulated by Goodenough (1965), who was extremely influential on the researches of Binford and Saxe. Curiously, Binford and Saxe neglected to consider in their work the possibility of dissimulated social identities (Goodenough 1965), which Goodenough suggested as a likely option in funeral contexts. “People often pretend to social identities for which they are personally qualified, but such pretence is usually regarded as a serious breach of one’s duties to fellow-members of one’s peace group, duties that attach to one’s identity as a member of a human community” (1965, 5).

However, processual archaeology has two main guidelines: developing interpretative methods to explain the archaeological record and to find “laws of cultural change and evolution” (Binford 1970, 25). The studies of Binford (1970) and Saxe (1970; 1971) produced three principal assumptions. Firstly, the organisational level of a society influences the dimensions of the social persona in a burial – e.g. egalitarian societies, which are considered having a simple social structure, make distinctions limited to biological traits like sex and age, while complex and hierarchical societies differentiate more the social positions and social relationships. Secondly, Binford indicated that the level of complexity of a society influences the dimensions of the social persona – e.g. a social persona can acquire more social meanings and roles the more hierarchic is the society where he or she lives. Finally, the form of the funeral ritual is shaped by the dimensions of the social persona symbolized; as a consequence the grave goods are related to status, gender, age and local tradition (Binford 1971). Additionally, Tainter developed Binford’s social modules and showed a correlation between social status and level of energies consumed for the burials (Tainter 1975; 1978).

Hence, the main purpose of processual archaeologists is to look for cross-cultural guidelines in burials, to detect and reconstruct the society with the assumption that burials may be a reliable mirror of correlated living communities. The ethnographic comparisons are relevant. However, the processual approach has revealed apparent deficits. Ethnographic analyses have provided controversial results, the other main social dimensions – horizontal, age and gender – have been inadequately investigated, and poor attention has been paid to the characteristics of ritual and burial and their links with archaeological evidence. Finally, both Binford and Saxe did not take into account the likelihood of numerous attitudes to death in a society, while ethnographic comparisons have often suggested that the same society usually has alternative disposals for the dead (Ucko 1969; Mc Hugh 1999; Parker Pearson 1999). Moreover, models derived from cultural anthropology do not fit well onto interpretations of the archaeological record. For example, recently Peter Rowley-Conwy presented his talk about relations between farmers and hunters-gatherers in Northern Europe during Mesolithic and Neolithic. He restated that anthropological and ethnographic models derived from colonial Europeans are inappropriate comparisons to interpret the archaeological record (York Seminar, York 06-11-2013).

Fahlander (2004) showed some incongruences that are inherent in archaeological approaches derived from anthropological models. These weaknesses can be summarised in the following list:

1. Some current ethnographical models may not be applicable to past situations and societies.
2. Oral sources are not entirely objective and they can be ideologically manipulated.
3. Cultural groups completely isolated do not exist. Human communities are influenced, with different degrees of impact, by other communities.
4. Inferences from analogy are limited and cannot explain subjects like ideologies, social identities and cosmologies.

Furthermore, archaeologists, who use ethnographic models, risk applying modern ideologies to past societies. A convincing advice against this use was suggested by Pader (1982, 30-35), who criticised simplistic transfer from modern perspective to past contexts, because this process tends to ignore and mislead the understanding of material culture and the ideology that relies on it. Deetz (1996), who influenced Pader, proposed a method where material culture combined with historical sources reconstructed the changes in early New England society, demonstrating that modern behavioural patterns are not the best comparison for archaeological subjects.

1.2.2 Post-processual approaches

So-called post-processual archaeology cannot be defined as one of orthodoxy in archaeology, like the processual school is (Shanks 2008), but this term describes all archaeologists that have been critical regarding processual archaeology and have followed different paths. Here, the definition of post-processual does not mean one school of thought or method, but embraces all those archaeologists who do not identify themselves as processual. In the 1980s, post-processual archaeologists, namely Hodder (1982; 1984), Shanks and Tilley (1982), Shennan (1982), Rissman (1988), Taylor (1989) and Barrett (1990), produced a notable quantity of publications, which have changed the point of view in mortuary studies. Burial practices have not been considered as direct and authentic representations of the related living communities.

Post processual studies highlight a number of points. Firstly, in some cases burials may be extremely symbolised, consequently rank disparities could be hidden and the society may seem more egalitarian than it actually is. For instance, Lodagaa, in western Africa, buried all their dead with rich clothing as they appear in a chief or high class individual (Goody 1962). In other cases emphasis or exaggeration of rank differences may occur in funeral practises. For example, in Madagascar, Merina people use the mortuary rituals to emphasise in death three ancient classes of social structure that currently are not as substantial as they were in the past (Parker Pearson 1999, 138-139). Thirdly, it is debatable whether the importance of burials detects rank information. In fact, some communities may use other social factors to show rank or burial may not have the same importance for all the groups of persons within a society. The first case is clear in Muslim burial tradition, which prescribes a strict funeral code and all dead are buried similarly irrespective of social status in life (Green and Green 2006, 277-278). The second circumstance is reflected in numerous contexts, as in Greece between Protogeometric and Late Geometric I (1050-735 BC) where there was not the correct proportion of dead and the young are underrepresented. It was suggested that their burials were not archaeologically perceptible (Morris 1989, 302), but still society showed that a significant part of the population was not be represented in death.

These cases are a small example of how burials may be influenced by social, political, economic, ethnic and religious choices and they may not be a precise representation of society of the living (Parker Pearson 1982). Finally, the role of religious and philosophical beliefs were reconsidered as a central and determinant matter of mortuary studies in archaeology (Carr 1995), because they were obscured in Saxe and Binford's research.

The post processual approach is mainly intended to provide "ideological interpretations" (McHugh 1999). As well as processual studies, these types of analysis present various limitations. Primarily, the archaeological evidence may have problems in distinguishing what is an ideological representation from other processes. Then, the use of burial data to categorize several societies might be problematic. Thirdly, ideological interpretations may be distorted not only by rank but also by other burial dimensions, such as gender or age. Eventually, it needs to take into account the possibility that a burial could either reliably represent a society or not (Mc Hugh 1999).

1.2.3 Archaeologists and ethnographical studies

The contribution of ethnographic studies has changed in value, but it has been a strong influence in the field of the archaeology of death. Ucko (1969) has written a fundamental and seminal article where a wide range of ethnographic examples were provided to show the huge variability in burial customs and practices that an archaeologist should take into account when interpreting funeral remains.

Although, Ucko advised the use of ethnographic cases just to expand the knowledge of probabilities, the new archaeologists Binford (1971), Saxe (1971) and Tainter (1975; 1978) have broadly used ethnographic data to support their hypothesis and detect cross-cultural constancies and generalizations. Incidentally, Binford dealt with the mortuary practises based on ethnographic literary sources without any direct study of archaeological contexts; while Saxe tackled this subject both on theoretical and ethnographic aspects (1970), and also archaeological contexts (1971). However, this approach is limited by the availability in the ethnographic record of all the practises related to death, which might be used in past societies. Saxe (1970, 1) stated that his method "is functional in the sense that it involves a search for regularities in the way the elements of a sociocultural system interact with each other", so mortuary practises were investigated as a part of an integrated system. Moreover, his study was "cross-culturally comparative because we would like to know if there are regularities in these functional relations which are not idiosyncratic to one system". He was therefore examining correspondences in the processes of mortuary practises and not as a formal attribute of those practises, because they are specific to each system. Consequently, the processual theories have tested all mortuary customs instead of the basic burial information (Mc Hugh 1999).

The following reaction of post-processual archaeologists has developed ethnoarchaeological studies, which may overcome the limits of traditional ethnographic description and analyse past societies from the point of view of archaeologists (e.g. Hodder 1982a, 1984; Parker Pearson 1982; 1999). Both processual and post-processual schools have shown a constant concern regarding ethnographic analogies and their caution is worthwhile for further researches. Interestingly, the direct approach on ethnographic contexts by archaeologists was started by processualists (Binford 1978), but it was also applied by post-processualists in order to critique nomothetic methods, which aim to find general laws for burials, and proposed investigations addressed to specific contexts (Hodder 1982a; 1984; Parker Pearson 1982; Pader 1982).

Although, archaeologists have always considered studies on burials and related topics, recent research has furnished innovative archaeological views on mortuary practises. Both processual and post-processual approaches, even if they have a different point of view, have highlighted the importance of so-called mortuary dimensions, which are vertical, horizontal, age and gender (Mc Hugh 1999).

1.2.4 Mortuary studies beyond the processual and post-processual framework

Another interesting theoretical approach, which comes outside of the processual/post-processual dualism, is provided by the so-called “microarchaeology”. It was developed by Swedish archaeologists Per Cornell and Fredrick Fahlander of the University of Goteborg. The name microarchaeology does not imply an archaeological investigation by the use of microscopes. In fact, this name stresses the importance of studying the archaeological context starting from the minute evidence that often is neglected by big archaeological narratives (Fahlander 2013). Fahlander presented the theoretical framework of microarchaeology in his PhD thesis (2003) and the application of this approach investigating burials in the Asea Valley, Greece. Microarchaeology revitalises the study of contexts, starting from small evidence and information that is usually neglected by the big narratives. Fahlander (2013) compared wittily this approach to that of Sherlock Holmes, who starting from a series of accurate investigations on details, always reconstructed the entire scene and found the person guilty of the case. Microarchaeology proposes an examination that emphasises all small finds, rather than starting from big theoretical concepts.

Taking into consideration Chapman’s suggestions, I will analyse funeral material evidence, which is of social significance, examining how material aspects can influence social evaluations. In a way, I may partially consider this as microarchaeological research, because small evidence of clothing and personal equipment is investigated to produce a bigger picture. Moreover, this research is more oriented to understanding the impact of fragmentary and perishable materials, like textiles, in archaeological interpretations that deal with broader social investigations, like variation across populations.

1.3 Late Antiquity in Britain: an outline

Traditionally, the studies of late Roman and Anglo-Saxon cemeteries are tightly linked with the wider context of Late Antiquity. This happened because in the archaeological record cemeteries have provided the most evident range of data and the discrepancy showed by the cemeteries of these two cultures is so marked that it rightly claims a predominant position in archaeological studies of British Late Antiquity.

The term Late Antiquity defines at the best the period of transition when the Western Roman Empire collapsed and its inheritance was acquired in different models by the rising of Barbarian kingdoms in Western Europe and by Byzantium in Eastern Mediterranean regions. This matter is not easy to deal with. There are intrinsic limits, which originate in the extent and variety of topics, including socio-economic evolution, political adaptations, religious beliefs, changes in technology and trades and new cultural trends. Moreover, extrinsic restraints rely on different academic backgrounds, which often cannot communicate directly (Whickam 2003, 385-386; Wendy 2009).

Generally, the framework of late cultural evolution has been depicted by three mai n paradigms. The first is about violent Germanic invasions, which occupied Roman provinces and started new kingdoms (Gibbon 1981). The second model highlights the continuity between the Roman Empire and the new regional states (Dopsch 1937). Pirenne (1925; 1939) offered a third interpretation, better known as the "Pirenne thesis". He identified the Arabian invasion during the 7th century as causing the actual breakdown in the Roman world. The matter is extremely complicated and it is not easy to produce original models to explain changes in Late Antiquity.

Whickam (2003, 385-386) strongly criticized the absence of new perspectives and interpretations despite the progress in archaeological researches since the 1970's. We may agree with his point of view and state that numerous researches try to set their results in those three paradigms, or better in the invasions and continuity theories, while the Pirenne thesis has weak influences in the current archaeological agenda (Hodges and Whitehouse 1983). Wickham himself proposed four basic factors or "parameters" to evaluate European and Mediterranean late antique changes: war, state economic infrastructures, land ownership and private wealth and structural integration into the Roman World-system (Whickam 2003). He applied these parameters to three case studies, Tunisia, Italy and Northern Gaul, from the 5th to the 8th century AD. The result was that it is not possible to create a unique pattern to define social, economic and cultural development of different regions.

Another important contribution to delineate Late Antiquity is the broad scheme proposed by Randsborg (1991; 1992) who sets European and Mediterranean Late Antiquity in the concept of "centre and periphery", where the movement of economic and political interests to the eastern provinces of the Roman Empire were followed by a crisis in the western regions. More in detail, archaeology reveals specific restrictions, mostly linked to the status of the archaeological record (Whickam 2003). Considering, the undisputable poverty of Western regions during Late Antiquity in the archaeological record, compared with the monuments and artefacts of the earlier stages and compared with the contemporaneous evidence from Eastern Mediterranean regions, clear evidence is provided of the growing crisis occurring and the eventual transformation.

1.4 Late Roman inhumations in Britain framework

This section introduces the main aspects of Roman cemeteries and inhumations in Britain and it explains the criteria under which the Roman sites were selected for the purposes of this research. In the past studies and excavations of Roman cemeteries in Britain were disregarded apart from few exceptions (Toynbee, 1971; Thomas 1981, 229). Recently, an increasing interest on Roman cemeteries and burial practises has been supported by numerous excavations published in exhaustive reports, like Eastern cemetery of London (Barber and Bowsher 2000), Lankhills (Booth *et al.* 2010), Alington Avenue (Davies *et al.* 2002), Cannington (Rahtz *et al.* 2000), Cirencester (McWhirr *et al.* 1992) and Poundbury (Farwell and Molleson 1993), surveys (Philpott 1991; Cooke, 1998; Hatton 1999) and scientific research, like molecular analysis (Brettell *et al.* 2013).

There were different funeral rituals in use during Late Roman are inhumation, cremation and embalmment. In Britain, cremation was the main ritual during the 1st and the first half of 2nd century AD. After a period of transition, inhumation substituted entirely cremation during the 3rd and 4th century AD (Pearce 2000; 2014). This research is focused on ordinary inhumation ritual for some reasons. Firstly, inhumation was the predominant Roman funeral ritual by 3rd and 4th century AD. This creates a direct chronological link with Anglo-Saxon inhumations, which are subject of the present study (ch. 1.5). Secondly, inhumation provides an ideal environment to understand the mechanisms of textile preservation while not affected by fire. For this study, a regular inhumation is defined as excavated burial either with or without coffin or other forms of covering, which contained human remains associated or not with grave goods (Cooke 1998, 20). The inhumations are part of a cemetery of urban or rural sites and they are not isolated.

This study does not include unusual type of Roman burials during the 3rd and 4th century, like cremations, because this ritual could affect textile evidence, leaving no traces or carbonizing the textile remains (Cooke 1998, 18-19).

Late Roman and the change to Anglo-Saxon cemeteries are biased in some regards. As follow, the main issues are presented. The chronological uncertainty generated difficulties in the researches (Millett 1995, 133). Late Roman and Anglo-Saxon burials are evidently distinct from each other (Williams 1999, 103), but their timescale has not been sufficiently periodised (Millett 1995; Williams 1999; Dickinson 2011). Although different dating methodologies have been applied, the bulk of chronology is still based on typology of artefact classes (Philpott 1991; Lucy 1998; Cooke 1998; Scull, and Bayliss 1999; Stoodley 1999; Leahy 2007; Carver *et al.* 2009). The chronological inaccuracy affects interpretations about identity of these burials (Shephard 1979; Williams 1999).

Another challenging subject is the representation of religious beliefs in Late Roman cemeteries. It is complex to identify first phases of Christianity in Britain, while it seems likely that from the second half of AD 2nd century Christian influence from Gaul reached Britain (Watts 1998, 11-12). Christian burials are often described as uniform, in order to follow religious rules (Thomas 1981, 228-239), while this statement did not explain numerous exceptions that have been found in the field. It has been argued by Petts (1998, 123), and I agree with him, that behaviour of dealing with death is not shaped by the beliefs but by the practice. This may explain better varieties within the context of Late Roman burials.

The relation between pagans and Christians is also problematic. Both Romans and Anglo Saxons were pagans at the beginning and gradually became Christians. However, there was not a sharp difference. In fact, the paganism included different beliefs for Romans and Anglo-Saxons and Early Christianity was multi-faceted with several doctrines and cults (Clarke 1975; Thomas 1981; Henig 1984; Watts 1991 and 1998; Lucy 2000; Meaney 2003; Sparey-Green 2003; Johnson 2009). For instance, there is a popular bias about the shift from paganism to Christianity at the end of the Empire (Watts 1998, 64). It is believed that Christians annihilated all traces of pagan traditions in the 4th century AD. Conversely, it has been explained that the change from pagan religions to Christianity was inconsistent and reversible (Watts 1998, 134-135) and archaeological studies revealed a religious outline more structured (Philpott 1991; Sparey-Green 2003). For example, the ritual switch from cremation to inhumation has been argued to be not based on the rise of eastern religions, like Christianity. Conversely, that change was linked to more structured links between the centre of the Empire, Rome and the emperor, and the peripheries, like Britain (Morris 1992, 52-69).

Regional and ethnic differences in burial customs in Britain are still unclear not easy to distinguish (Ward-Perkins 2000). Some ritual aspects may appear still blurred, the use of stable isotope analyses in same Late Roman cemeteries provided a solid contribution in defining migratory routes mirrored in burials. Samples of the populations of Wasperton (Warwickshire) (Montgomery *et al.* 2009) and Lankhills (Winchester, Hampshire) (Evans *et al.* 2006; Edckart *et al.* 2009) were analysed and the results showed a portion of non-local people from the Mediterranean area in the first cemetery and from Central Europe in the second. These outcomes obviously suggest the continuity in human movement from the Mainland to Britain, but they do not explain the reasons and the effects of migration.

Hence, it is valuable to examine ethnic, political, economic, regional and religious aspects that might superimpose or combine with each other, so they make their interpretation more complex. Moreover, funeral customs change according to all those factors, but they are not always archaeologically identifiable. For instance, it has been suggested that Iron Age tradition can have new life or can again become visible in the archaeological record after a period of invisibility (Carver 2008; Maldonado 2011, 257-260). This statement may be applied also to burial tradition. For example, a particular concentration of Anglian crouched burials in Eastern Yorkshire has been interpreted as a return of Iron Age funerary practice (Higham 1992, 184), but this interpretation is debatable because Lucy (2000) stated that Anglian crouched burials were more likely functional rather than recall Iron Age custom (Whimster 1981, 78; Lucy 1998, 64), as they reappeared during the first centuries of Anglo-Saxon migration.

All the previous issues make clear that changes in burial rituals are connected to changes in society, and vice versa studying the burials we can have a better understanding of their society. For instance, the process of “Romanization” helps to understand the British cultural evolution. Romans encouraged the emergence of new cities and the process of urbanisation especi ally in the South and East of Britain (Jones 2004). This process was managed more by natives rather than Roman soldiers, who were more occupied in conquering and controlling the territory (Niblett 2004). Architectural features and position of native settlements close to the new cities support this historical reconstruction (Millett 1990, 62-63). In the North and West regions of Britain, a different process of urbanization occurred. When army camps ceased their military functions, some of them were transformed by local populations into settlements or cities. All of these changes are reflected in the funerary practises, by the creation of urban and rural cemeteries and the change of ritual from cremation to inhumation (Hatton 1999).

Considering all limitations reported above, some criteria are considered to select the Roman cemeteries included in this research. All sites are selected according to the method of excavation, which is extensive investigation. The sites are published in detailed archaeological reports, which contain relevant information. The chronology of the Roman sites is usually included the 3rd and 4th century AD. The sites are geographically distributed in Southern England. The cemeteries are Lankhills (Clarke 1979; Booth *et al.* 2010), the Eastern cemetery of London (Barber and Bowsher 2000), Poundbury (Farwell and Molleson 1993) and Alington Avenue (Davies *et al.* 2002). More details about the sites are provided in Appendix I.

1.5 Early and middle Anglo-Saxon inhumation framework

This section surveys intrinsic issues of early Anglo-Saxon burials from the 5th to the 7th century AD and it explains the criteria under which the Anglo-Saxon cemeteries were selected for this study. In contrast with the studies of Roman cemeteries, the Anglo-Saxon burials have a well-established tradition in archaeology.

The recent publication of "The Oxford handbook of Anglo-Saxon Archaeology" (Hamerow, Hinton and Crawford 2011) has shown the great progress that has been accomplished in different fields, and burials are still a central focus in these studies, namely for the earlier phases, because they still are the most significant containers of archaeological data. Hills (1979; 2003) has summarised how the study of Anglo-Saxon cemeteries can be multifaceted.

Traditionally, the study of Anglo-Saxon cemeteries supported two contrasting and extreme historical reconstructions. During the nineteenth century, Freeman (1887) advanced the theory of a violent and mass Germanic invasion of Britain, which did not give any chance of survival for native people. The migration theory is the oldest one and it still has followers (e.g. Collingwood 1930; Collingwood and Myres 1936; Leeds 1936; Hills 1979; Bassett 1989; Arnold 1997) with two main explanations. Germanic invaders occupied Britain after they had served as mercenaries under Britonic lords. Anglo-Saxons might have committed genocide of native peoples and replaced them in Britain or enslaved them. Such dramatic events may leave traces in both biological and cultural changes (Scull 1993).

Conversely, during the 1960s, another perspective of the events became popular. It was proposed a small scale Anglo-Saxon migration (Chadwick in Lewis 1963) that left almost unchanged the native population. Other scholars interpret archaeological data diversely (Hills 1979, 2003; Hamerow 1994). There was, for instance, not a Germanic wave, but elite groups, likely a warrior aristocracy, which moved into Britain, offering new options to the locals. Consequently, Roman Britain did become Anglo-Saxon not because of a massive immigration of new people, but because the indigenous people changed their costumes for convenience. This event happened in East and South England, while the western groups evolved differently. Others (Hodges 1989a) proposed complete adoption of traditions, which recall a Germanic ancestry, without a real change in population.

However, different approaches developed the framework of early Anglo-Saxon period beyond the polar debate of migration versus local evolution (Pader 1982; Parker Pearson, Van De Noort and Woolf 1993; Arnold 1997; Lucy 1997; 1998; Stoodley 1999; 2000; Carver 2010; Williams 2010; Hamerow 2012). The recent contributions of this topic are discussed below, including prosopography, linguistics, anthropological and genetic researches and archaeology.

Hills (2003) argues that medieval historical sources that refer to Anglo-Saxon migrations and their establishment, could be considered literal for two main reasons. The literary sources, such as Gildas

De Excidio et Conquestu Britanniae, Nennius, *Historia Brittonum*, Geoffrey of Monmouth, *Historia Regum Britanniae*, Bede *Historia ecclesiastica gentis Anglorum*, *Domesday Book*, were political accounts rather than objective reports. The authors were interested in promoting ideals or defending a cause, they did not intend to provide an accurate account of historical events and to represent fairly the low classes of the population (Hills 2003, 21-40). Thus, we may assume that changes in funeral customs and traditions were linked to political and social developments portrayed in the written documents but these events are difficult to identify in details by the only literary evidence.

Linguistics apparently offers strong arguments on the Anglo-Saxon invasion of southern and eastern Britain since the fall of the Western Roman Empire. Undoubtedly, modern English is a Germanic language. Conversely, this result cannot be considered a conclusive proof, which demonstrates when and how British people started to speak English. Linguistics like archaeology has some limits. Major difficulties lie in identifying the geographical distribution of languages and dialects, and in analysing their differences related to gender, age, status and culture (Hogg 2006, 352). Additionally, the written sources of the early period are limited and they do not offer information about Celtic dialects, which are witnessed only by toponyms (Gelling 1993). However, the principal argument of linguistics is extremely convincing. In fact, it is the affinity between Frisian and English (Hogg 2006, 6). Frisian is a German dialect spoken in the Dutch region Friesland and in the German region Schleswig-Holstein, which are two historical regions that Anglo-Saxon migrants left to move towards Britain. Moreover, Old English and Old Frisian have a common language ancestor called Anglo-Frisian (Hogg 2006, 5 fig. 1.3 and 6 fig. 1.4).

Studies on biological traits including bones and genetics may appear even more decisive. Analyses on ancient DNA are limited by the rapid degradation of DNA in human tissues after death. Moreover, modern DNA (Mulligan 2006) can easily contaminate the results on ancient DNA. Anglo-Saxon inhumations are often placed in sandy and free draining soils, which affect the DNA in bones. Hills (2003, 66) was sceptical that DNA analyses are suitable to find genetic differences between Britons and Anglo-Saxons. However, studies of Y-chromosome proved the value of genetic researches in this subject (Weale *et al.* 2002; Thomas *et al.* 2006). In fact, the research of Thomas (Thomas *et al.* 2006) demonstrated that elite of Continental migrants moved to Britain. The newcomers had social and economic privileges that within a time of fifteen generations made their DNA dominant in the most of England (Thomas *et al.* 2653-2654). Discussing recent developments in ancient DNA examinations of Anglo-Saxon human remains, Härke (2011) remarked a combination of traditional archaeological methods, stable isotopes and Y-chromosome DNA analyses, provided more positive results to describe in more detail the passage from Romano-British to Anglo-Saxon populations.

Anthropological measurements on skulls revealed more similarities between Romans and Saxons, while major bone changes occurred between Anglo-Saxon and medieval groups (Brothwell and Krzanowski 1974). Studies on the population of Cannington cemetery corroborated that there are no visible differences between Roman and Anglo-Saxon skeletal remains (Brothwell and Powers 2000 in Rahtz, Hirst and Wright 2000). However, bone measurements do not rely only on ethnicity, but also on diet and pathology.

Archaeology does offer methods and techniques to outline, discuss and define this subject. Evidence of material culture can be analysed and interpreted in order to understand the degree of variation in past populations and their practical and social outcomes. As Parker Pearson wrote "It must be stressed that material culture is not a somehow 'objective' record of what is actually done as opposed to what is thought or believed… it does embody concepts but in a tacit and non-discursive way, unlike writing or speech" (Parker Pearson 1982, 100). Hence, archaeology can actually record, examine actual objects from the past, but it also has a duty to interpret those materials. Moreover, it has been suggested that ethnic identities are a construct based on "birth, language, culture and location" and may be intentionally changed (Hines 1994, 49-50).

Some archaeological studies have contributed to the new readings of Anglo-Saxon burials. For example, Härke demonstrated that there is a significant correlation between weapon burial and wealth and stature (Härke 1990). In some cemeteries, like Finglesham, Kent, and Berinsfield, Oxfordshire, weapon burials were also determined by bloodline (Härke 1990, 41-42).

Another important advance is the gender role in Anglo-Saxon cemeteries (Lucy 1998; Stoodley 1999; 2000). The association of skeletal data and grave goods differences between the two genders, which were strongly linked to the biological sexes (Stoodley 1999). Grave goods embodied identities of men and women in the Anglo-Saxon society (Stoodley 1999), but some ambiguities occurred in female burials containing masculine grave objects and vice versa male graves accompanied with feminine objects (Lucy 1997). The threshold for adulthood was between late adolescence and the early twenties; a period that does not show marked biological changes. However, it appeared that women were more influenced by ageing in their funeral accompaniments than men (Stoodley 2000).

Below, there are the parameters for the Anglo-Saxon cemeteries presented in this research. The criteria are consistent to those applied for the Roman cemeteries (ch. 1.4), but they differ in chronology and regional distribution. All sites were excavated extensively. The sites are published in exhaustive reports, which contain relevant data. The chronology of the Anglo-Saxon sites ranges from the 5th to the 7th century AD. The sites are geographically distributed in Southern, Middle and Northern England. The cemeteries are West Heslerton (Haugton and Powlesland 1999 and 1999a), Norton-on-Tees (Vyner 1984; Sherlock and Welch 1992); Butler's Field (Boyle *et al.* 1998; Boyle *et al.* 2011); Empingham II (Timby 1996); Spong Hill (Hills 1977); Alton (Evison 1988); Beckford A and B (Evison 1996) and Sewerby (Hirst 1985).). More details about the Anglo-Saxon sites are provided in Appendix I.

1.6 Textiles and clothing in Roman and Anglo-Saxon inhumations. Background

Textiles and clothing are clearly important for a discipline that is interested in the past. Archaeology has developed in recent decades a specific field of ancient textiles, in order to better understand the limits and possibilities of these materials. Studies of ancient texts and iconographies are undoubtedly a further rich source of information. In antiquity, statues and portraits usually represented high-ranking people. Moreover, these sources are not always in a good state of preservation. Literary sources on textiles have also been revealed as not straightforward, because of technical terminology that may be not correctly interpreted (Michel and Nosch 2010).

Archaeology can add a substantial contribution to the study of ancient textiles and in the last few decades, it became a field of specialization within archaeological research. Textiles have a perishable nature and they have fewer occurrences in the archaeological record in comparison with pottery, metalwork or lithics. However, even if limited in quantity their informative value is considerable. Ancient textiles reveal information about the sources exploited to obtain the fibres -this is linked with zooarchaeology and paleobotany - then all the technological processes, from the selection of the fibres to the final product provide technical and economic information. Finally, the product itself informs about the society (Good 2001; Andersson Strand *et al.* 2010; Gleba 2011). For example, clothing can reveal differences between rich and poor people and also if the production of clothing was on a large scale or a more limited scale.

These general basics about textiles in archaeology are valid for the study of funeral clothing, which is the main aim of this research. Clothing is valuable archaeological evidence that helps our funerary understanding and develops knowledge of funeral practises and what mortuary traditions may reflect of the living. This field does require specialists who are able to deal with two major subjects. Firstly, the material aspects of textiles need knowledge of all processes of textile production from the growth of natural fibres to the technological operations that lead to clothing and garments.

Secondly, costumes bring explicit and implicit social messages, which involve an expertise dedicated to decode apparent and elusive meanings in costumes. Walton-Rogers complained that often these two fields are still disjointed and the specialists often do not communicate enough (Walton-Rogers 2007, 1).

The understanding of funeral clothing is obviously challenged by the natural breakdown of fibres, which will be presented extensively in chapter 2, but burials are the best archaeological contexts to find textile evidence. In fact, numerous reconstructions of ancient costumes are still based on textile finds and associated fasteners, which come directly from burials – with the contribution also from secondary sources, like iconographies and ethnographic comparisons. However, the latter documents do not offer the same quality in data that archaeological textile finds provide.

The field of textile specialists in archaeology has increased only in the last few decades. This is reflected also in the archaeological literature. In the past, excavation reports dedicated only limited space to textile analyses. Numerous archaeological reports surveyed for this research often confined textile finds and clothing evidence to a few descriptive comments and brief discussion on broader contexts. Conservators in numerous excavation reports have made valuable contributions, where they write the textile section.

However, since the community of specialists has increased, the improvements in this sector have been visible. These developments are extremely beneficial for understanding the passage from Britain ruled by Rome to England dominated by Anglo-Saxons. For example, Hines (1994; 1996) indicated the importance of clothing in the creation of local identities in Anglo-Saxon communities.

Improvements in the studies of clothing are visible in some recent research projects (e.g. Coatsworth and Owen-Crocker 2007; Owen-Crocker 1986, 2004; Walton-Rogers 2007; Carroll and Wild 2012). Some research projects have been accessible by their database online, like “The lexis of cloth and clothing in Britain c. 700-1450: origins, identification, contexts and change” of the University of Manchester (2012) and the digital archive related to the work of Penelope Walton-Rogers (2007a).

Before the twentieth century, textiles were only erratically reported (Coatsworth and Owen-Crocker 2007, 1). The pioneering work of Grace M. Crowfoot from the 1950’s was the solid base for textiles and clothing in archaeology. She brought her experience developed in Egyptian and Near Eastern contexts (1934; 1951; Crowfoot and Davies 1941) to British and Anglo-Saxon sites (1951a; 1953).

Elizabeth Crowfoot, daughter of Grace Mary, followed the path initiated by her mother and she specialised mostly in Anglo-Saxon textile finds, her numerous published and unpublished works can testify to the huge mass of researches carried out from the end of the fifties until the present

(Coatsworth and Owen-Crocker 2007, 66-77). During the last decades, the community of textile and clothing specialists has grown in number and skills. These scholars have explored Roman and Anglo-Saxon costumes in Britain. Their expertise has painted a valuable picture of ancient British clothing based on archaeological records, which improved in time due to the number of excavations and the development of field and post-field recovery techniques. Fundamental contributions can be found in the works of Elizabeth Crowfoot (Crowfoot *et al.* 2001) and Peter Wild (2012), who have built a framework about textile finds in archaeological excavations, the first author on the Middle Ages and the latter mainly on the Romans. Further improvements have been provided by the researches of Gale Owen-Crocker (1986; 2004; 2011) and Penelope Walton-Rogers (2007). The latter scholars have contributed enormously to the stitching together of sparse evidence from the field, collections, literary sources and art and they have put textiles and clothing in the context of Anglo-Saxon archaeology. Currently, Anglo-Saxon clothing is well investigated and linked with the broader context of early Middle Ages studies. This success was due mostly to the dedication of specialists that have been referred to above and because of the Anglo-Saxon burial ritual of inhumation. In fact, the main evidence of Anglo-Saxon costumes comes from burials rich in metal fasteners, which often started processes of metal replacement that support fibre preservation. Mineralisation is not the only factor of fibre preservation, but it is the principal one that preserves visible textile evidence. More details on fibre preservation will be presented in chapter 2. The studies of Anglo-Saxon clothing outlined diachronic evolution and synchronic variations in England from the early to the late phases (Walton-Rogers 2007).

Briefly, the study of Walton-Rogers (2007), mostly based on textile finds from burials, showed that Anglo-Saxon clothing had some regional variations and chronological development, which fits with the broader archaeological contexts of Anglo-Saxon studies. She admitted (2007, 58) that her study was more effective in following adult female costumes rather than men and children. This is because women were better represented in burials. It is possible to identify four regions distinguished by the distribution of women's dress accessories. These regions correspond approximately to the Anglian area, the Saxon area, to an area in between Anglian and Saxon mixed artefacts and Kent and the Isle of Wight (2007, 107-110, fig. 3.37). However, these boundaries in costumes are not strict and some mixed costumes or "exotics" might be found. Minor archaeological representation of male costume depends on less numerous metal fasteners and other accessories, while men of a certain class were accompanied by weapons or other tools (Härke 1990).

This condition of low representation of clothing is common in several archaeological contexts, and it may depend on both cultural and taphonomic causes. A good cultural example is provided by Celtic regions, which have not provided the same amount of clothing evidence, both textiles and leather, than has been recovered in Anglo-Saxon regions in the British Isles (Laing 2006, 144-146). In this case, it may be suggested that Celtic-Britons followed previous funerary traditions, like Romano-British traditions, and they did not furnish burials with metal fasteners and other grave goods. In the case of Anglo-Saxon male inhumations, the inequality between men and women may be interpreted as an actual disproportion between variable female garments and uniformity of male dress.

Roman funeral clothing and more general clothing is less detailed than that of the Anglo-Saxon. Wild's publications (1970; 1970a; 1976; 1988; 2004; 2012) are the main contributions in the general field of Roman textiles, but still Roman funeral clothing cannot be reconstructed accurately like the Anglo-Saxon. There are principally two causes that affect our knowledge of Roman textiles and clothing. Firstly, burial rituals were not suitable for organic preservation. Secondly, specialists in Roman archaeology showed limited interest in textiles and clothing found in burials (Wild 2012, 17). Some good attempts at the investigation and reconstruction of Roman clothing have been done. For example, a multidisciplinary approach has been applied with good results in order to reconstruct Roman fashion clothing (Sebesta and Bonfante 1994), but some biases make those reconstructions not entirely useful for the purposes of this research. For instance, literary sources are extremely limited in time, most of them dated to 1st century AD and they mostly described the funeral of high status people or a part of the population not representing the common people. This excludes the majority of the population of an Empire that covered an area from the Atlantic to the Sahara. The artistic representations, namely statues, mosaics and more rarely paintings, are similarly not representative of all the population and frequently did not depict real costumes but mythic or fabulous clothing (Croom 2000, 13-17). However, the Romano-British clothing for living people was moderately similar to that used in Gaul (Croom 2000, 136): men wore trousers, tunic and a cloak and women dressed with a tube-dress fastened with brooches. From the 2nd century AD, women regularly included a cloak in their costume. Variation in regional costumes of Roman Britain cannot be easily examined further except by ancient texts and artistic representations. It seems interesting to explore this subject further by other means, like a statistical evaluation (ch. 3.6, 3.8).

Clothing belongs to a category of extremely degradable artefacts, which leave few organic traces in the archaeological record. If in the past the attention on textiles was limited, especially in those regions where organic preservation is poor, this subject has received new developments with the introduction of more scientific approaches. The main authority in this field is Robert Janaway (1983; 1985; 2002; 2008), who has explored fibre textiles using both archaeological and experimental methods. His researches are of considerable interest in the present work especially for the taphonomic aspects and the degradation of textiles, which will be broadly discussed in chapter 2.

Although the literature on clothing and textiles in Roman and Anglo-Saxon contexts appear to be improving in terms of records, analyses and interpretations, there is space for some improvement if we think about the fragmentary state of clothing in archaeology. Can social interpretations be linked to the fragmentary conditions of textiles? Or to what extent can taphonomy influence archaeological inference on cultural reconstruction? This research will operate on both sides, cultural analyses and taphonomic examinations in order to evaluate funeral clothing.

1.7 Conclusions

This research is developed in the context of funerary archaeology and investigates the extent of taphonomic influences on the organic archaeological record. Starting from material traces of funeral clothing (Chapman 2005; Cornell and Fahlander 2002; Fahlander 2003), considers fragmented conditions and how this fragmentation was produced. I will then deal with textile remains and personal costume assemblages and degree of preserved material and likely causes of loss of information of these organic artefacts. The study will then revise the survival of textile fibres in different contexts (ch. 2). Then the methods of analysis are presented and applied (ch. 3). The results of analyses will evaluate the changes in burial practises of Anglo-Saxon and Roman cemeteries (ch. 4). Late Roman and early Anglo-Saxon cemeteries of ordinary folk in England, covering roughly a chronological range between the late 4th and the 7th century AD are the case studies under examination. These objects of research will be analysed in two aspects. Firstly, textile fibre preservation in different type of soils will be examined. Then macroscopic evidence of textile and microscopic and elemental analyses related to the InterArChive project (University of York 2012), will be considered. Additionally, it will underline the key factors, which facilitate textile preservation.

As a second important component of the research, cemetery populations will be tested by the application of the Principal Component Analysis (ch. 3.6) and Penrose formula (ch. 3.7, 3.8), in order to highlight the differences between cemeteries, as well as between sex and age groups by selected artefacts found in graves. The applied formula is fast and easy to use and can provide new views on disposal of the dead. The results are extremely interesting in showing patterns of continuity and change during the historical passage from Late Roman Britain to Anglo-Saxon England. The intention is to review critically the concept of identity expressed by funeral assemblages and to understand where preserved clothing evidence was due to special taphonomic conditions, cultural choices or a combination of both.

Common inhumation burials are selected as case studies, this choice allows the exclusion of cremation and embalmment burials. Moreover, statistical analysis considers the evolution of funeral costume for common populations.

Major limits have been highlighted by this chapter. A part of the shortcomings stands on the chronological framework of Late Antiquity. Another problem was linked to the absence of balance in funeral studies and textile studies between Anglo-Saxon and Roman finds. Finally, the same data sets provided polar interpretative theories on the identities of people buried in those inhumations. This study aims to contribute seeking possible patterns by the analysis clothing assemblages in burials.

The following chapter has two purposes. Firstly, it drafts a description of elements that play a role in textile preservation and the physical characteristics of principal textile fibres in Antiquity, providing some paradigmatic examples of their preservation in archaeological contexts. Secondly, it contributes to outlining the background of Late Roman and Anglo Saxon clothing.

Chapter 2: Textile fibres and leather, diagenesis and preservation

2.1 Introduction

Natural textile fibres and leather were the main component of Anglo-Saxon and Roman clothing (Wild 1970, 4-21; Croom 2000, 20-21; Walton-Rogers 2007, 14-15). These materials are of archaeological interest (Hodges 1989, 123-152). Unfortunately, because of their organic nature, they are subject to more intense degradation and deterioration (Cronyn 1990, 240-24; Fedorak 2005, 1) and they tend to be ephemeral for the archaeological record (Wild 1988, 7-12). Conversely, other objects related with clothing, like metal fastening, are more durable (Cronyn 1990, 160-161) and better represented in the dataset.

The degradation of textiles, like all natural materials, depends on intrinsic and environmental factors (Cronyn 1990, 14; Brown and Brown 2011, 115-116). Both agents have a role in the diagenetic processes of deposited remains. The intrinsic factors are the characteristics of the textile fibres, while the environmental factors are represented by the burial conditions. The processes of deterioration operate continuously, unless some events occur that slow down degradation.

Another important aspect to take into account is the nature of the archaeological record. In fact, according to Schiffer (1987, 7), the archaeological record takes form by the combination of cultural and natural agents. Thus, cultural and natural factors participate in the processes of degradation of textiles. For example, the decomposition of human body begins immediately after death but the process is influenced by cultural factors, such as the presence of coffin, the presence of other artefacts, and by natural factors, such as the body composition and soil types of burial (Dent *et al.* 2004; Carter and Tibbett 2008, 31-33; Lowe *et al.* 2013). Deteriorative processes damage textiles continuously (Szostak-Kotowa 2004, 165), but from an archaeological perspective the most intensive and extensive deterioration of buried textiles is mostly caused by diagenetic processes during burial (Cronyn 1990, 243; Huisman *et al.* 2009, 83) (fig. 2.1).

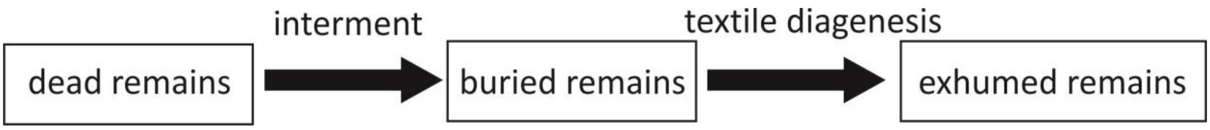


Figure 2.1: Scheme of buried textile deterioration.

Thus, when something happens that impedes deterioration, it is likely preservation of fragmentary textiles in a burial. The events that allow preservation are usually a combination of intrinsic and environmental factors (Cronyn 1990, 17). The following sections introduce the principal features textile fibres in use in Antiquity (ch. 2.2-2.9), and the mechanisms that preserve textile evidence (ch. 2.10-2.16). Valuable contributions to understanding textile diagenesis are provided by experimental studies of buried textiles (ch. 2.17). Then environmental factors are also discussed (ch. 2.18 and ch. 2.19).

2.2 Ancient clothing materials

Romans and Anglo-Saxons used mostly organic fibres and leather (Wild 1970, 4-21; Croom 2000, 20-21; Walton-Rogers 2007, 14-15) for their clothing, but also limited evidence of inorganic fibres, such as golden threads (Gleba 2008) and asbestos clothes (Goffer 2007, 360-361) have been found. Organic and inorganic fibres degrade with different pathways and rates (Goffer 2007, 271). Hence, it is necessary to define the characteristics of organic matter.

Organic matter is composed mainly of carbon atoms linked either to a few other elements, such as hydrogen, oxygen, nitrogen, sulphur, or to other atoms of carbon by carbon–carbon bonds (Goffer 2007, 266). These few elements are assembled together in living beings as four groups of macromolecules: carbohydrates, proteins, lipids, and nucleic acids (Goffer 2007, 268-270). After the death of an organism, they start to decay. However, their resistance to decay is different (Goffer 2007, 271-272, tab. 65). For example, under regular environmental conditions, carbohydrates decompose very quickly and only starch can leave significant residue for biological examination (Haslam 2004; Brown and Brown 2011, 132-134). Polymeric structure of DNA deteriorates fast but diagnostic sequences can survive and can be analysed using Polymerase Chain Reaction (PCR) (Brown and Brown 2011, 118-124). Similarly, some proteins, such as collagen (Collins *et al.* 2002; Hedge 2002) and keratin (Solazzo *et al.* 2014) break into amino acids and peptides (Brown and Brown 2011, 124-128), which leave significant traces of archaeological interest (Brown and Brown 2011, 39-40). Finally, lipids are more resistant to decay (Evershed 1993; 2008; Brown and Brown 2011, 128-135).

The natural organic textile fibres can be based either on proteins or on cellulose, which is a polysaccharide, and usually are classified according to their origin as animal and plant fibres (Cook 1984). The animal fibres and leather are proteinaceous, while the plant fibres are based on cellulose. Both plant and animal fibres have molecules arranged as polymers and the polymers are joined into microfibrils that are tied together into fibrils (Cronyn 1990, 238-239; Huisman *et al.* 2009, 71).

2.2.1 Identification of archaeological fibres

A crucial step in textile studies is the identification of the fibres. Modern textile manufacturers can apply numerous tests to identify fibres (Houck 2009). However, diagnosis of textile fibres is usually extremely hard when they are found in archaeological contexts because they are normally poorly preserved (Janaway 1983; 1989). There are several methods to analyse archaeological textiles that involve limited or none damage, these investigative techniques can apply chemical and microscopic examinations (France 2005; Janaway and Wyeth 2005; Goffer 2007, 361-362; Morton and Hearle 2008). Microscopic examination can identify fibres through specific structural feature, such as superficial characteristics, cross-section shape and diameter, lumen diameter, presence of nodes and cross markings (Appleyard and Wildman 1969; Appleyard 1978; Andersson Strand *et al.* 2010). Among the microscopic methods, the combination of the transmitted-light microscope and scanning electron microscope (SEM) can allow textile identification from 47 to 85% of examined samples (Walton-Rogers 2007, 60). High-resolution light microscopy (HRLM), fluorescence microscopy, transmission electron microscopy (TEM) and SEM examinations were adopted to investigate the histology of human hair (Wilson *et al.* 2007; 2010), which provide better understanding of archaeological human hair and a comparison for archaeological keratinaceous fibres.

However, microscopy can be limited in some circumstances. For instance, metal replacement changes the internal structure of the fibres and makes them dense and impenetrable to microscope (Walton-Rogers 2007, 60). Under these conditions, SEM examinations are the best way of considering the external part of the fibres, allowing a distinction between plant fibres and wool or other animal fibres, but it cannot go into details because of the obscured medulla and lumen. Moreover, the microscopic approach has further limitations with bast fibres identification, because these fibres can vary greatly in their characteristic structural features (Haugan and Holst 2014).

Chemical analyses offer additional options to these studies (France 2005). Radiocarbon methodology can date archaeological textiles and animal skins (Mannering *et al.* 2010). Energy X-ray dispersive spectroscopy (X-ray EDS) can examine mineralised fibres (Chen *et al.* 1998). Proteomics identifies animal species (Plowman 2003; Hollemeyer *et al.* 2008; Solazzo *et al.* 2011; 2012; 2013; 2013a; 2014). Isotopes analyses provide information about geographical origin (Frei *et al.* 2009), but further studies demonstrate some limitations of this method (von Holstein *et al.* 2014; 2015). Absorption spectrophotometry supplemented by chromatography and chemical tests (Walton 1988) and High Performance Liquid Chromatography (HPLC) are applied for dye examinations (Vanden Berghe *et al.* 2009; Mouri *et al.* 2014).

The following sections illustrate the main materials of clothing, including natural organic fibres and leather that were in use in Antiquity.

2.3 Wool and animal hair

Animal hair differ from each others for some morphological, chemical and physical characteristics, such as, cuticle shape, internal structural proportions and amino acids composition (Menkart *et al.* 1966). However, in a general sense wool and animal hair, including human, are very similar mechanically, physically and biochemically (Bowman 1885, 127-130; Höcker 2002, 60; von Holstein *et al.* 2015, 84). For example, their chemical composition is of 90-97% α-keratin and the rest 2-8% is melanins and 2% lipids (Ryder and Stephenson 1968; Höcker 2002; Solazzo *et al.* 2013a, 2685; von Holstein *et al.* 2015).

Currently, wool is the most diffused animal fibre, more correctly the term wool describes the undercoat made by short and fine hair of several types of domesticated sheep in contrast to the term "hair", which describes the outer coat as composed of long and coarse fibres (Cook 1984, 80). Other animal hairs are used to produce textiles for clothing. Among the various woolly mammals it is worth mentioning goats (cashmere and mohair), several animals from the *camelidae*' family, muskoxen (qiviut) and rabbits (angora) (Franck 2001; Höcker 2002; Braaten 2005). Sheep's wool was the most widely used animal fibre to weave into clothing and it is the most represented animal fibre in use also in Roman (Wild 1988; Croom 2000) and Anglo-Saxon times (Walton-Rogers 2007). Its spread is strictly linked with the process of domestication of sheep, which was among the oldest domesticated animal (Clutton Brock 1987, 56; Uerpmann 1996, 232). Wool is a perfect insulating material, which protects from cold and heat. Sheep are adaptable animals and it is not surprising that their extensive diffusion is associated with the spread of humans (Ryder 1983).

Animal hair can be identified by microscopy examination of the whole fibre, the cross-section and the scale pattern (Appleyard 1978). However, degradation of archaeological textile finds can reduce severely identification of fibres by microscopy, while analyses like Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometric (MALDI-TOF MS) (Hollemeyer *et al.* 2008; Solazzo *et al.* 2013a), proteomics (Solazzo *et al.* 2013) and Peptide Mass Fingerprinting (PMF) (Solazzo *et al.* 2014) can identify keratin with more successful results. Consequently, when the degree of deterioration is high for microscopic examination, chemical analyses can still provide meaningful assistance in distinguishing between different kinds of wools or other hairs.

When the fibres are sufficiently well-preserved, which rarely occurs in archaeological contexts, it is easy to recognise different animal orders or groups, whereas it is more difficult to identify different animals of the same family (Appleyard and Wildman 1969). In general, wool and other kinds of hairs share some morphological similarities, such as the superficial cuticle layer and the cortex (Appleyard 1978; Höcker 2002, 67-78). However, there are some major physical differences, such cuticle scale pattern, inner medulla, pigment distribution, which help to distinguish hair by animal family (Applerayrd 1978; Franck 2001). For instance, mohair, cashmere and camel hair appear uniform in fibre thickness (Franck 2001), while sheep wool is more variable along its length (Appleyard and Wildman 1969). Wool is usually crimped, elastic and grows in staples. These physical characteristics distinguish wool from other hair (Cook 1984, 79-80).

It has been implied that the nutritional versatility, the climatic adaptability and the exploitation of secondary products were the reasons for the early and wide domestication of this animal (Clutton Brock 1987, 69-80; Greenfield 1988). Wool contributes both as thermal insulant and as a secondary product. In fact, the domestication of sheep was directed towards improving the density of undercoat wool and to substituting kemps with long-stapled wool (Wild 1988, 13-14). The first introduction of wool in the Mediterranean area was probably in Egypt, due to Asiatic immigrants. The earlier finds of wool were by Petrie at Predynastic Naqada, Egypt (Allgrove-McDowell 2003, 32). Early evidence of woollen fabrics dates from the Late Neolithic in Europe (Greenfield 1988; Wild 1988, 13-14). In Great Britain, the most ancient woollen textiles date to the Early Bronze Age (Wild 1988, 14) and the first evidence of short wool, medium wool and long wool fleeces are dated to late Roman times (Wild 1988, 15).

2.3.1 Wool fibre morphology

Typical morphology of wool fibres has the following components (fig. 2.2). The thinner external part is called the cuticle and it mantles the inner parts. The cuticle is divided into four layers, which are called from the outer to the internal epicuticle, A-layer and B-layer of the exocuticle, and endocuticle. Cuticle cells overlap partially, like tiles, in the direction of the hair growth, and the cuticle tips are always separated from the cuticle cells below (Cook 1984, 100-101; Höcker 2002, 67-69). The cuticle layers protect a thick cortex made by a mass of spindle shape-cells. The cortex and the cuticle layers are embedded in cell membrane complex that provides strong intercellular bonding holding the cuticle and cortex together (Höcker 2002, 67).

The cortex represents 90% of the whole fibre (Höcker 2002, 70; Plowman 2003). The cortex is split into paracortex cells and orthocortex cells. The latter are proportionally more abundant, while the former have more sulphur, which results in stronger cross-links (Cook 1984, 101; Höcker 2002, 70-71). In crimpy wool, paracortex and orthocortex cells are arranged like two half cylinders that stretch alongside one another and proceed like a spiral along the fibre length (Höcker 2002, 70-71 fig. 3.4). The 90% of cortical cells is arranged following the length of the shaft in intermediate filament proteins (IFPs) with associated matrix and the rest is membranes and residues of nucleus and cytoplasm (Plowman 2003). The elementary units of wool are the IFPs that are made of four α-helix filaments. IPFs are surrounded by a matrix of keratin associated proteins (KAPs) (Plowman 2003). Cysteine, which is an amino acid rich in sulphur, is placed at the ends of IFPs and crosslinks with disulphide bonds with KAPs (Plowman 2003). KAPs are small amorphous proteins high in sulphur content, which are found also in the cuticle (Solazzo *et al.* 2013, 51).

Every cortical cell is arranged in group of 5 to 20 macrofibrils that are contained within a cytoplasmic matrix. Each macrofibril includes from 500 to 800 microfibrils (Höcker 2002, 72). The innermost part of animal hair is medulla, which is a hollow space running within the hair shaft (Cook 1984, 99, 101-102). The proportions of medulla vary greatly depending on the fibre coarseness. Coarse wool fibres have big medulla, whereas fine wool fibres have extremely thin medulla (Cook 1984, 102).

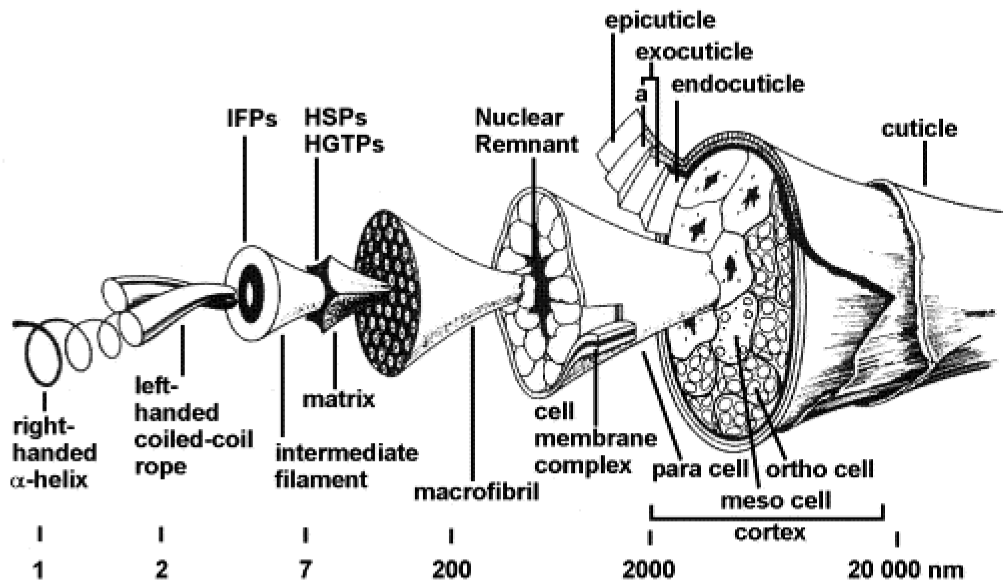


Figure 2.2: woollen fibre structure (adapted from CSIRO http://www.scienceimage.csiro.au/image/2489/diagram-of-wool-fibre-structure//large under Creative Common license).

2.4 Silk

Silk is a fibre produced by larvae of some insects and some spiders. The silk is produced by the silkworm of the domesticated mulberry silk moth (*Bombyx mori*) is the most manufactured. When this animal transforms itself from the larval stage to the pupal stage to eventually become an adult, it starts to produce raw silk by its salivary glands. It then spins the filament around itself and finally becomes a cocoon, where the transformation occurs (Cook 1984; 147-148; Currie 2001, 9-10). Silk is the only natural fibre in the form of a continuous filament. If the thread is intact, it needs only to be reeled and not spun (Currie 2001, 2). Thus, the silk weaving is simpler than other fibres.

Filaments produced by domesticated *bombyx mori* have identical amino-acid composition (Becker *et al.* 1997, 27), but silk is produced also by wild silkworms (Good 1995, 959; Cook 1984, 151-152; Marsh *et al.* 1955) and spiders (Cook 1984, 157-158), which may differ in their composition (Vollrath and Sponner 2005, 245, 249; Mondal *et al.* 2007, 69). In fact, in archaeology the term silk may be confusing for two reasons. Firstly, ancient Greek and Latin literary sources use the term silk to describe a wide range of precious textile fibres, not necessarily produced from the silk of *bombyx* *mori* (Good 1995, 965-966). Secondly, in Europe archaeological evidence of silk is usually extremely degraded and methods, such as comparison of diameters, offer little help in identification. Conversely, polarized and electron microscopy, biochemical analyses are good systems for identification (Good 1995, 961). Moreover, degradative processes and residue of silk fibres were analysed with proteomics (Solazzo *et al.* 2012), Raman spectroscopy and electron paramagnetic resonance (Gong and Yang 2013) and high performance liquid chromatography (Degano *et al.* 2011).

According to the legend, the domestication of mulberry silk moth and silk production were firstly established in China during the half of the 3rd millennium BC (Currie 2001, 2), while archaeological evidence confirms it (Good *et al.* 2009, 458) and also proves that wild *antheraea* silk was produced by Harappan civilization during the second half of the 3rd millennium BC (Good *et al.* 2009). The first introduction in Europe is a matter of debate, because the early evidence is sporadic (Good 1995). Classical authors clearly had a certain degree of knowledge about silk. For example, Aristotle, who lived in the 4th century BC, described the silkworm metamorphosis and the weaving process. He also stated that Cos was the first place where silk was produced in the Mediterranean area (*Historia Animalium* V, 19). The existence of two species of Mediterranean silkworm with silk textile production in Cos has been reported, but there are no definitive proofs of that (Wild 1970, 11).

After the battle of Carrhae in 54 BC, the silk of Middle Asia circulated within the boundaries of the Roman Empire, but usually it was confined to the upper classes. For example, in Rome, the use of silk garments was regulated by several laws through time, because of the deep impact on the economy (Yates 1875, 1128; Good 1995; Currie 2001, 2). Anglo-Saxon silk clothing was a precious and rare imported good (Walton Rogers 2007, 86).

2.4.1 Silk fibre morphology

Unprocessed silk fibres are composed of two subtle threads fixed together by a gummy layer. The major components of silk are proteins fibroin, which forms the two inner filaments, and the external coating of the protein sericin, silk includes also other impurities (Cook 1984, 158-159; Currie 2001, 10; Fedorak 2005, 26; Mondal *et al.* 2007, 65, tab. 1).

Fibroin has a highly crystallized structure, while sericin is an amorphous protein (Marsh *et al.* 1955; Mondal *et al.* 2007; Solazzo *et al.* 2012, 1217). The traditional manufacture of silk goes through the process of degumming, which is the removal of sericin layer from the cocoons (Currie 2001, 32). Hence, after degumming, fibroin filaments, which are called brins, are ready for reeling (Cook 1984, 185-187). The fibroin has two forms, the light chain and the heavy chain (Marsh *et al.* 1955; Solazzo *et al.* 2012, 1218).

The light chain is a short protein. The heavy chain is a long protein and is organized into short cyclic hydrophobic crystalline regions alternated with amorphous hydrophilic regions packed together in a β-pleated sheet structure by small side chains of amino acids residues, and the extremities are hydrophilic regions. (Becker *et al.* 1997, 27; Solazzo *et al.* 2012). The heavy chain is linked to the light chain fibroin by a disulphide bridge and the architecture of fibroin is consolidated by a glycoprotein incorporated once in every six heavy chain light chain dimers (Marsh *et al.* 1955; Solazzo *et al.* 2012).

2.5 Cellulose based fibres

Wool and silk are animal textile fibres and are based on proteins. The plant textile fibres come from a wide variety of plants and are classified into different groups according to their origin, such as bast fibres, seed fibres and leaf fibres (Cook 1984; Blackburn 2005; Jindal and Jindal 2007). The most used plant fibres are bast fibres, such as flax and hemp, and seed fibres like cotton (Cook 1984), these plant fibres were also the most in use in the chronological during the Roman (Wild 1970; 2004) and Anglo-Saxon (Walton-Rogers 2007) periods. All plant fibres are based on cellulose as common molecule in their cell walls (Kozlowski *et al.* 2005).

Cellulose is a polymer composed of a long chain of D-glucose molecules. The glucose molecules are linked together through glycosidic bonds. The arrangement of cellulose is linear with succession of crystalline regions to amorphous regions (Goffer 2007, 289-293). The cellulose chains are lined up and strongly packed one to another through hydrogen bonds, which are formed in the crystalline regions and connect the chains side-by-side. The microfibrils are entangled into a polysaccharide matrix (Goffer 2007, 289-293; Brown and Brown 2011, 73).

2.6 Flax

Flax fibres derive from the stem of *Linum usitatissimum*, an annual domesticated plant, which grows in numerous temperate and sub-tropical regions of the world. The fibre filaments are made by thin, long thick-walled cells, which are in the interior bark of this plant. The textile produced by flax is commonly defined as linen (Cook 1984, 4-12). Flax fibres and all the other plant fibres are made up by similar components: cellulose is the principal and then waxes, fats, hemicellulose, lignin, ash and pectin are the secondary components. Table 2.1 provides a list of chemical composition of plant fibres.

In the wild state flax is either annual or perennial. Genetic studies suggest that the most likely ancestor of *Linum usitasissimum* is *Linum bienne*. This wild type is distributed from Caucasus to the Mediterranean region, from Western Europe to North Africa. India appears to be the most probable country of origin of flax. This is strongly implied by the huge biodiversity of the flax plant family currently present in that region (Vavilov and Dorofeyew 1992).

Flax can be used as a multi-purpose source for different needs. Flaxseeds can be used for diet, as a cereal, or it can be employed as medicinal, because of its curative qualities. Flax oil is used for frying or as fuel for oil lamps. It is also a preservative for paint and flooring (Kozlowski *et al.* 2005). The most ancient and best-documented evidence for flax are fabrics of wild flax threads from Dzudzuana cave, Georgia, which dates to the Upper Palaeolithic (Kvavadze *et al.* 2009). Some of the threads were dyed and one was twisted (Kvavadze *et al.* 2009). The archaeological outline of early domesticated flax diffusion suggests that the original centre was between Indus valley and the Middle East (Judd 1995). In fact, the cultivation of flax is strictly linked to the emergence of the first civilizations in the Fertile Crescent (Van Zeist and Bakker-Heeres 1975; Vaisey-Genser and Morris 2003). Archaeological evidence of flaxseed cultivation date to 5500-5000 BC (Helbaeck 1969) and the first artefacts of linen were recovered at Nahal Cave, in the Dead Sea area, Palestine. They are basketry, matting and cordage and date by C^{14} to around 6500 BC (Schick 1988). After the first introduction around 6000 BC, flax was widely cultivated in Egypt and the early examples of linen clothes are dated at least from the Neolithic, 5500 BC. Mummification demanded great quantities of linen bandages, consequently linen weaving became an industry to produce bandage, clothing and household textiles (Allgrove-McDowell 2003).

Table 2.1: Chemical composition of plant fibres discussed in this work. NP = not present. The values refer to the dry weight and are reported in percentages (data collected from Kozlowski 2012).

	Flax	Hemp	Cotton
Cellulose	84-85%	78%	88-96%
Hemicellulose	7-9%	6%	NP
Lignin	2.5-4%	2%	NP
Pectin	1.5-2.5%	1.5%	0.7-1.2%
Fats and waxes	5-2%	1.5%	0.4-1.0%
Protein	2-0%	2.5%	1.1-1.9%
Ash	4-1%	1%	0.7-1.6%

2.6.1 Flax fibre morphology

Domesticated modern flax strands have a length of between 6 – 65 mm and a mean diameter of about 0.02 mm (Cook 1984, 9-10). Microscopic analysis reveals these main characteristics of flax. The cells are long transparent, cylindrical tubes, which may be smooth or striated lengthwise. Unlike cotton, flax fibres do not have convolutions and the width is variable along its length. Swellings, nodes and cross-markings characterise this fibre (Cook 1984, 9-10). These cells are crossed by a canal through the centre. The canal is narrow, well-defined and regular in width. It finishes near the end of the fibres, which become gradually narrower to a point. The cross-section analysis reveals that the mature cell-walls are thick and polygonal. Conversely, the immature flax fibres are more oval in cross-section and they have thinner cell walls so the inner canal is larger than in the mature fibres (Kozlowski *et al.* 2005).

The structure of the flax stem cross-section (fig. 2.3) shows the following organization from outward to inward (Kozlowski *et al.* 2005):

- Epidermis is the outer layer and is covered by a cuticle.
- Primary cortex is made from 2 to 7 layers of parenchyma cells.
- Phloem is the layer that includes bundles of bast fibres and phloem parenchyma.
- Secondary cortex is made of small cells forming vascular bundles.
- Cambium is the tissue of secondary plant growth. It produces xylem inwards and phloem outwards.
- Xylem is a dense wall cells that works as tubular system for water transport along the stem.
- Pith is the layer of old woody tissues.
- Core channel (or lumen) is the hollow space that is extended along the whole length of the stem.

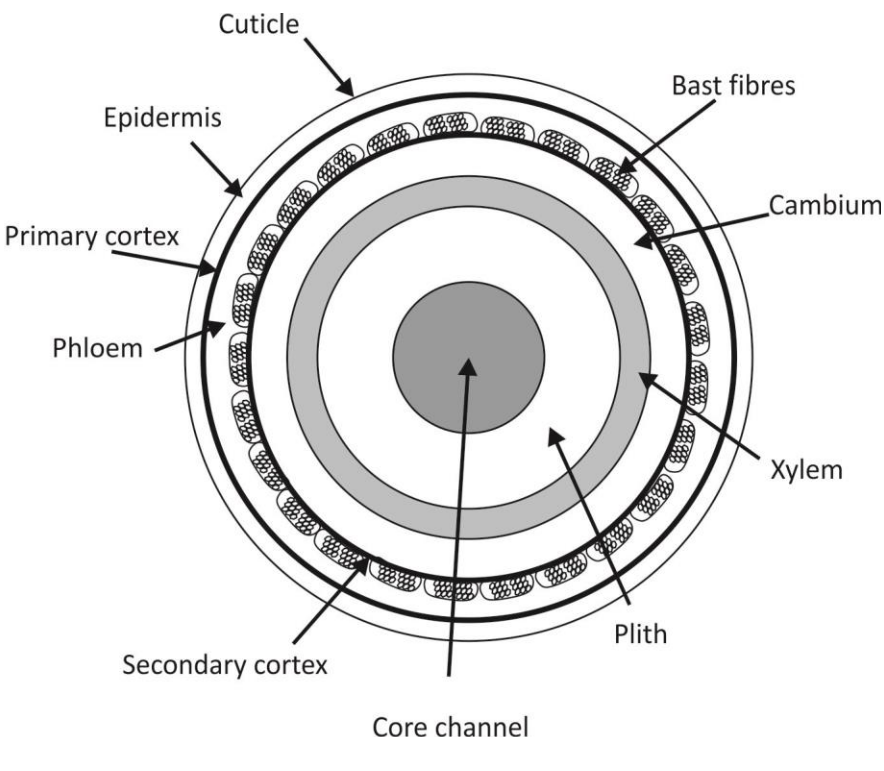


Figure 2.3: flax stem cross-section (drawing of the author based on description in Kozlowski *et al.* 2005).

2.7 Hemp

Hemp is a bast fibre like flax and it is obtained from *Cannabis sativa*. This herbaceous plant belongs to the family of Moraceae; it is annual and is very adaptable, and it can live from northern cold regions to tropical climates. It can grow to 4.5 - 5 m, requires little water and is very resistant to parasites. This plant is extremely versatile and it can be processed for numerous purposes, such as food crops, oil, animal feed, fuel, drugs, medicine, cordage, rope, paper, ship sails and clothing fabrics (Deitch 2003, 3-10). First domestication of hemp started in China around 2800 BC and it came later into Europe around the early Christian period (Kozlowski *et al.* 2005, 51-52).

Hemp and flax share some similarities. They are harvested and treated similarly, but also the morphology and physical and chemical properties are close. However, the two fibres are distinct in length of fibres, hemp fibres being longer than flax. It has also been reported that hemp fibre has in cross-section an internal lumen (Thygesen 2006). The major length provides more strength to hemp fibres. Hemp is colourless. Long flax fibres of textile require fewer treatments than hemp, which has larger and stronger fibres and so it requires more effort to separate those singularly. Retting flax is easier than for hemp, because hemp is coarser than flax (Cook 1984, 17).

2.7.1 Hemp fibre morphology

As written above, some similarities link hemp with flax. The main morphological features are especially similar, such as the cross-section bundles and the longitudinal view (Horrocks and Anand 2000, 380, tab. 14.3). However, the cross-section of hemp is flat and circular, while flax is polygonal (Sponner *et al.* 2005, 179). A hemp bundle contains several fibres and bundles are linked by unit cells. The outer layers of bundles are longer and thicker than the inner layers (Sponner *et al.* 2005, 181). A fresh hemp stem has a diameter between 20 and 40 µm and consists of a hollow tube covered by a few layers, which are called in order from the outer side to the inner side epidermis, cortex, cambium, xylem and lumen or core channel (Thygesen 2006, 18-19, 20, tab. 2). The more external fibre layers contain bast fibres, while the inner include wood (Amaducci and Gusovius 2010, 212). The internal lumen is empty when stems are dried and it is larger than the ones of other fibres such as flax and jute (Thygesen 2006, 18-19).

2.8 Cotton

Cotton (*Gossypium*) is a fibre, which comes from the seeds of the plant, and in this way it is different from the fibres, which are produced by the bast plants. It belongs to the *Malvaceae* (mallow) family (Cook 1984, 35). Its fibres are attached to the seeds of the cotton plant, to absorb moisture essential to sprout the same seeds. It is a perennial plant, which can reach 6 m high in tropical regions. However, cultivation has transformed the majority of cotton species into annual plants (Cook 1984, 39). Currently it is the most exploited fibre by the textile industry for clothing production. Its first domestication started independently in the Old and in the New World. In Asia, Europe and Africa the most diffused cultivated species are *Gossypium herbaceum* and *Gossypium arboreum*, which are genetically divergent (Dochia *et al.* 2012, 12-13). The American species are *Gossypium hirsutum* and *Gossypium bardadense* (Wilkinson 1912). The cultivation of *Gossypium herbaceum* species started in Arabia and Syria, while *Gossypium arboreum* species has its origins in the Indus Valley and Pakistan (Weber 1999; Dale 2009). It was first domesticated around 5000 BC in the Indus Valley and from there it reached Mesopotamia and Egypt during the second millennium BC and later Europe (Roche 1994, 5; Weber 1999; Dale 2009).

2.8.1 Cotton morphology

Cotton has numerous differences in the shape and form of its fibres. It is possible to appreciate the extent of these differences by microscopic analysis. Additionally, the microscope reveals how cotton can diverge from one species to another and how different growth conditions can modify the same species (Cook 1984, 58). Mature cotton fibres are characterised by convolutions, which are twists specific for any type of cotton and they turn direction after every two or three convolutions (Dochia *et al.* 13-14). For instance, currently Sea Island cotton has 300 half-convolutions any 25 mm, the Egyptian 230, the Brazilian 210, the American 190 and the Indian 150 (Cook 1984, 59). Variety of plants and growth conditions affect deeply the length of cotton fibres and the state of maturity. In contrast, the width of cotton fibres tends to be uniform (Cook 1984, 59). One end tapers to a tip and the other is open and irregular; the latter one is the point where the fibre was torn from the seed during ginning. A standard cotton fibre is wide, between 12 and 20 µm (Cook 1984, 60). The ends of the fibre are thinner than the central section. The cross-section of a typical mature fibre has an oval or kidney bean shape. The inner core of cotton fibres is hollow. The immature fibres are different from the mature. The first have thinner cell walls and when they are dry do not have the oval or kidney bean cross-section. Alternatively, the immature fibres can display numerous distorted shapes; and commonly their cross-section is U-shaped. The immature fibres may not twist because of their thin-walls, but their convolutions are almost as pronounced as those of mature fibres.

The SEM has provided further understanding of the internal microstructure of cotton fibre (fig. 2.4). The wall consists of two layers: a cuticle, which is the outer layer, and a secondary wall that is the inner layer. The outer layer is strong and it has a protective function. Its surface appears wrinkled. Chemical analysis has revealed that this primary wall not only contains cellulose, but also waxes, proteins and pectinaceous substances (tab. 2.3; Cook 1984, 61; Dochia *et al.* 2012, 13-14). The core of cotton fibre is formed by the inner layer, which is pure cellulose and is almost 90 per cent of the whole fibre weight (Dochia *et al.* 2012, 13-14). Within the secondary layer is a hollow tube (Dochia *et al.* 2012, 13-14). When the fibres are living, this lumen serves to carry nutrients and protoplasm

(Cook 1984, 62-63; Dochia *et al.* 2012). When the fibres died, the nutrients leave and it remains an empty tube – the lumen-, which runs along the centre of the fibre (Cook 1984, 62-63). The width of the lumen depends on the quantity of deposited cellulose during fibre life; in some cases the lumen space may be minimal (Cook 1984, 64; Dochia *et al.* 2012, 13). Sometimes dry fibres are more similar to a rod rather than a tube. In contrast, immature fibre has a wider lumen because of the reduced cellulose deposit. If strong solvents attack the two celluloid layers, it remains just a thin membrane of protoplasm, which is residual material of the liquid nutrients (Cook 1984, 64). It also has the endochrome, the coloured substance, which provides the natural colour to cotton fibre (Cook 1984, 64-65). Cotton easily absorbs water because of the empty space provided by the lumen and because the walls have porous surfaces (Cook 1984, 66-67).

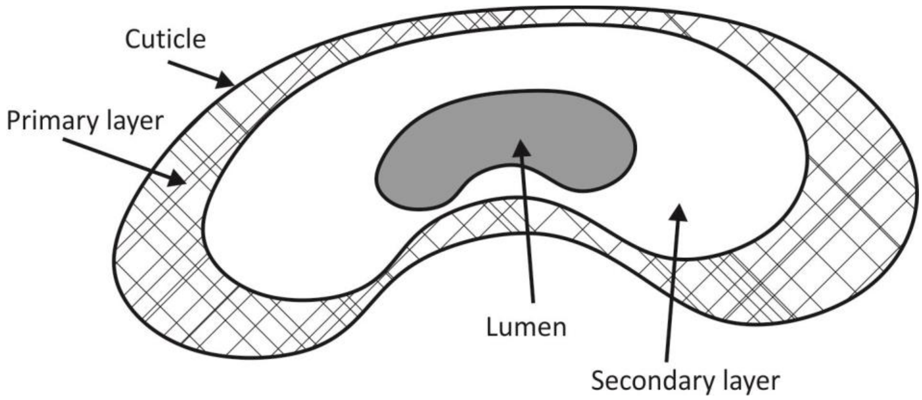


Figure 2.4: Cotton fibre cross-section (drawing of the author based on Cook 1984; Dochia *et al.* 2012).

2.9 Leather

Leather can be defined as a group of related materials with several features in common, derived from animal skins (Kite and Thomson 2006). It is not a textile, because it is not produced by animal hair or plants. It has completely different procedures of production from the textile fibres used for clothing. However, it is another material used to produce clothing and it has been extremely popular since antiquity. Hence, it is included as part of clothing material examined in this research.

It has been suggested that leather and animal skin products were the earlier source material for clothing before the development of weaving technology, and its use has been experienced among almost all human cultures (Thomson 2006). Skins are generally very resistant, but they lose its mechanical properties when hydrated and then dried (Covington 2006). Conversely, the process of tanning improves hydrothermal stability of leather (Covington 2006). Tanned leather shows some specific properties, it is flexible, strong, resistant to shock loads, puncturing, tearing and abrasion, heat insulating, with thin density and most of all particularly resistant to degradation (Thomson 2006).

The principal characteristics of leather are resistance from bacterial attacks and the proteolytic enzymes are responsible for this capacity. This characteristic can be reduced in waterlogged environments, where anaerobic can attack leather (Strzelczyk *et al.* 1997). Leather manufacture prevents bacterial activities through several practices such as salt curing, drying, solvent dehydration and acid pickling.

Impregnation of rawhide with fatty materials is the key technique to improve leather and pseudo-leather material resistance to bacteria in wet conditions (Covington 2006). When leather pieces are dried, the fats cover the individual skin fibres and the voids between them are filled (Covington 2006). This prevents bacterial damage. In contrast, oil-tanned skins are treated with reactive, oxidizable oils, usually extracted from sea fauna (Thomson 2006).

All animal skins can be converted into leather. This process changes the skin into a dry, non-perishable matter. Tanning is the operation, which produces leather from raw skin (Covington 2006). It greatly modifies the characteristic natural skin to leather, allowing, among the other changes, a better preservation and reducing microbiological exposure (Covington 2006).

The leather and skin products have been in use a long time (Thomson 2006a, 66), but direct archaeological evidence, such as proper pieces of leather clothing or tanneries of Prehistoric times, are not frequent because of the rarity of good preservation contexts. Substantial evidence of leather manufacturing is provided by microwear analysis of *lissoirs*, found in the neanderthalian sites of Pech-de-l'Azé I and Abri Peyrony in France (Soressi *et al.* 2013). The first direct evidence of clothing made in leather is provided by the assemblage of Ötzi and it dates back to 4550±27 Cal BP (Spindler 1994; Bonani *et al.* 1994). The assemblage includes a pair of shoes, a loincloth, a cap, a coat, a pair of leggings and a belt with a pouch, all these items were made in leather of different animals (Spindler 1994, 137-156; Hollemeyer *et al.* 2008). The manufacture of hide leather for footwear is confirmed by the find of a shoe at the Chalcolithic pit in the cave of Areni-1, Armenia, dated 3627–3377 Cal BC (Pinhassi *et al.* 2010). Further evidence is provided by rock art and Egyptian paintings that show skin and leather clothing at different sites. Civilised communities, such as the ancient Greeks and Romans, had developed a valuable leather industry to satisfy the needs of the population (Thomson 2005a). For instance, information from the Roman world is provided by Pompeii, where there was still conserved the remains of a Roman civilian tannery, as well some tools of Roman tanners (Thomson 2005a, 66-73).

2.9.1 Leather morphology

Protein collagen is the basic component of all skins and it is common to the skin of all vertebrate animals, which include fishes, reptiles, birds and mammals. Moreover, protein collagen is the crucial factor, which allows the transformation of raw skin into leather. Generally, collagen has the form of elongated and helical fibrils (Ramachandran and Kartha 1955; Traub *et al.* 1969).

Leather collagen is made by 20 different amino acids, connected together in a chain of 1000 units (Haines and Barlow 1975; Haines 2006a). The most occurring amino acids of collagen are glycine (30%), proline (10%) and hydroxyproline (10%). The most regular sequence is a tripeptide that includes always glycine in first position, either proline or hydroxyproline in second position and another amino acid in third position (Haines 2006a). Hydroxyproline and proline shapes the chain into a left-handed helix and a collagen molecule is made of three helices that are twisted together into a right-handed spiral (Haines 2006a, fig. 2.5, 2.6). The length of collagen molecules is particularly long, if compared to their cross section. This triple helix is further strengthened by hydrogen cross-links between the three backbone chains (Haines 2006a). Collagen molecules are bound into fibrils. Each fibril ends with a non-helical region that binds with the closest fibril through a covalent bond. Fibrils are packed into a staggered arrangement. These bundles of fibrils make leather fibres (Haines 2006a).

The fibres interweave and interlace between them in the three dimensions through the skin. This texture characterises leather (Haines 2006a, 9). Moreover, this fibrous structure provides its typical physical properties and ability to adapt to the tensions and movement imposed during its use. These properties are common to all mammalian skins with minimal or none differences (Haines 2006a, 9).

Although all vertebrate skins can be converted into leather, the incidence of different animal sources in the archaeological record is not the same (Haines 2006, 12). For example, Roman and Anglo-Saxon tanners preferred working mammal skins, such as cattle, goat and sheep. This distinction is important, because mammal skins are covered by hair and have other specific characteristics, such as a layered structure (Thomson 2006). Generally, mammal skins have an external layer, called grain, an intermediate layer, which is the junction between the grain and the corium, and the corium, which is the lowest layer of skin before the flesh starts. The whole thickness, the thickness of single layers and the proportion between the layers are characteristics for any species (Thomson 2006). The skins of mammals differ even for grain surface patterns (Haines 2006, 12). For example, the pattern of hair is typical for species. Consequently, the analysis of the holes created by the removal of hair can help to detect the original animal source of the piece of leather, but this approach is not helpful when the skin pattern is not recognisable. A more advanced method of skin identification is successfully applied to medieval parchments through the application of non-destructive electrostatic ZooMS to proteins collected with PVC erasers (Fiddyment *et al.* 2015).

The third distinctive aspect of leather is the so-defined "three-dimensional weave of the fibre bundles" (Haines 2006, 19). The animal skin has a systematic pattern that links the grain surface to the dominating way in which the majority of the fibres are directed (Haines 2006, 19-20). This pattern originates back with the foetus formation, when the collagen fibrils are created. Hence, the natural direction of fibrils corresponds to the main lines of tension as when the backbone stretches, the legs lengthen and the growth of fur keeps the same directions.

The physical attributes of skin and leather are influenced directly by the structural characteristics described above. For instance, in a piece of leather the dominating direction of fibrils is at the same time the strongest and the less extensible part. Consequently, this property influences practically the choice of leather cut to produce footwear rather than a piece of clothing.

The chemical composition of leather includes the understanding of tanning. Tanning is the chemical process, which converts collagen skin, a perishable material, into leather, a resistant material to microbiological attacks (Huisman *et al.* 2009a). Even the raw skin shows a certain degree of stability, but the exposure to water or wet conditions followed by dry conditions affects it seriously. Tanning and lubricating improves leather resistance to water (Huisman *et al.* 2009a).

Tanning modifies the leather shrinkage resistance. However, heat produces shrinkage in leather and collagen, because it starts hydrogen bonding collapse. The complex origin of hydrothermal stability of leather is not entirely understood, but it seems extremely probable that the tanning process substitutes the water bonding structure of collagen with the tanning agents, which enforce the whole structure (Covington 2006, 22-23).

The processes to preserve leather are numerous, but only tanning changes effectively the skin structure allowing a long time existence. Currently, there are numerous techniques and agents for tanning, but those sources were not easily accessible even in antiquity. There are not many archaeological data about tanning processes, before the Middle Ages. The main source of information comes from ancient literature (Thompson 2006a, 66-7). However, it has been assumed that the principal tanning process in use since Roman times was vegetable oil tanning, even if recent experimental tests have reduced the diffusion of this technology (Van Driel-Murray 2002).

2.10 Chemical textile degradation

Degradation of archaeological buried textiles can be chemical or biological (Cronyn 1990, 241-243; Huisman 2010, 83; Fedorack 2005, 1; Neilson and Allard 2008, 3). The presence of water and oxygen can produce chemical degradation of organics (Brown and Brown 2011, 237) and hydrolysis and oxidation are chemical processes that deteriorate the structure of textile fibres (Von Holstein 2012;

Von Holstein *et al.* 2014; Solazzo *et al.* 2013). Oxidation occurs in the presence of oxygen and it is accelerated by heat or light (Goffer 2007, 76-77). Oxidation breaks down polymeric structure of textiles, causing embrittlement, weakening, and discoloration and fading of pigments (Cronyn 1990, 31, 243; Goffer 2007, 77; Huisman *et al.* 2009, 83; Solazzo *et al.* 2013, 54). For instance, studies on photo-oxidation of degummed silk demonstrate that causes rupture of peptide bonds, cross-links or changes of amino acids residue side-chain and the loss of tyrosine from fibroin heavy chain (Solazzo *et al.* 2012).

Thus, it is unlikely that oxidation occurs in buried or submerged environments (Brown and Brown 2011, 237). Experimental burials demonstrated that oxidation is limited in these environments, in accordance with the limited oxygen supplies, whereas oxidation is extremely harmful to textiles in open air environments, such as museums (Solazzo *et al.* 2013).

Experiments on wool degradation show that hydrolysis attacks wool proteins in several ways, such as hydrolysis of peptide bonds, amino acid racemization and amino acid decomposition to other amino acids or other compounds (von Holstein *et al.* 2014, 2121). All these reactions are peptide selective (von Holstein *et al.* 2014, 2121). The combination of temperature, pressure and pH can accelerate the rate of hydrolysis (Cronyn 1990, 20; Huisman *et al.* 2009, 83).

Leather is chemically deteriorated by hydrolysis and oxidation, which are influenced mainly by environmental agents, such as water, moisture, heat, light, pH and acidic gases (Florian 2006). Hydrolysis and oxidation effect leather differently and even the damage that they produce on leather are different. It must be premised that most studies are on deterioration of vegetable tanned leather and not all decay of cured skins have been examined (Strzelczyk *et al.* 1987; 1997). Hydrolysis is caused mainly by sulphur dioxide and nitrogen dioxides, which are present in air pollution. Oxidative deterioration originates from high-energy free radicals from light, oxygen, sulphur dioxide, oils and continuous internal chemical reactions (Florian 2006).

2.11 Biodeterioration

Chemical degradation is detrimental to buried textiles, but biodeterioration can damage textiles at faster rate (Cronyn 1990, 241; Neilson and Allard 2008, 51; Huisman *et al.* 2009. 83), because natural fibres are nutrient source for numerous microorganisms (Szostak-Kotowa 2004; Goffer 2007, 432; Brown and Brown 2011, 115-116). However, usually chemical and biological degradation operate in combination (Solazzo *et al.* 2013; fig. 2.5).

Numerous microorganisms can degrade cellulose (Hogg 2005, 399) and cellulose based fibres follow different pathways of deterioration depending on the microorganisms and on the content of cellulose (Buschle-Diller *et al.* 1994). Both bacteria and fungi can secrete enzymes with cellulolytic results (Szostak-Kotowa 2004, 166). These enzymes are specialized into break hydrogen bonds in the crystalline and amorphous regions of the fibres and they work simultaneously. In all cases, the result is hydrolysis of the long polymeric structure of cellulose into the shorter glucose (Buschle-Diller *et al.* 1999; Szostak-Kotowa 2004, 166). Plant fibres, such as cotton and flax, have a superficial waxy layer, which is called cuticle, that protects the fibre from the complete deterioration until is not removed (Szostak-Kotowa 2004, 166). If the fibre is highly crystalline, it is more resistant to biodeterioration, while the content of hemicelluloses and pectins make the entire structure of the plant weaker and more susceptible to biological degradation (Szostak-Kotowa 2004, 166). These amorphous regions promote the microbial attack because of their weak chemical bounds (Szostak-Kotowa 2004, 166). Usually, the superficial layer is the first to be degraded and consumed by all microorganisms. Then bacteria and fungi behave differently. Bacterial degradation starts from the cuticle and move inwards. Fungi after breaking the surface, they attack the lumen, where they develop and invade the lumen, consuming the fibres with cellulolytic enzymes from the inside and making their outwards (Basu and Ghose 1962; Szostak-Kotowa 2004, 166). Fungi are more detrimental for plant fibres, especially *Penicillium* and *Aspergillus* because that are more adaptable in moisture limits (Szostak-Kotowa 2004, 166; Kavkler *et al.* 2011). Laboratory experiments on artificial aged cotton and non-aged cotton demonstrated that fungal attacks degrade cellulose through hydrolysis, depolymerisation and decreasing the molecular order (Kavkler *et al.* 2015). Nevertheless, some differences of deterioration occur depending on the fungal species (Kavkler *et al.* 2015, 8). The studies on cellulolytic bacteria are less explored, but bacteria affect cellulose fibre to a lesser extent when compared to fungi because their requirements of moisture are more stringent (Szostak-Kotowa 2004, 166; Hogg 2005, 402).

Keratin based fibres, such as hair and wool, are also susceptible to bacterial and fungal deterioration, like cellulosic fibres (Peacock 1996; Wilson *et al.* 2007a). Disulphide bonds give high breaking strength to wool (Szostak-Kotowa 2004, 167). Moreover, experimental short term burials show extensive macroscopic degradation of wool, but no changes in amino acids composition, elemental composition and isotopes were observed (von Holstein *et al.* 2014). Nevertheless, in archaeological contexts, hair and wool survive only in limited environments. In fact, hair is source of food for numerous microorganisms that can exploit keratin, by-products of digested keratin and lipids (Agarwal, and Puvathingal 1969; Wilson *et al.* 2007a). Laboratory and field experiments show that fungal tunnelling is the principal alteration of hair (Wilson *et al.* 2007a, 157). Fungal biodeterioration is split between keratinolytic fungi that secrete keratinases to deteriorate directly α-keratins and keratinophylic fungi that consume the by-products of keratin partially decomposed

(Filipello Marchisio 2000). Thus, the enzymatic ability to break keratin delimits the rate of animal hair degradation (Wilson *et al.* 2007a, 455).

Fungal attacks can degrade hair from two sides: erosion of the external surface or radial penetration through hyphae (Filipello Marchisio 2000). The first consumes hair from the outside inwards, while the second produce an inner tunnel that wears the hair from the inside causing a final collapse of the shaft (Filipello Marchisio 2000; Wilson *et al.* 2007a). The study of Wilson *et al.* (2007a) proves that biodeterioration of hair follows a predictable pathway. The deteriorative sequence starts in both structures of cuticle and cortex poor in cysteine, then it continues weakening of the disulphide bonds (Kunert 1989) and it follows the enzymatic attack to the protein (Szostak-Kotowa 2004, 167). There are differences in the rate of deterioration between the external and the internal portion of the hair. The cuticle may show good preservation, while cortex is seriously deteriorated (Wilson *et al.* 2007a, 157).

Hair biodeterioration follows the sequence illustrated in table 2.2 below:

Table 2.2 : sequence of biodeterioration of cuticle and cortex of hair shaft. The sequence is ordered from the weakest (1) to the most resistant component (6). (reworked from Wilson *et al.* 2007a, tab. 1, Copyright © 2007, John Wiley and Sons).

Steps of biodeterioration from the weakest to the most resistant component	Cuticle	Cortex
1	Intercellular δ-layer cell membrane complex	Intercellular δ-layers cell membrane complex
2	Endocuticle	Cell membrane complex β-layers
3	Cell membrane complex β-layers	Intermacrofibrillar matrix/nuclear remnants
4	Exocuticle	Microfibrils
5	Epicuticle	Intermicrofibrillar matrix
6	A-layer.	Pigment granules

It is also demonstrated that melanin granules are the most resistant to biodeterioration, leaving traces in the soil even after the keratinous structures are long disappeared (Wilson *et al.* 2007a, 157-158).

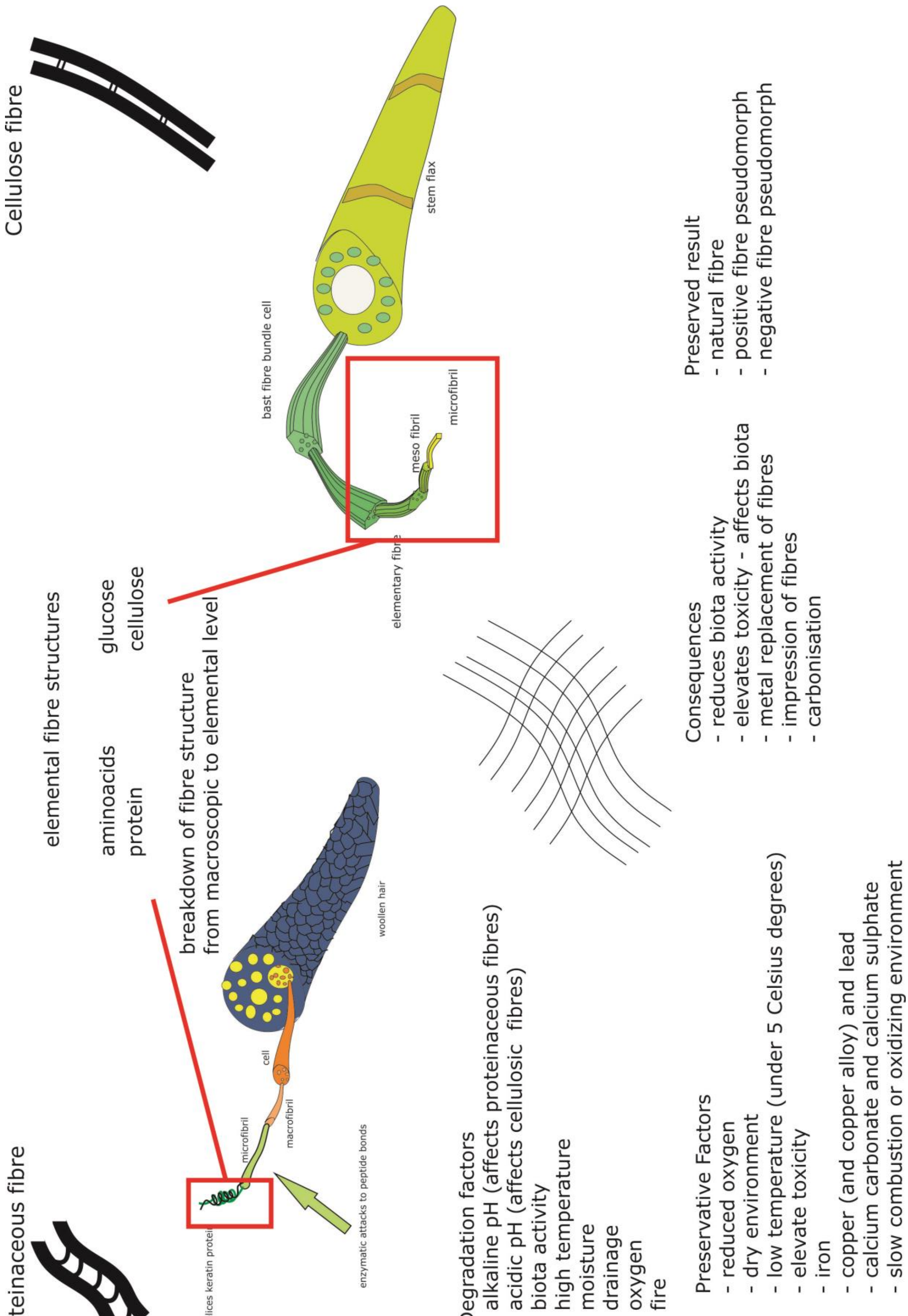


Figure 2.5: diagram of wool and plant fibres degradation and preservation (illustration of the author).

Silk proteins, namely fibroin and sericin, have different degree of resistance to biodeterioration. In fact, raw silk is readily degraded by microorganisms when it is buried in soil (Szostak-Kotowa 2004, 167). Conversely, limited microorganisms can affect degummed silk. Experiments on soil burials silk show that there was bacterial growth only on gummed silk, but no evidence of fungi was detected (Seves *et al.* 1998). Few bacteria were found on buried fibroin and only *Pseudomonas cepacia* was isolated as capable of exploit fibroin as nutrient (Seves *et al.* 1998). The study of Tajima *et al.* (2000) charted that the bacterial deterioration of fibroin begins on the surface and proceeds inwards and the rate of decay becomes faster in the later stages.

Biodeterioration affects also leather. Studies of modern leather manufacture demonstrate that microbial attacks can occur since the first stages of leather production, when the surrounding environment provide good conditions for microorganism growth (Orlita 2004). This study also shows that different biota attack leather in different stages. During pre-tanning phases, bacteria are dominant, whereas tanned leather is more subject to fungal deterioration (Orlita 2004, 160-161, fig. 1, tab. 1).

In archaeological contexts, preservation of untanned leather is not frequent (Huisman *et al.* 2009a, 64). In buried environments, leaching of water eliminates soluble particles from tanned leather and water transports within leather soil organic particles of elution, causing partial loss of tannins and proteins (Strzelczyk *et al.* 1997; Huisman *et al.* 2009a, 64). In waterlogged environments, leather is affected by slow anaerobic biodeterioration which is generated by surrounding organic sediments (Strzelczyk *et al.* 1997). This deterioration of leather produces toxic elements, which stop the degradation (Strzelczyk *et al.* 1997, 301). Moreover, the damage of leather is enhanced by hydrolysis in alkaline environments (Huisman *et al.* 2009a, 65).

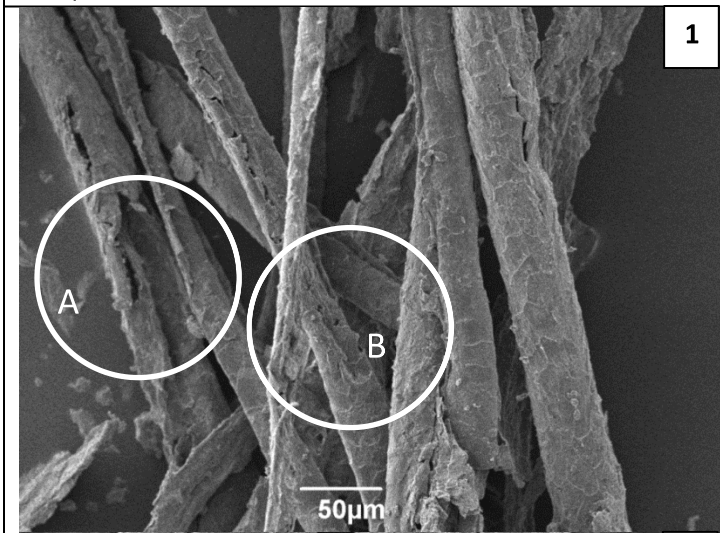
In conclusion, this section has shown that soil microorganisms can deteriorate natural textile fibres. Thus, organic preservation occurs only in such conditions that slow down soil biota activities. These environments are illustrated in the following sections.

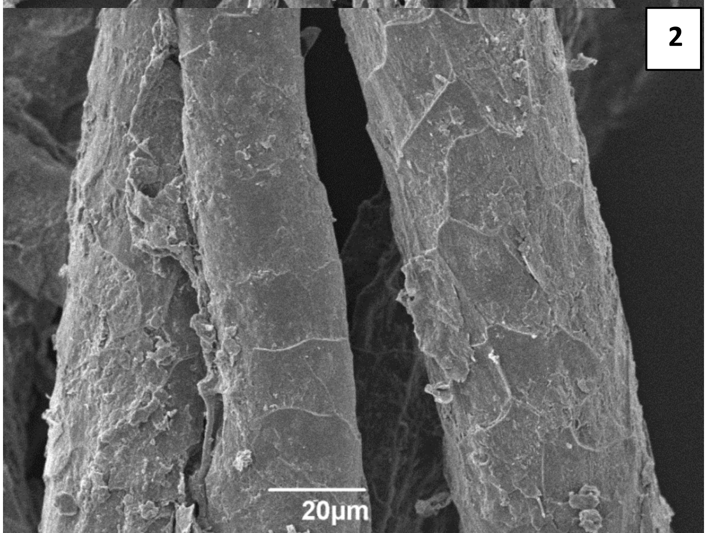
Examples of biodeterioration of textile fibres and human hair are found in some archaeological samples of the InterArChive project and other excavations that the author had examined using the SEM microscope of the Department of Biology at the University of York. The photos included in tables 2.1-5 were produced by that SEM, unless differently reported. The codes reported below mark the samples collected by the InterArChive team.

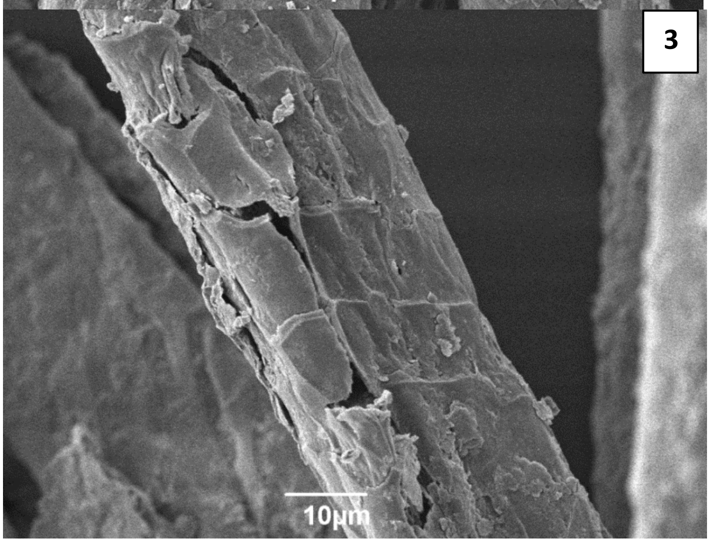
Table 2.3, pictures 1-3: is a sample from SK 1750. The sample was collected close to the feet area of a cadaver in the mass grave of WWI, at Fromelles, Frances. During the analyses, there were found woollen fibres that likely belonged to the socks of the deceased. Mass grave cemeteries are conducive to a slower rate of decomposition (Mant 1987, 72; Haglund *et al.* 2001, 58; Haglund 2002, 248-249) than single grave. It is also reported that when the bodies are very close to each others, the core area of mass grave can preserve soft tissues for years, whereas at the peripheral areas decomposition is faster (Mant 1987, 72; Haglund *et al.* 2001, 58; Haglund 2002, 248-249). Clothing and textiles are likely finds within mass graves (Haglund *et al.* 2001). The causes of differential decomposition in mass graves are not entirely explored. However, it is suggested that the core of compact mass graves is colder than the edges and is an anaerobic environment (Troutman *et al.* 2014). The local soil is heavy clay and slow draining soil. The circle 1A shows cuticular scales have limited damages, while the medulla of most of the fibres is under attack. The circle 1B highlights a collapsed fibre. The complete absence of medulla was caused by fungal tunnels (Wilson *et al.* 2007a). Picture 2 presents the external preservation of wool fibres, while picture 3 reveals fungal tunnels within the fibres, caused by specialised fungi, which destroy only the internal structure of woollen fibres (Wilson *et al.* 2007a, 451; Solazzo *et al.* 2013, 49). The column on the right offers two comparisons. Pictures 4-6 are modern woollen samples that have intact cuticles and no signs of degradation. Pictures 7-8 are archaeological samples from Vindolanda. These show initial signs of deterioration, but the extent of degradation is inferior to the more recent sample of Fromelles.

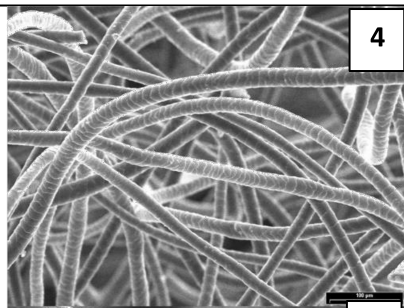
Table 2.3: SEM pictures of woollen fibres (author). InterArChive's collection. SK 1750 Fromelles, WWI mass grave site (1-3). Comparison. SEM picture of modern woollen fibres (reprinted with permission from Lo Nostro *et al.* 2002, fig. 1. Copyright © 2002 American Chemical Society) (4-6); wool fibres find of Vindolanda (7); modern woollen specimen. Scale 10 µm (Cork *et al.* 1997, fig. 5. © 1997, Elsevier) (8).

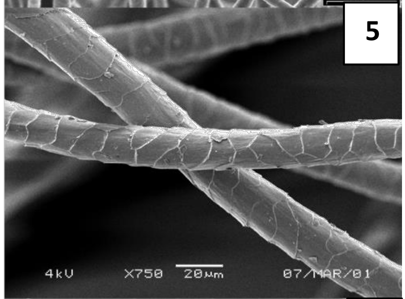
Wool	
Sample SK 1750 Fromelles	Comparison

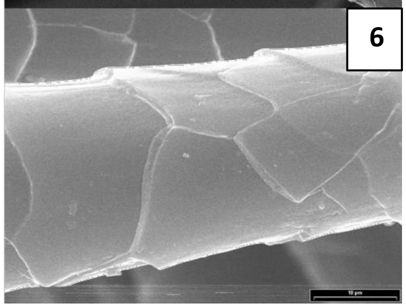


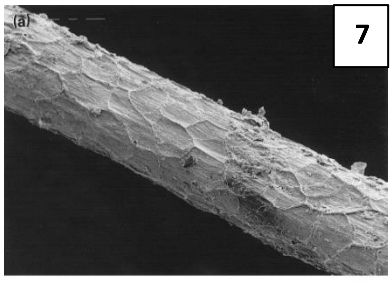












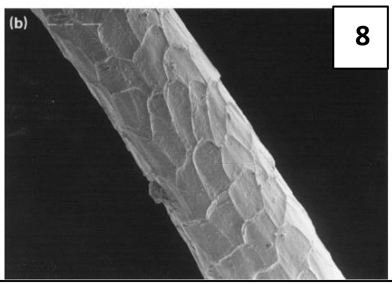
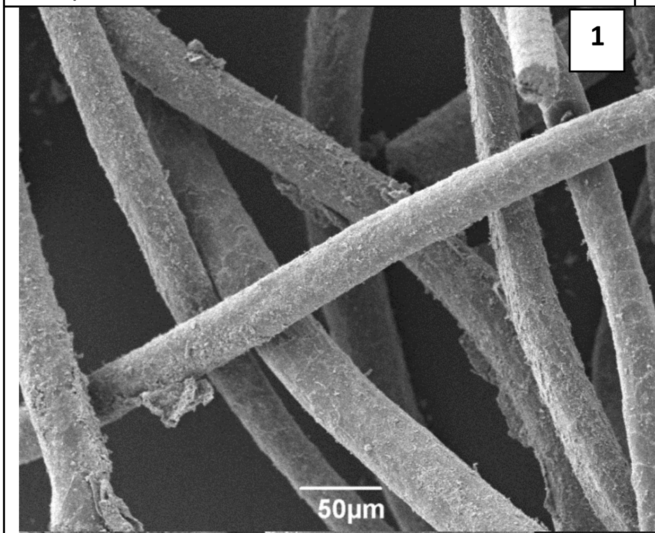
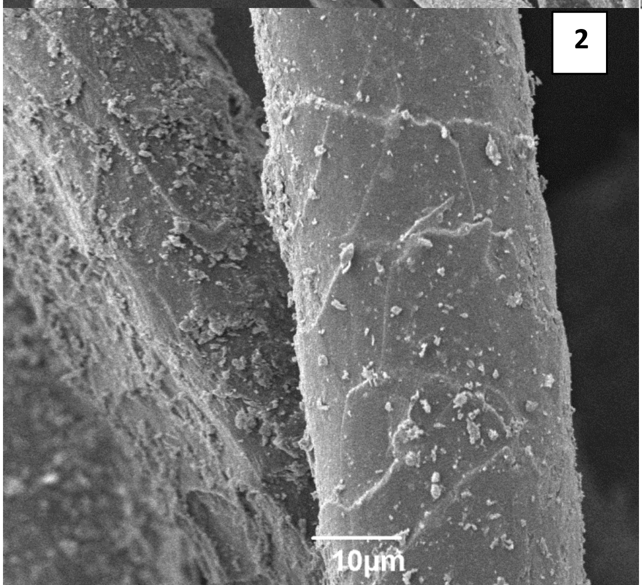


Table 2.4 pictures 1-3 is a sample from SK 1725b. This sample was collected from the mass grave at Fromelles. There are fibres, which were originally wool and processed by felting. Pictures 2 and 3 show cuticular scales that belong to wool. Picture 1 shows the arrangement of the fibres that appear to be felt, even if it is not clear whether this felt was made intentionally or it occurred accidentally. The comparison (pict. 4) shows a modern fragment of felt. The two samples appear different in the degradation of the surface: the modern sample is shiny and smooth, while Fromelles's sample is degraded.

Table 2.4: SEM pictures of felt (author). InterArChive's collection. SK 1525b Fromelles, WWI mass grave site (1-3). Comparison. SEM micrograph of a felt fragment (X 100 magnification) (by Prof Claire Davies, Chris Hardy, released under CC BY 2.0 license) (4).

<table>
<tr><td colspan="2">Felt</td></tr>
<tr><td>Sample SK 1725b Fromelles</td><td>Comparison</td></tr>
<tr><td>



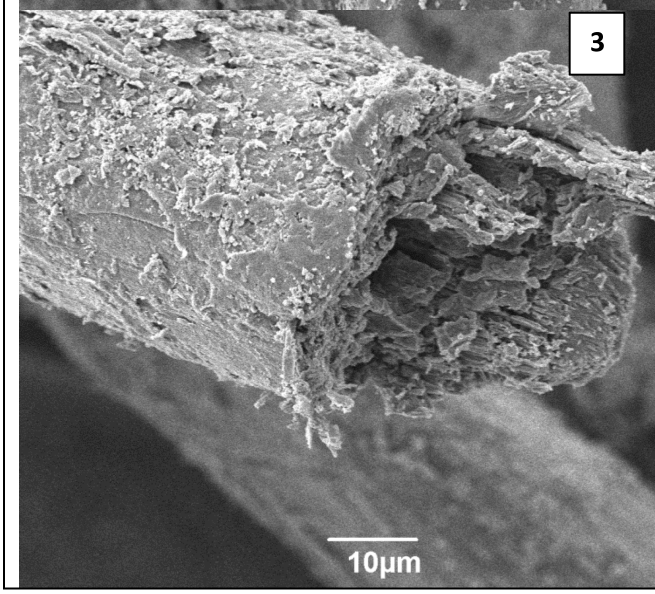
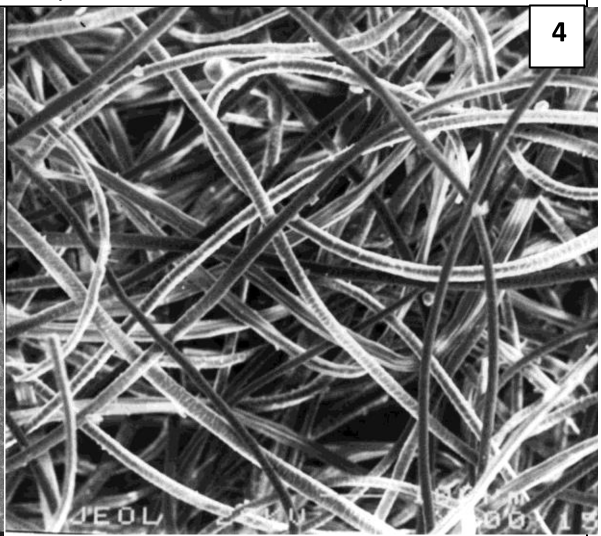

</td><td>
</td></tr>
</table>

Table 2.5 pictures 1-3 is a sample A3 from Mechelen, Belgium, another mass grave site. The local soil is sandy, which is the type of soil with quick water drainage. This characteristic limits bacterial activity, but it can consume textile by friction. Usually, sandy soil is associated with acidic pH, which tends to preserve animal fibres rather than plant fibres. Conversely, the pictures show fibres with plant features, like the hollow tunnel in picture 3. Pictures 4 and 5 display the external rounded joints typical of plant fibres, like fax or hemp. The fibre is deteriorated and shows signs of fibrill ation (pic. 3).

Table 2.5: SEM pictures of possible flax fibres (author). InterArChive's collection (1-3). Comparison. SEM images of modern flax fibres (© 2013 Majda Sfiligoj-Smole, Silvo Hribernik, Karin Stana-Kleinschek and Tatjana Kreže. Originally published in [short citation] under CC BY 3.0 license. Available from: http://dx.doi.org/10.5772/52372) (4-5).

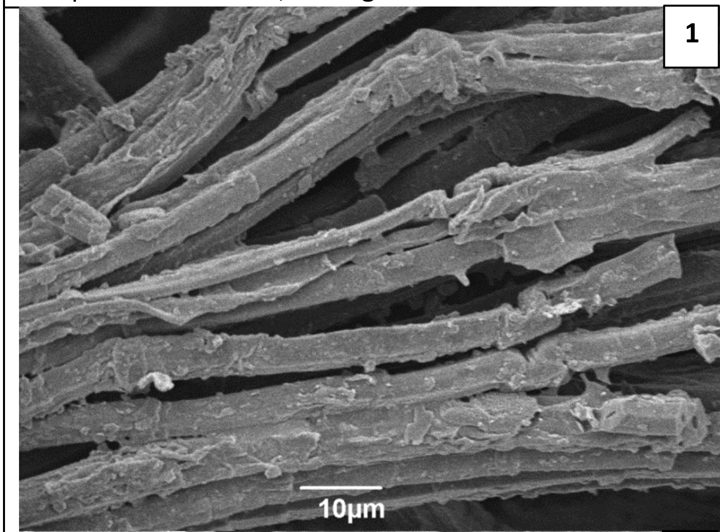
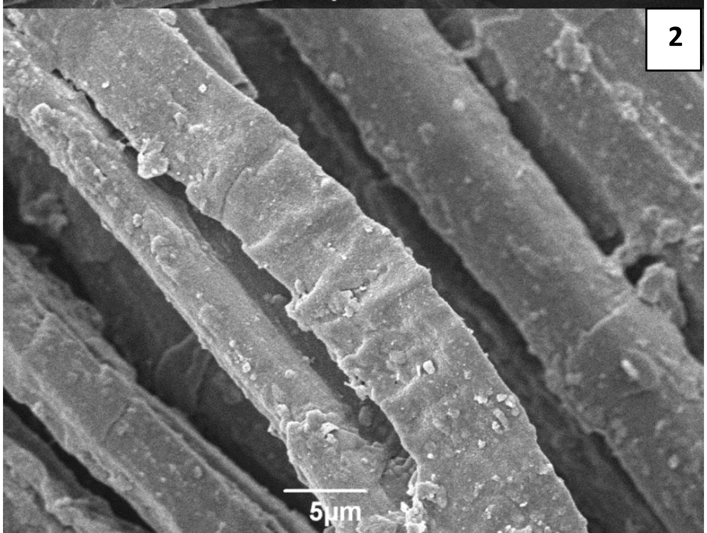
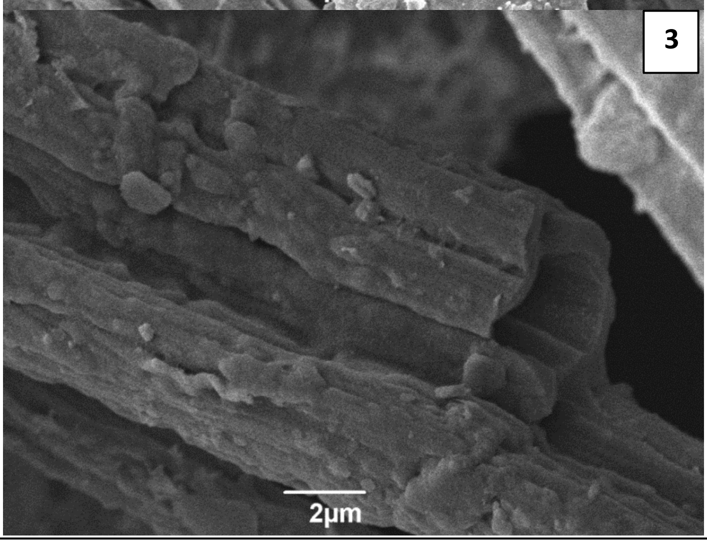
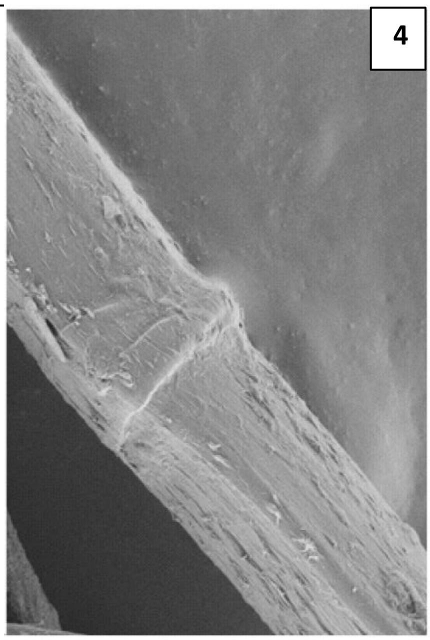
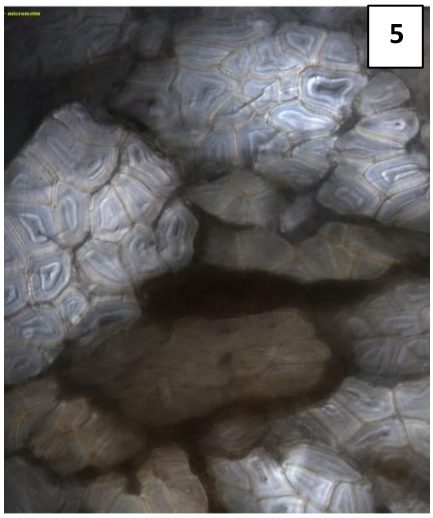
Flax or Hemp	
Sample A3 Mechelen, mass grave site	Comparison
  	 

Table 2.6 pictures 1-4 is a sample of an inhumation burial from the site of Portmahomack, Scotland (Carver 2008). The sample was collected because it was thought to be of fibrous consistency by the naked eye. SEM examination suggests plant origin of this fibrous material. It is not clear whether this "fibrous material" is a textile fibre or grass. Pictures 3 and 4 show circular elements that were not identified, although several comparisons we made.

Table 2.6: SEM pictures of plant fibres from Portmahomak (author). Samples from Brothwell's collection, 1-4).

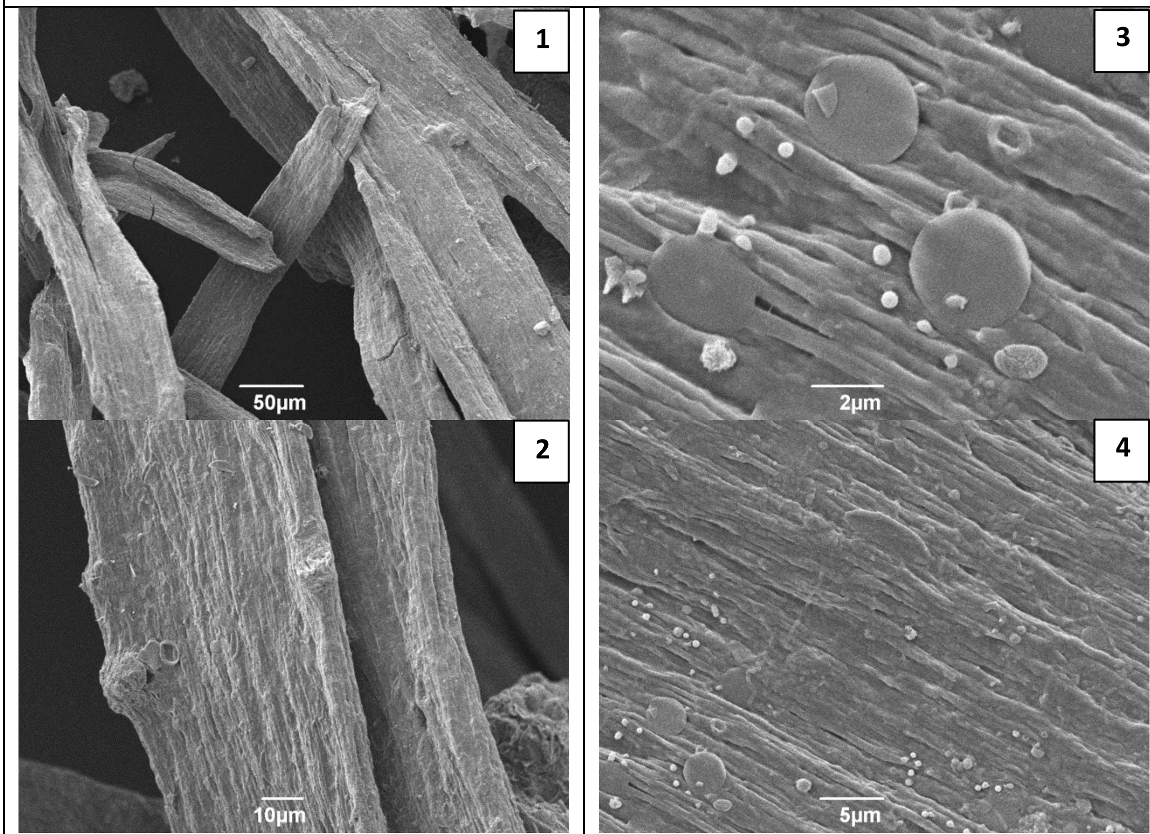
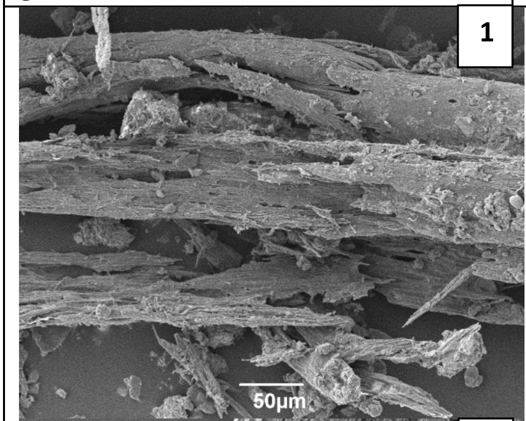
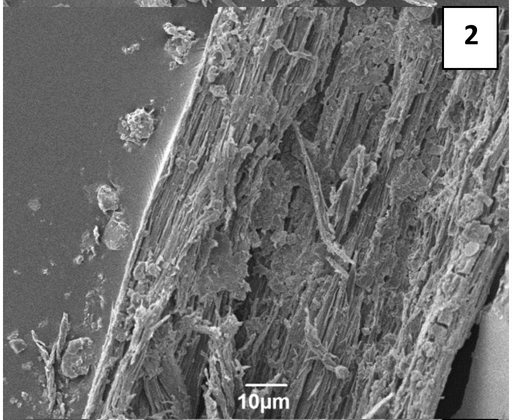
Plant fibres. Sample Portmahomack, Iron age burial.


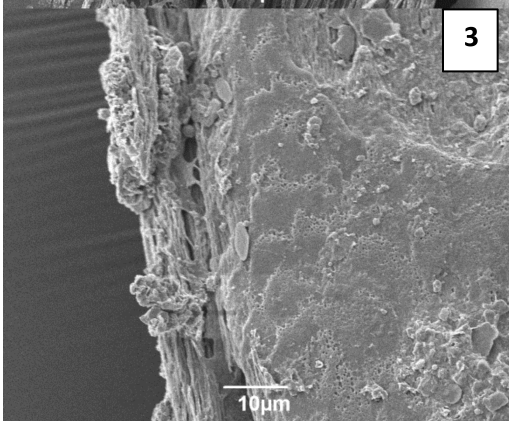
Table 2.7 pictures 1-4 is a sample from SK 289, which was collected from a grave of the 19th century at Fewston, the site being on limestone. Limestone is high in calcium carbonate, which means an alkaline environment. The sample shows highly degraded human hair. There are evident signs of hair erosion and fungal tunnel. The degradation is severe in both the external and internal structure of the hair and picture 4 shows a likely hypha that indicates fungi presence. The second hair sample (pic. 5) was found in tomb 530 of Naqada II. It was excavated by Petrie in 1894-1895. Petrie described the graves to be an unusual type, having a niche on the eastern side, which contained the body. This recess was closed by a row of ash-jars. The body was found in good condition of preservation. External soft tissues were complete and in a dried state. The head was removed from

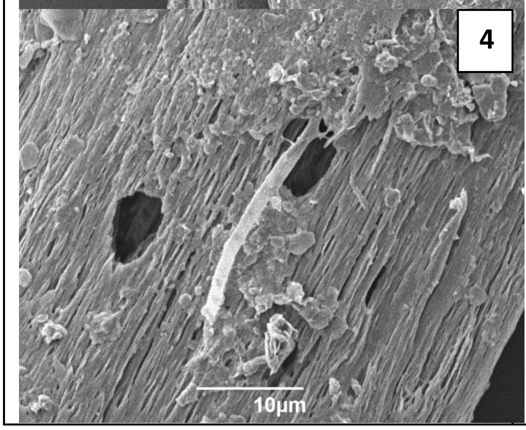
the body and its preserved hair is visibly in good preservation. Petrie also noticed that the arm bones were dyed greenish by the malachite which lay with them (Flinders Petrie and Quibell 1896, 22). The picture shows details of the surface of hair sample from the burial of grave 530 in Naqada II. The cuticular scales are in good condition. Some biological agents adhere to the surface and the cuticles are marked by linear dips, which run along them. These are traces of initial decomposition of the external layer of this hair. Decomposition was likely slowed down by the dry environmental conditions. This archaeological comparison shows the great difference in preservation between the contrasting environments of Fewston and Naqada.

Table 2.7: SEM pictures of possible human hair from Fewston (author). InterArChive's collection (1-4). Comparison. SEM image of human hair from Predynastic Naqada 2 cemetery, grave 530 (photo from Brothwell's archive) (5).

<table>
<tr><td colspan="2">Human hair</td></tr>
<tr><td>Sample SK 289 Fewston, 19th century grave</td><td>Sample grave 530, Naqada II</td></tr>
<tr><td>






</td><td>
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</table>

Since major deteriorations of archaeological textiles are largely determined by biota activities, the following section show the principal factors that slow down biota activity and consequently make better chances for textile preservation. As it has been illustrated in the previous section, soil microorganisms needs specific conditions to life. Temperate climatic regions, like England, satisfy all these requirements (Cronyn 1990; Huisman 2009). Hence, it is assumed that organic preservation is rare in such countries. Conversely, extreme environments, such as warm arid deserts or frozen arctic regions, can limit biodeterioration (Cronyn 1990; Huisman 2009). In temperate regions, circumstances that can impede biodeterioration are the absence of water, oxygen or food.

2.12 Textile pseudomorphs

When in contact with liquids or gases metals corrode (Goeffer 2007, 188-189). The corrosion products of metals, like iron, copper, lead and silver, lead to mineralization that can preserve textile fibres with the partial or total replacement of the organic matter with inorganic matter (Sibley and Jakes 1982; Gillard *et al.* 1994, 132; Chen *et al.* 1998). Mineralization of textiles can produce either positive or negative casts. Positive textile pseudomorphs take place because corrosion products convert the organic fibre into an inorganic morph. Negative textile pseudomorphs are formed because corrosion products cover the surface of the fibre, leaving an organic portion to decay (Sibley and Jakes 1982, 25; Gillard *et al.* 1994, 133; Kite and Thomson 2005, 257). Usually, when biodeterioration starts, it consumes all the fibres. However, some metals, like copper, can reduce soil biomass (Brookes and McGrath 1984) and the activity of microorganisms (Chen *et al.* 1998). Thus, negative fibre casts are frequently associated with iron, which does not have toxic effect on microorganisms, while positive casts are often associated with copper alloy (Janaway 1985, 30; Gillard *et al.* 1994, 137). Different methods have been applied for mineralized textiles, like SEM (Janaway 1983; Jakes and Sibley 1983; Sibley and Jakes 1984) to identify the type of fibre, and organic residues within mineralized fibres have examined with Fourier Transform Infrared (Gillard and Hardman 1996), with light stable isotope analysis (Von Holstein 2012) to identify the geographic provenance of the textile finds, with peptide mass fingerprinting (Solazzo *et al.* 2014) and proteomics (Solazzo *et al.* 2013) to identify the original sources of the fibres.

The experiments prove that mineralization occur in two phases. Firstly, copper ions oxidise disulphide bonds and fill all accessible reactive sites within fibres. Then, copper minerals deposit at those sites within the fibres, when the concentration of copper ions is low. When the copper ions concentration is high copper minerals accumulate on the surface of the fibres (Gillard *et al.* 1994, 134-138; fig. 2.6). Hence, the extent of textile pseudomorphs is related to the speed of reactions, type of fibre and type of metal (Janaway 1985).

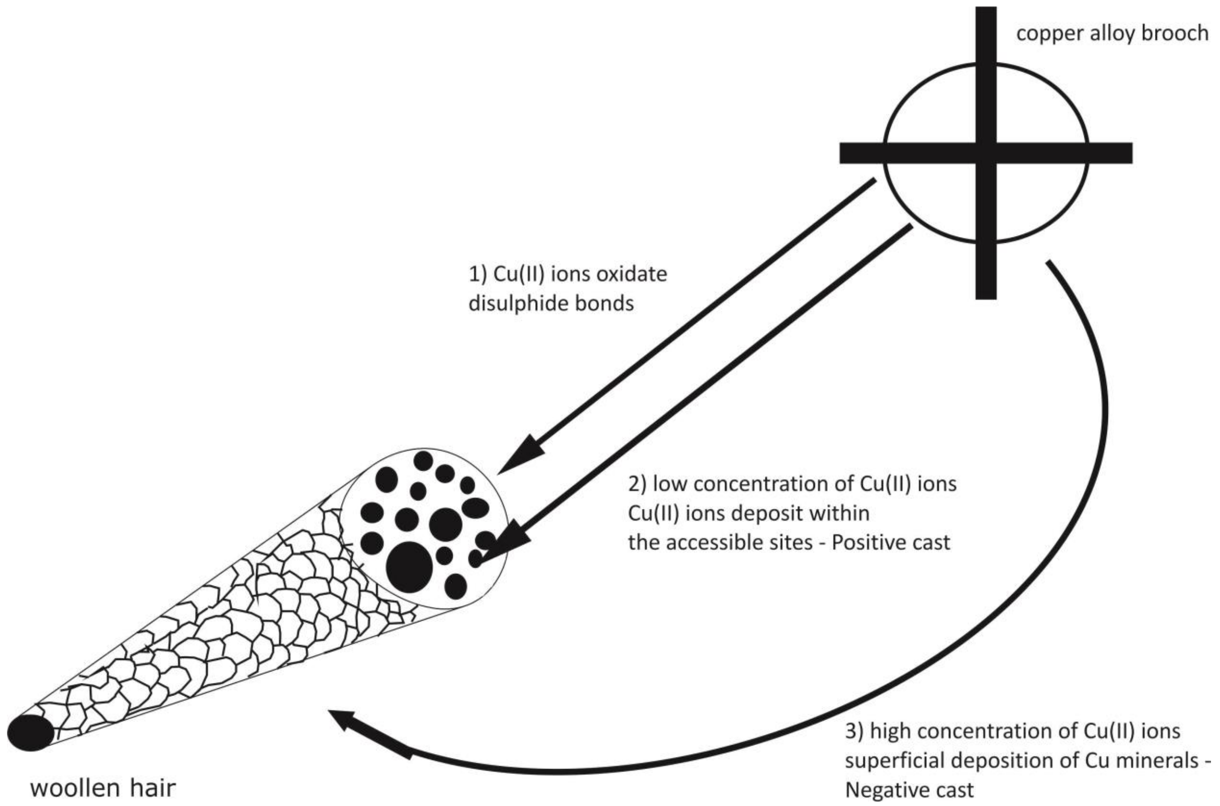


Figure 2.6: Scheme of woollen fibre mineralization, after the experiments of Gillard *et al.* 1994. (Illustration of the author). Stage 1) copper ions oxidise disulphide bonds, filling all accessible reactive sites within the fibre; stage 2) if the concentration is low, copper ions deposit within the fibre; or 3) if the concentration is high, copper ions deposit on the surface of the fibre.

The structure of the fibres influences the speed of mineralization. Fibres with more crystalline regions mineralize more slowly than fibres with more amorphous regions (Gillard *et al.* 1994, 134). Copper ion concentration and the rate of uptake of minerals of the fibres determine the structure of the fibre (Gillard *et al.* 1994, 136). Mineralization offers different degrees of textile preservation, from extremely well preserved fibres, which is rare, to extremely degraded remains (Solazzo *et al.* 2013). The majority of Anglo-Saxon textile finds included in this research (ch. 4) have been preserved through mineralization of fragmentary textiles near metal objects. Mineralization can occur with extensive preservation like in the case of Hochdorf, where textile cloths were used to cover bronze grave goods (Biel 1981; 1984; Körber-Grohne 1988; Banck-Brugess 2012; Appendix 2), and also there are mineralization at smaller scale, such as the burials of Harewood cemetery, where the internal copper tacks of coffins preserved small fragments of textiles (Rowe 2010; Appendix 2) are presented as illustrative examples of mineralized textiles found in the field.

It has been indicated that soil microorganisms are slowed down by the presence of some metals that are toxic for their life (Janaway 1985, 30). Toxic metals like lead, copper and zinc reduce effectively microbial activity in soil as it has demonstrated experimentally (Brookes and McGrath, 1984; Aka and Darici 2004). "Factors such as microbial biomass, specific respiration rate, and potential metabolic activity tend to be particularly affected; while elevated levels of heavy metals in soils can decrease the population size of the microbial communities." (Nwachukwu and Pulford 2011, 1140). However, the mechanism of archaeological textile preservation through metal toxicity it has been not explored. For instance, it was suggested that lead ions had a role in preserving textiles inside lead coffins at Spitalfields, London, but it was not understood the mechanism behind organic preservation (Janaway 1993, 97).

Calcium carbonate and wet alkaline environment produce mineralization of organic materials, including textiles (Cronyn 1990, 28-29). When textile deterioration is complete, calcium carbonate mineralization may preserve only textile impressions, like the case of the Agora, Athens (Unruh 2007; Appendix 2) and Sidon (Doumet-Serhal 2010; Appendix 2). Another preservative process of ancient textiles is charring. In fact, the carbonization of fibres at low-temperature makes them resistant to microbial attacks (Hillman *et al.* 1993, 95). This condition is showed in archaeological examples, such as the charred textile finds of the burials of Ben Himmon valley (Shamir 2007; Appendix 2) and Dedoplis Gora (Kvavadze and Gagoshidze 2008; Appendix 2).

2.13 Textile impressions

Another archaeological evidence of textile is impressions, which is the negative trace of textile fabrics on surfaces like clay, mud, and plaster or other soft materials from architectural features and ceramic pots (Cronyn 1990, 29; Good 2001, 215). Different cultures produced pottery using cloth; this technique leaves clear traces of the textile fabrics on the surface of the pots and occasionally may preserve organic fibre traces encapsulated within the impression (Good 2001, 215). An example of textile impressions on pottery is found on the surfaces of prehistoric pots of the site of Begash (Doumani and Frachetti 2012; Appendix 2).

Additionally, there are funerary contexts where textile impressions are frequent. For example, the late Roman tradition of burying within coffin filled with plaster or gypsum produced evidence of textile impressions. In fact, some of the Roman textile finds included in this work were impressions on the plaster that filled the coffins (e.g. Poundbury ch. 4.3).

2.14 Anaerobic environments

The absence of oxygen is traditionally considered as a crucial inhibitor of aerobic microorganisms (Cronyn 1990, 24-25; Hogg 2005). However, not all biological activities are halted by anoxic environments. In fact, microorganisms vary greatly in their oxygen requirements and some of them are partially or entirely anaerobic (Hogg 2005, 100; Neilson and Allard 2008, 202-203). In archaeology, sealed burials can create an anaerobic environment. There are different types of burials that produce such conditions, like the Bronze Age interred trunk of Rylstone (Grenwell 1877; Appendix 2), the sealed Roman sarcophagus of Aquincum (Hollendonner 1917; Nagy 1935; Wild 1970, 20; Appendix 2), the monumental mound of Lady Dai (Buck 1975; Appendix 2) and the golden casket of the Royal tomb II at Vergina (Andronikos 1984; Gleba 2008; Appendix 2). Waterlogged sites are also conducive of anaerobic conditions (ch. 2.15) and there are example of anaerobic environment where organic preservation occurs, notably bogs (e.g. in Scandinavia, as shown by archaeological finds Halvorsen 2010; Vanden Berghe *et al.* 2010 and experimental studies Solazzo *et al.* 2013).

2.15 Waterlogged environments

Waterlogged sites can protect organics in excellent conditions. Sites such as low-lying urban sites, perched water tables, wetlands, river floodplains, lakes and marine environments may preserve archaeological remains. The principal cause of preservation is the absence of available oxygen for microorganisms because the soil is saturated with water (Cronyn 1990, 26). Thus, aerobic biodeterioration is impeded (Cronyn 1990, 26-27), whereas anaerobic degradation (Betina and Frank 1993, 713) and hydrolysis (Cronyn 1990, 26) continue. Archaeological sites that are under the water table such as peat bogs (ch. 2.15.1), low-lying urban sites, such as Coppergate (Walton 1989; Walton-Rogers 1997; Mould *et al.* 2003; Appendix 2) and Spitalfields (Thomas 1999; Appendix 2) are waterlogged and produced evidence of preserved clothing.

2.15.1 Bog bodies

Bogs are special environments that prevent decay of organic materials because of wet, acidic and anaerobic natural conditions. In North-Western Europe, several buried bodies have been found in bogs, which are now referred as “bog bodies” (Brothwell and Gill-Robinson 2002). Usually those cadavers preserve all keratin parts (hair, nails and wool) as well as skin and leather, decalcified bones, by the effects of bogs (Brothwell 1986, 78; Brothwell and Gill-Robinson 2002; Goffer 2007, 229; Pestka *et al.* 2010). It has been observed that the absence of oxygen, the occurrence of sphagnan, a polysaccharide in the sphagnum moss, and tannic acids are the key element of preservation of all animal soft tissues (Van der Sanden 1996, 180). Conversely, tannic acids demineralize bones (Pestka *et al.* 2010, 394).

However, not all peats offer similar conditions for preservation. Raised bogs prevent the decay of animal soft tissues and hair, thanks to sphagnum moss and high acidity (Pestka *et al.* 2010, 394), while fen peats keep skeletons but no other organic substances (Van der Sanden 1996, 74). Additionally, different studies have attributed a significant role to the speed of emersion of the body in the bog (Brothwell 1986; Van der Sanden 1996), while analyses of lipids have provided a better comprehension of the processes of degradation (Evershed 1988). Consequently, the name “bog bodies” defines cadavers from different periods, regions and causes of death. (Munksgaard 1984) that are found in wetland peat deposits (Brothwell and Gill-Robinson 2002, 122). They cannot be considered as a conventional burial ritual for any archaeological culture.

The possible clothes and other organic grave goods associated with the bodies can benefit from the ideal preservation conditions offered by the bogs. Materials such as leather, skin or wool might subsist (Huisman *et al.* 2009, 59 and 85), whereas acid bog environment hardly allows the survival of vegetable fibres in identifiable form (Pyatt *et al.* 1991, 62; Huisman *et al.* 2009, 84). Not surprisingly some bog bodies have provided evidence for clothing (Appendix 4.3 provides a long but not complete list of European bog bodies and their associated clothing). Incidentally, several bog bodies have been recovered totally or partially naked and it has appeared questionable what caused their nudity. Lindow II, better known as “the Lindow man”, could be a good case study to explain the occurrence of apparent nakedness of some bog bodies. He was found during peat-works and the lower part of the body was cut and partly lost. The remains belong to a young man in good physical condition and well-nourished who died a violent death (Connolly 1985; Stead *et al.* 1986; Brothwell 1986). Lindow man has raised several questions, about his identity, the cause of his death, and if he was buried intentionally. The scanty grave goods associated with him do not help the interpretation. Significantly he was discovered almost naked, except for a fox fur arm band, a leather cord and a little iron object (rod), which does not have any archaeological known counterpart (Stead *et al.* 1986).

On the one hand, the nudity of Lindow man has been hypothesised as a casual burial or more convincingly as a ritual which prescribed a naked burial linked to a particular social status, as “a king or a pauper” (Brothwell 1986). On the other hand, it has also been demonstrated that the recognition of vegetable fibres in bogs is difficult (Pyatt *et al.* 1991; Van der Sanden 1996, 18; Peacock 1996, 39). Consequently, it is not easy to take into account the possible presence of vegetable clothing, possibly consumed by the bogs. This could be a likely suggestion, even if far from being proved, why numerous Bronze and Iron Age bog bodies of Northern countries have been recovered almost naked except for objects made from animal materials, like the fur band and the strip of Lindow man (Stead *et al.* 1986).

Incidentally, Lindow III, another bog body found at Lindow moss dismembered into 70 pieces by a conveyor belt, exhibits traces of dye over his skin (Turner and Scaife 1995). The excessive incidence of various metals and silica has been interpreted as probable residues of a clay-based colorant, which had at least partially covered Lindow III (Turner and Scaife 1995, 65). This dye has been interpreted as having a similar function to pigments in use among various British populations in different historical periods (Pyatt *et al.* 1991). However, hypothetically it may be advanced that those pigments are the last traces of coloured clothes in vegetable fibres, which the bogs have consumed. In fact, further evidence of dyed clothing worn by bog bodies it was found in Scandinavian bogs (Vanden Berghe *et al.* 2009). It has proven experimentally that some dyes can alter textile degradation. In fact, madder-dyed woollen textiles have a slower rate of degradation than undyed, wed-dyed and indigo-dyed textiles (Solazzo *et al.* 2013, 54-55).

2.16 Dry and arid environments

Water is an essential element to start chemical reactions (Brown and Brown 2011, 237) and for soil microorganisms (Hogg 2005, 394-395). The complete absence of water in soil is not common, but it can occur in arid and semi-arid regions, where evaporation exceeds precipitations, such as in the deserts. Moreover, limited availability of water can occur in very cold regions, where the water turns into ice, such as arctic regions. The absence of water or its inaccessibility is relevant for organic preservation. There are excellent cases of clothing preservation in an extremely cold site, such as Herjolfsnæs, Greenland (Nørlund 1924; Østergård 2004; Appendix 2) and in an arid site, like Chehr Abad Douzlakh, Iran (Pollard *et al.* 2008; Aali *et al.* 2012; Mouri *et al.* 2014; Appendix 2).

2.17 Experimental burials containing textiles

Experimental studies have been produced in order to understand mechanisms of textile degradation in different environments. Potential outcomes of these approaches are extremely useful for archaeological interpretation of finds in the field and post-excavation studies. For example, recently experimental buried textiles revealed that processes of wool degradation are different according to which protein is affected by an external agent, either biological or chemical (Solazzo *et al.* 2013).

Some experimental studies aiming at the taphonomy of organic textiles have already been cited above. Here, some of them are explained in more detail relative to the results of degradation of textiles. In the USA, the body farm experiments are concerned to provide evidence of material decay for forensic purposes (University of Tennessee 2011). Similarly, in the United Kingdom, the Experimental Earthwork Project (Bell *et al.* 1996), Robert Janaway's studies and the InterArChive project, have all tried to fill this gap for archaeology. Here it is important to explain their main purposes.

The Earthwork project was proposed in 1958 during the Charles Darwin centenary meeting of the British Association for the Advancement of Science, the research committee aimed to examine experimentally the formation, alteration, preservation and retrieval of archaeological records in the short and middle-term from experimentally constructed earthworks (Bell *et al.* 1996). The plan was to create two earthworks, which would be tested with an interdisciplinary approach for a period longer than one century. The selected sites were Overton Down, near Avebury, Wiltshire, which was made in 1960 (Jewell 1963) and Morden Bog, near Wareham, Dorset, which was built in 1963 (Evans and Limbrey 1974). The two locations were chosen for their different soils; the first one is in chalky soil, whereas acidic heathland is the soil of the latter. It was planned to dig up samples periodically on a progressive time scale of 1, 2, 4, 8, 16, 32, 64 and 128 years (Bell *et al.* 1996, tab. 1.1). The original excavation program has been modified for Wareham because of difficult conditions and it was rescheduled (Bell *et al.* 1996, tab. 1.1). Both earthworks had sets of banks and ditches to compare possible changes in their size and shape. All banks and ditches contained structural archaeological features and different materials were buried: wood, metal, glass, human and animal bones, leather and textiles (Bell *et al.* 1996; Lawson *et al.* 2000).

At Overton, samples were buried in chalk and in turf environments. The selected buried textiles fibres include dyed and undyed cotton, wool with chromium mordant and without mordant and half-bleached flax. Leather was buried in all environments (Janaway 1996). At Wareham, textiles cloth, leather and raw goatskin were buried in sand and turf environments. Cotton and half-bleached flax cloths were not included in these burials. The woollen and flax cloths were buried with a copper coin and a steel discs in direct contact (Bell *et al.* 1996, 217) (tab. 2.8).

Table 2.8: Textiles and leather degradation in the experimental burials of Overton Down and Morden Bog, Wareham. Scale of preservation 4 = well preserved; 3 = local degradation; 2 =general degradation; 1= traces only (diagram reworked from Bell *et al.* 1996, tab. 14.1 © Bell *et al.* 1996).

M metal association
○ no trace
■ no record

	Overton Down										Wareham Heath									
	Chalk					Turf					Sand					Turf				
years	2	4	8	16	32	2	4	8	16	32	1	2	5	9	17	1	2	5	9	17
Undyed cotton plain cloth	3	2	○	○	○	○	○	○	○	○	not present					not present				
Dyed cotton twill cloth	4	4	3	3	3	○	○	○	○	○	not present					not present				
Wollen cloth with chromium mordant	3	3	3	2	2	2	1	3	2	○	3	3	3	M 3	M 3	3	■	3	M 3	M 2
Wollen worsted garbadine	4	2	3	3	2	2	1	3	○	○	3	3	2	M 2	3	3	3	2	M 2	M 2
Flax unbleached Wareham half-bleached Overton	4	3	3		3	1	○	■	○	○	M 3	■	■	M 1	M 1	M 3	■	■	M 1	M 1
Flax half-bleached	3	4	3	2	2	1	○	■	○	○	not present					not present				
Leather	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Raw goatskin	not present					not present					■	■	1	1	M 1	■	■	2	M 1	M 1

It was observed that textiles buried in the turf degraded at a faster rate than those buried in the chalk and in sand, except for leather that reveals to be the most resistant material in all environments. However, leather buried in sandy burials was detanned by water drainage (Bell *et al.* 1996, 241). Conversely, raw goatskin degraded easily. Evidence of microorganisms were found on the majority of the textile fibres, expect on the dyed cotton in the chalky burials. No traces of textiles were found after 32 years at Overton Down (Bell *et al.* 1996, 238). Woollen cloths were better preserved than plant fibres cloths in both sites, but they still showed signs of deterioration and complete decay in turf burials at Overton Down. Undyed cotton was more sensible to biodeterioration. Cotton cloths buried in turf at Overton Down degraded completely within the first two years and also flax cloths were subject to intense decay, leaving only fragmentary evidence after the first excavation (Janaway 1996; Bell *et al.* 1996, 217-221, 238-241). All textiles buried at Wareham were completely degraded after 33 years (Lawson *et al.* 2000), except for those associated with copper and steel discs. Thus, short-term experiments were conducted to reassess the early stages of degradation of flax, hemp, cotton and goatskin (Lawson *et al.* 2000). The results indicate that plan materials were readily decomposed by selective soil microorganisms, attracted by carbohydrates, mostly cellobiose (Lawson *et al.* 2000, 283). It was noted that microorganism had limited response to flax cellobiose, resulting in slower decomposition of flax material, but it was not found an explanation for this difference (Lawson *et al.* 2000, 283). Goatskin was decomposed by microorganisms that consume more substrates, including amino-acids and carbohydrates (Lawson *et al.* 2000, 284). Three compatible ways are suggested to explain the presence of carbohydrate decomposers in the goatskin sample.

1. "… micro-organisms associated with the goatskin were exploiting other C sources in the soil and there could have, therefore, been a priming action in which the added material was promoting the decomposition of some of the C from the original turf." (Lawson *et al.* 2000, 284).
2. "… micro-organisms which were active in the soil associated with the goatskin were capable of amino acid utilization were also capable of carbohydrate utilization." (Lawson *et al.* 2000, 284).
3. "… a component of the microbial community associated with the goatskin was utilizing the metabolites and products of the primary colonizers of the goatskin and some of the compounds involved were carbohydrates." (Lawson *et al.* 2000, 284).

The InterArChive project (University of York 2012), funded by the European Research Council and led by Professor Don Brothwell, beside chemical and micromorphological analyses of soil samples from archaeological burials, has provided a series of experimental burials in order to identify decomposed traces of biological degradation (Usai *et al.* 2014). The author of this thesis has taken part to the InterArChive project as associate, after it was already started. He contributed in the discussion of the partial results during the internal meetings on an archaeological perspective, presented to the symposium “InterArChive: expanding the horizons of human burial research” and has participated to the excavation of some burials.

The InterArChive experiments started in 2010 and the burials were placed in five sites in Yorkshire, and all of them contained the bodies of piglets. The contrasting soil composition was a criterion for the selection of the sites. The conditions of the burials were intentionally different. The experimental burials were in Hovingham, which had one burial in controlled clear sand and another in crushed limestone. At King's Manor, York one piglet was buried in loamy garden soil. Three burials were placed at West Heslerton, which is a lacustrine sand-rich soil. Two piglets were buried at Folkton, which is a peaty soil context. The last three piglets were inhumed at Heslington east, York, which is an acidic heterogeneous sandy soil.

The piglets have been buried with coffin or without coffin, and with or without dissimilar and organic grave goods, like hair, beeswax, tobacco and oats. At the experimental sites of West Heslerton, Heslington East (fig. 2.7) and King’s Manor in York and Hovingham, burials had associated muslin bags containing selected organic materials buried with the piglets.

Muslin is a woven cotton fabric, which is usually a white cloth, produced from carded cotton yarn. One of its main characteristics is its porosity. Therefore, air and water can move simply through muslin. The buried muslin bags associated with piglets’ remains were observed by the naked eye and have been registered during the burials’ excavation by the InterArChive team and the writer. Micromorphologists and chemists have continued their analyses in the lab. The writer participated to some excavations. The following sections report the observations made during the two excavations at Hovingham and Heslington East.

Two burials were at Hovingham, and they were dug up on the 29th September 2012. The first piglet was interred in limestone soil at half metre depth, at the end of a slope. The lower side of the burial was closed by the foundations of a shed. Consequently, possible rainfall could have drained away slowly except for bones. The piglet remains had almost disappeared and any trace of the muslin bag was not observed. Conversely, evidence of the pupae of insects was still identifiable and they testify to intense biological activity in the burial. The massive decomposition of the body and the associated materials may be ascribed to bacterial spread and to fungi. The second Hovingham grave was a coffined burial. It was excavated in sandy soil in a gentle slope, without any close obstacle. This case has revealed a better preservation of the piglet bones and traces of filamentous dark white materials, which was interpreted by macroscopic analysis, as the degraded muslin bag, after around two years and a half of interment. Many traces of biological activity were found.

At Heslington East, the three experimental burials were excavated on the 18th October 2012. The area is periodically subject to waterlogging. The NERC (2011) web site describes the area with the following definitions: the soil group is from light to medium, the soil thickness is deep, the grain size of the parent material is fine and according to the "European Soil Bureau Description" is breccia and sandstone and the soil texture is loamy (Cranfield University 2012). All the burials were associated with a muslin bag placed at the head and thorax of the piglet bodies. Piglet 5 had a muslin bag placed beneath the snout and another near the abdomen. Piglet 6, which was coffined, had a muslin bag beneath the snout. Piglet 7 had a muslin bag under the snout and another that was near the body but not attached to it. Deteriorated filaments of muslin bags have been found. They were still identifiable by the naked eye but the conditions of preservation were extremely poor. Some remains kept the resemblance of weave, but they were loose and in small pieces.

From a strict archaeological perspective, the experimental piglet burials have some limitations. In fact, some caveats have been raised in the use of pigs as human analogues, because of the differences in the rate of degradation (Notter *et al.* 2009) and in some physical attributes, such as different leg length (Schotsmans *et al.* 2014, 141.e3). Nevertheless, pigs have been successfully used in several experimental burials because of the similarities in their physiology, fat muscle ratio, internal organ distribution and omnivorous diet (Payne 1965; Rodriguez and Bass 1985; Wilson *et al.* 2007; Lowe *et al.* 2013, 332). However, the differences between newborn pigs and adult humans are less explored, while it is well-known that young mammals have different body composition than their adult counterparts (Moulton 1923). Secondly, the burials did not replicate any specific archaeological interment, such as an Anglo-Saxon or a Roman grave, and there were not buried metal objects within the graves, as it has been done in other experimental burials (Janaway 1985).

In conclusion, the two experimental cases proved that muslin is an extremely perishable material under the conditions provided by the InterArChive experiments. A shorter span than three years was sufficient to destroy the original shape of the bags in all types of soils. The position of the bags in comparison with the piglets has not shown particular differences in deterioration, at least by the naked eye. It is assumed that the biological activities under the earth and the seasonal rainfalls were the main causes of muslin decomposition in both Heslington East and Hovingham.

Figure 2.7: Heslington east, York, experimental burials (first publication in © Antiquity Publications Ltd. Usai *et al.* 2014, fig. 5).

Among several experimental activities aiming to investigate taphonomy of organic matter, Janaway has raised the interest in textile taphonomy from archaeological and forensic perspectives. His studies on textiles pioneered archaeological work (Janaway 1983; 1985; 2002). He investigated relations between organic textiles and metals and how preserved fibres may occur in burial contexts. Among, the several updates he produced, he highlighted the theoretical ratio between metal influence and textile preservation, and the different outcomes of plant and animal based fibres associated with either copper alloy or iron objects (Janaway 1983; 1985). The experiments of Janaway (1985) illustrate the importance of time for mineralization of textiles.

Recently, forensic and archaeological studies have aimed at similar targets and their results can be used in both disciplines. This bond between the two disciplines has produced studies and experiments that may have interesting outcomes in both fields. The range of variability in soil taphonomy is extremely wide and difficult to reduce to simple patterns. Hence, experiments, which begin with similar bases, may produce different results.

For example, it is worth comparing results of a recent forensic experiment (Lowe *et al.* 2013) carried out in Canada. This study aimed to investigate the effects of different soil texture on textiles associated with decomposing bodies (Lowe *et al.* 2013, 332). Thirty clothed pig carcasses were buried in three sites with different soil characteristics: silty clay loam, fine sand and fine sandy loam. All carcasses were "dressed" in both natural cotton and blend cotton and synthetic clothing (Lowe *et al.* 2013, 332). Additionally, there were five control burials containing only cotton and mixed cotton-polyester clothing in each site. All the graves were 0.76m deep. The experiment ran for 14 months. Bodies were exhumed after 2, 12 and 14 months (Lowe *et al.* 2013, 332). Qualitative and quantitative analysis of fatty acid composition using IR spectroscopy and GC–MS was applied to all collected samples of textiles (Lowe *et al.* 2013, 333). All the carcasses after two months were in the autolytic stage, while after twelve and fourteen months were in the putrefactive stage. The control burials showed visible degradation of the cotton shirt after two months, serious degradation after twelve months and complete degradation after fourteen months in the silty clay loam and fine sandy loam field sites. The fine sand site preserved only a small cotton fragment extremely degraded. The cotton polyester briefs resulted no degraded at the naked eye in all three stages (Lowe *et al.* 2013, 333-334, fig. 1). Conversely, at a macroscopic scale, after all three stage exhumation, it was observed that both natural cotton and cotton-polyester clothing were well preserved in all burials with pigs after exhumations (Lowe *et al.* 2013, 334, fig. 2).

Essentially, this experiment demonstrated that when clothing was associated with the pigs, textiles were preserved. In contrast, clothing buried without carcasses was consumed in silty clay loam and fine sandy loam, while something was left in the burial with fine sandy soil. The principal outcome of this experiment demonstrates that at a macroscopic scale, cotton clothing is better preserved in association with a corpse rather than on its own, at least up to 14 months. Secondly, it shows that cotton responds to different soil textures almost in the same way up to fourteen months burial. Not surprisingly, the analyses of the textiles revealed that microbial biomass was greater in the burials containing the carcasses than in those with only clothing. Hence, a mechanism of competition leads to different microbial activity between the burials containing carcasses and the burials without carcasses (Lowe *et al.* 2013, 335-338). This may explain different preservation between clothing associated with pigs, and clothing with no association. In fact, bacteria released during pig decomposition are not able to degrade cellulose, which results into cotton preservation. Conversely, cotton buried without a decomposing body was attacked by microorganisms that degrade cellulose (Lowe *et al.* 2013, 336).

This result appears to be in contrast with the extreme degradation of the muslin bags associated with piglet bodies of the InterArChive project. In fact, it is not the case. The decomposition of the human analogues played a key role in the preservation of cotton. The Canadian experiment did not register the complete skeletonization of the carcasses, while the InterArChive piglets were skeletonized. Climatic differences between Southern Ontario, Canada and North Yorkshire, England and contrasting physiologies between adult pigs and piglets (Moulton 1923) influenced the rate of decomposition of the carcasses. Thus, it is suggested that InterArChive piglets underwent to faster decomposition, which lead to total or almost complete degradation of buried muslin bags.

Both the InterArChive project and Lowe' experiments (Lowe *et al.* 2013) explored processes of organic degradation underground, but they were addressed to answer different queries and they have employed different methods (tab. 2.9). Nevertheless, Lowe' study (Lowe *et al.* 2013) contributes to the understanding about complete degradation of buried muslin bags of InterArChive project.

Table 2.9: differences between InterArChive and Lowe *et al.* 2013 experiments.

	InterArChive	Lowe *et al.* 2013
Research purposes	Recovering cultural and environmental information of organic degradation from burials containing piglet carcasses and associated organic goods.	Defining the role of body decomposition and soil in deterioration of buried clothing associated with pig carcasses.
Disciplines	Soil micromorphology and chemistry	Chemistry
Body analogues	Newborn pigs	Adult pigs
Experimental burials	Coffined and un-coffined	Coffined
Soil types	Clear sand; crushed limestone; acidic heterogenous sandy soil	Silty clay loam; fine sand; fine sandy loam
Timing	Exhumation after 18-20 months after burial	Exhumations after 2, 12 and 14 months after burial
Analyses of soil samples	SEM and MALDI microscopy; Trace organic analysis: GC; GC-MS; LC-MS; pyrolysis GC-MS; Elemental Analysis: composition of C, H, N, S and O; Total inorganic and total organic carbon.	None.
Analyses of textile samples	None.	ATR-FTIR spectroscopy; GC–MS.
Textile preservation	Total degradation of muslin bags.	Gradual degradation of cotton t-shirts in control burials; preservation in burials containing carcasses.

However, to some extent the contrasting results of the two experiments provide some suggestions. Type of soils, burial features, position of the fabric textile and dimension of the carcasses may produce different outcomes in preservation. For example, it is assumed that the presence of coffin and the depth of the burial can change the chance of preservation of textiles. Similarly, decomposition of the body influences degradation of associated organic clothing (Lowe *et al.* 2013). In this respect, there may be differences between an adult pig and a piglet in terms of degradation products. In fact, differences in body composition between adult and juvenile mammals were earlier observed by Moulton (1923).

The following sections will describe the other two main elements, which have a primary role in the deterioration of buried materials: soil (ch. 2.18) and the human body (ch. 2.19). Both aspects show numerous variables and changes that are diverse, but interact and even affect associated material, such as possible clothing on the dead.

2.18 Soil features

Soil is classified variously according to the different academic disciplines. In fact, several sciences are directly concerned with soil such as soil science, geology, biology, mineralogy, geography, chemistry and ecology. Archaeology also has a great interest in soil, since almost all archaeological finds come from earth. At the dawn of the discipline, archaeology was deeply influenced by geology in many ways, and especially in matter of studies of soils and rocks (Herz and Garrison 1998, 4-6). Consequently, archaeological descriptions of soils have been acquired from the soil sciences, even if the point of view of archaeologists is different from that of geologists and soil scientists. However, awareness and understanding of the importance of systematic and specific studies of soil in archaeology is far more recent matter (Renfrew 1976).

Currently, recording, understanding and interpreting soils is a crucial part for archaeological studies. Soils are considered important, as artefacts and buildings, in the examinations of contexts. Particularly, soil formation, composition, texture and structure are relevant for understanding the palaeoenvironment, past human activities and site formation processes (Goldberg and Macphail 2006). Consequently, main soil features are recorded by field archaeologists. For example, the colours, the texture or the particle size, the inclusions or more correctly coarse materials, compaction, dimensions in plan and elevation and surface treatments are suggested to be recorded in the field archaeological reports (Roskams 2001, 173-183).

Soil is defined as “a generally loose, porous mixture of materials the porosity of which is the result of aggregation of organic and/or inorganic soil particles” (Camps Arbestain *et al.* 2008, 629). Soil can be morphologically determined as unconsolidated surface material forming “natural bodies” made up of mineral and organic materials and the living matter within them. Soil is not a static entity. On the contrary, it evolves continuously and it is in influenced by material addition, subtraction and transformation (Camps Arbestain, Macias Vazquez and Chesworth 2008, 629). Initially the bulk of soil derives from what is called parent materials, which are the basal parent rocks, and other material transported from different places to the current site. Secondly, a combination of climatic factors and living species modify the material in soil. For instance, the presence or absence of water is a relevant climatic factor, while plants and human presence are representative of living activities.

Additionally, it must be remembered that the soil of inhumations, which are the main interest in this research, responds to further processes. In fact, inhumations are defined to be non-deposits (Roskams 2001, 199), because their formation is different from the proper archaeological deposits. Inhumations are usually cut into the soil with different shapes, and then a bed of various materials may occur at the bottom. The corpse may be laid in a coffin with grave goods and other associated artefacts or nothing and finally earth is thrown in to back-fill the hole. It is evident that the knowledge of soil composition and processes helps to comprehend this transformation and decay of buried inorganic and organic materials.

An explanatory scheme of the composition and transformation of soil to emphasize the processes and agents of decomposition in soil is given below. Soil is made of four primary components: mineral or inorganic matter, organic matter, air and water (Koorevaar *et al.* 1983, 1; ch. 2.18.1-4). More details of soil formation factors are reported in Appendix 4.

2.18.1 Mineral or inorganic material

The mineral and inorganic matter may be of crystalline composition or amorphous structure. As written above, minerals have a crystalline composition. Crystals are chemically defined by their own molecular formula. Nickel states that a mineral "is an element or a chemical compound that is normally crystalline and that has been formed as a result of geological processes" (Nickel 1995, 346). However, even if this definition includes almost all substances, which usually are known as minerals, there are some exceptions with different characteristics. One specific, but not essential, characteristic of minerals is having a crystalline structure. Crystalline structure is the organization of atoms, which can generate an "indexable" diffraction pattern when waves of suitable wavelength, such as X-rays, electrons, neutrons or others, cross the substance (Nickel 1995, 347). However, soil includes also amorphous matters that are not organised in a crystalline structure (Voroney 2007, 32-33).

Minerals are distinguished between stable and no-stable (Hawthorne 1992, 25-26). The firsts tend to maintain their structure under a wide range of changes in pH, pressure and temperature, while no-stable minerals have limited stability and respond to changes collapsing their structures into new forms. It is worth taking into consideration the fact that the mineral' surface may have an associated charge, which is principally negative, but sometimes it occurs positively. Charge provides specific properties to minerals, such as shrink–swell capacity of clay, and it participates to clay formation processes (Koorevaar *et al.* 1983, 16).

2.18.2 Organic components

The organic matter of soil can be defined as humic and non-humic. Non-humic matter includes all organic compounds such as proteins, peptides, amino acids, carbohydrates, fats, waxes and organic acids, whereas all organic materials with no specific physical and chemical features constitute humic soil (Schnitzer 1978, 1-2). Carbon compounds are the basis of organic materials (Conklin 2005, 58-59) and carbon plays a principal role in soil deposits (Horwath 2008). Carbon cycle determines the life and evolution of soils through the processes of fixation and mineralization that are led by bacteria, invertebrates and fungi, which operate on plant litter, roots and other organic remains (Betina and Frank 1993, 713). Consequently, biochemical activity use and creates organic molecules in soils. Soil litter, roots, leaves, insect and other animal activities are more concentrated near the surface of soil, and their dynamic interactions produce organic material that is accumulated on the surface (Herz and Garrison 1998, 40-41). Hence, organic soil is recognisable because of the darker colour of superficial layers than the lower layers and it is called humus (Goldberg and Macphail 2006, 26). Humus plays important functions. It feeds soil fauna, it sustains plant growth, it influences soil structure making more permeable and resistant to erosion and it protects soil against dramatic pH changes (Stevenson 1972). The microorganisms, which live in the soil, are considered part of that. Among soil microorganisms are included fungi, bacteria, protozoa, algae and actinomycetes, which participate actively in transforming parent material into soil (Betina and Frank 1993, 699-706; Adl 2003). Beside microorganisms, bigger organisms participate in the evolution of soil. For example, roots, rodents and other burrowing animals, worms and insects, distribute matter widely within a soil profile modifying deeply the structure of the soil (Jones *et al.* 1994; Jones *et al.* 1997). Certain conditions are required to provide the ideal environment for the organic soil components' life: water, oxygen, neutral or moderately acidic pH and a cold or mild temperature (Hogg 2005).

2.18.3 Water

Water helps to feed plants, which can absorb nutrients through it, and it sustains all living processes. Water is essential for hydrate and dissolving nutrients in the soil (Adl 2003, 87), the presence of water also regulates other factors, such as soil pH, temperature, redox reactions, oxygen and carbon dioxide content, that influence the life of microorganisms (Betina and Frank 1993).

A significant quantity of water is kept within the soil and it passes through soil porous structure by the mean of adhesion, cohesion and gravity (Foth 1990, 54-57). Adhesion is the attraction of water molecules to other substances, such as soil particles. This bond is strong, but it has a short range and only a thin film of water is absorbed by the soil particles (Koorevaar *et al.* 1983, 63; Foth 1990, 55).

When the adhesive water film is covering a soil particle, the remaining water molecules can bind together through cohesion, which is a bond with a larger range and weaker than adhesion (Koorevaar *et al.* 1983, 63; Foth 1990, 55). Consequently, the adhesive water is immobile and it is not accessible for plant growth, while cohesive water is partially mobile and available for plants (Foth 1990, 56). If soil particles are close enough, water particles tend to overlap and fill soil pores (Foth 1990, 56). Water in soil occurs also as gravitational water that is free to drain through soil under the influence of gravity (Foth 1990, 56). Therefore, soil porous structure and size of pores regulate both water movement and field capacity, which is the summation of adhesion water and cohesion water, retained by soil against the gravity (Conklin 2005, 73-76; fig. 2.8).

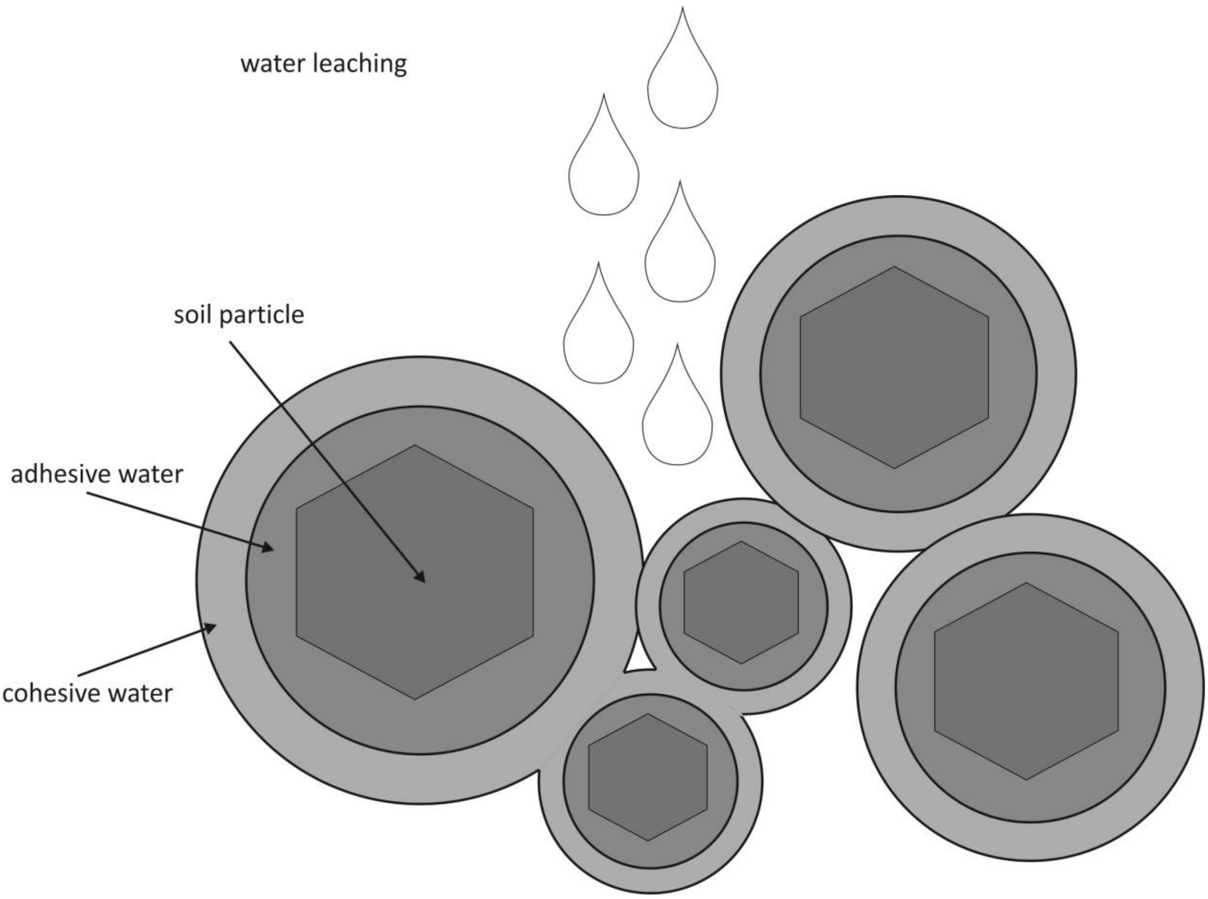


Figure 2.8: diagram of field water. Soil particles attract water with adhesive bond. The film of water around soil particles attracts other water with cohesive bond. When soil particles are close enough, water fill the soil porous (drawing of the author).

Another property of water is to slowing the adsorption of heat (Foth 1990, 38-39), so it can protect soil from violent temperature changes. For instance, humid soils heat slowly during warm seasons as well as they freeze slowly in cold periods (Koorevaar *et al.* 1983, 198-199). Water dissociates hydrogen ions from both organic and inorganic matter, and the pH of soil depends on that (Conklin 2005, 82-84). Hence, the solubility of minerals is influenced by the soil's pH. The quantity of water in the soil changes and it may be lost in different circumstances. For instance, transpiration from plant leaves, evaporation through the soil surface, drainage through soil pores to groundwater reservoirs, through lateral flow and the residual presence in small pores are the main ways of water loss from soils (Reed *et al.* 2000).

2.18.4 Air

Soil contains also air. The soil air has the same elements of atmospheric air, but it changes in their proportions. Moreover, soil air and soil water are in inverse variation in occupying available soil voids (Conklin 2005, 71). When the air content in soil porous is 50 percent or more, soil is defined aerobic. Soil is anaerobic, when water content fills most of voids (Conklin 2005, 72). For instance, when it rains heavily, water replaces air in soil pores. Water reduces oxygen diffusion, so respiration of soil organisms rapidly eliminates oxygen from the pores of a heavy moist soil. If the condition of high damp continues for long periods, an oxidation/reduction state will be affected by the low oxygen level. These changes leave visible traces even over long timescales. For, instance, the extreme reduced soil influences iron oxide minerals, which change colour from red/yellow to light grey (Reed *et al.* 2000). Soil air is the source of oxygen for roots, fauna and microorganisms. The respiration of all soil organisms produces carbon dioxide that is about one hundred times more concentrated than that in the atmosphere (Koorevaar *et al.* 1983, 183). Soil air moves into and out of soil pores mostly through diffusion.

2.19 Human body decomposition

The third natural factor of the equation about deterioration of funeral clothing is necessarily the human body decomposition. For a reliable understanding of the processes and stages, which decompose a cadaver forensic studies are primarily considered here (further details in Appendix 4.2). Anthropology and forensic science have an important impact on the understanding the human decomposition. Forensic taphonomy is an applied science with a strong interest in studying the decay processes of cadavers to date a corpse, establish cause and manner of death, discover locations of clandestine graves and identify the deceased (Carter and Tibett 2008, 29). As already stated above (ch. 2.17), several studies used pigs as human analogues, to examine different aspects of decomposition (Payne 1965; Rodriguez and Bass 1985; Wilson *et al.* 2007; Lowe *et al.* 2013, 332). For example, the study of Payne (1965) examined the differences between decomposition of unburied piglets exposed to insect activity and unburied piglets protected from insects. As a result, it demonstrated that open insect pigs had decomposed at a faster rate than the free insects pigs.

Important advances in the subject of human decomposition have been produced by the field facility of the body farm, based in the University of Tennessee and in other facilities across USA. This facility collects human bodies that are studied mainly for forensic purposes. The Anthropological Research

Facility (ARF) (University of Tennessee 2011) publishes papers mainly addressed to identify cadavers and understand crime scenes. For instance, some researches are dedicated to bone measurements (Konigsberg *et al.* 2009), while others are oriented to establish decomposition stages through entomology (Rodriguez and Bass 1983) or fatty acids deposited in soil (Vass *et al.* 1992).

2.19.1 Processes of human decay

The interest in body decomposition is not a recent issue, for example Duday (2009, 7-12) has reported a series of twelve Japanese vignettes of the early nineteenth century which re present very accurately different phases of decomposition, from the first moment of death to the funeral monument. This attention has carried on until the present with several studies and experiments (Payne 1965; Prieto, Magaña and Ubelaker 2004; Carter, Yellowlees and Tibbett 2007; Carter and Tibett 2008). As follow, the different stages of human decomposition are described following the account of Carter and Tibbett (2008) and Dent (Dent *et al.* 2004).

This work will refer to the terminology and descriptions by Carter and Tibett (2008) and Dent (Dent *et al.* 2004). When a corpse does not receive preservative treatments immediately after death (Dent *et al.* 2004, 577), decomposition follows into four big stages: autolysis, putrefaction, liquefaction and skeletonization (fig. 2.9).

1) **Autolysis** is the early stage of decomposition and during this phase the body starts an autodigestion. It begins shortly after death. The heart stops working and, so the blood does not carry more oxygen to the organs. The cells are not more active and release digestive enzymes that break down carbohydrates, proteins and fats. The internal aerobic bacteria consume the tissues searching for oxygen (Dent *et al.* 2004, 577), which means the destruction of cells. The oxygen exhaustion creates anaerobic conditions.

2) **Putrefaction** occurs simultaneously with autolysis. The absence of oxygen creates the ideal environment for internal anaerobic bacterial growth, which come from respiratory and gastrointestinal systems. These bacteria transform proteins, lipids and carbohydrate s into organic acids and gases (Dent *et al.* 2004, 577). Hence, the corpse shows changes in colour, odour and bloating. Bloating breaks the skin, apparently trying to get more oxygen for the body and recreate aerobic conditions (Carter and Tibbett 2008, 31).

3) **Liquefaction** is the stage when soft tissues and internal organs are turned into a liquefied mass. Protein decomposition provides a growth substrate for microorganisms that accelerate decomposition. The internal pressure pushes out the natural fluids through the orifices. The gases make the fluids frothy (Dent *et al.* 2004, 583). In un-coffined burials, the corpse is covered by a putrefactive liquor, which is the result of body decomposition products (Dent *et al.* 2004, 583), while

in coffined burials may produce "semi-fluid mass consisting of water and putrefied tissue with a powerful ammoniacal odour" (Dent *et al.* 2004, 583).

4) **Skeletonization** occurs when soft tissues are removed. When only bones are visible, complete skeletonization takes place. The rate of this process is influenced by depth of burial, soil type and surrounding environment (Dent *et al.* 2004, 583). Finally, bones undergo to complete deterioration through three different mechanisms of degradation, chemical diagenesis of the organic component, chemical diagenesis of the mineral component and biological diagenesis of the composite (Collins *et al.* 2002; Appendix 5, fig. 1).

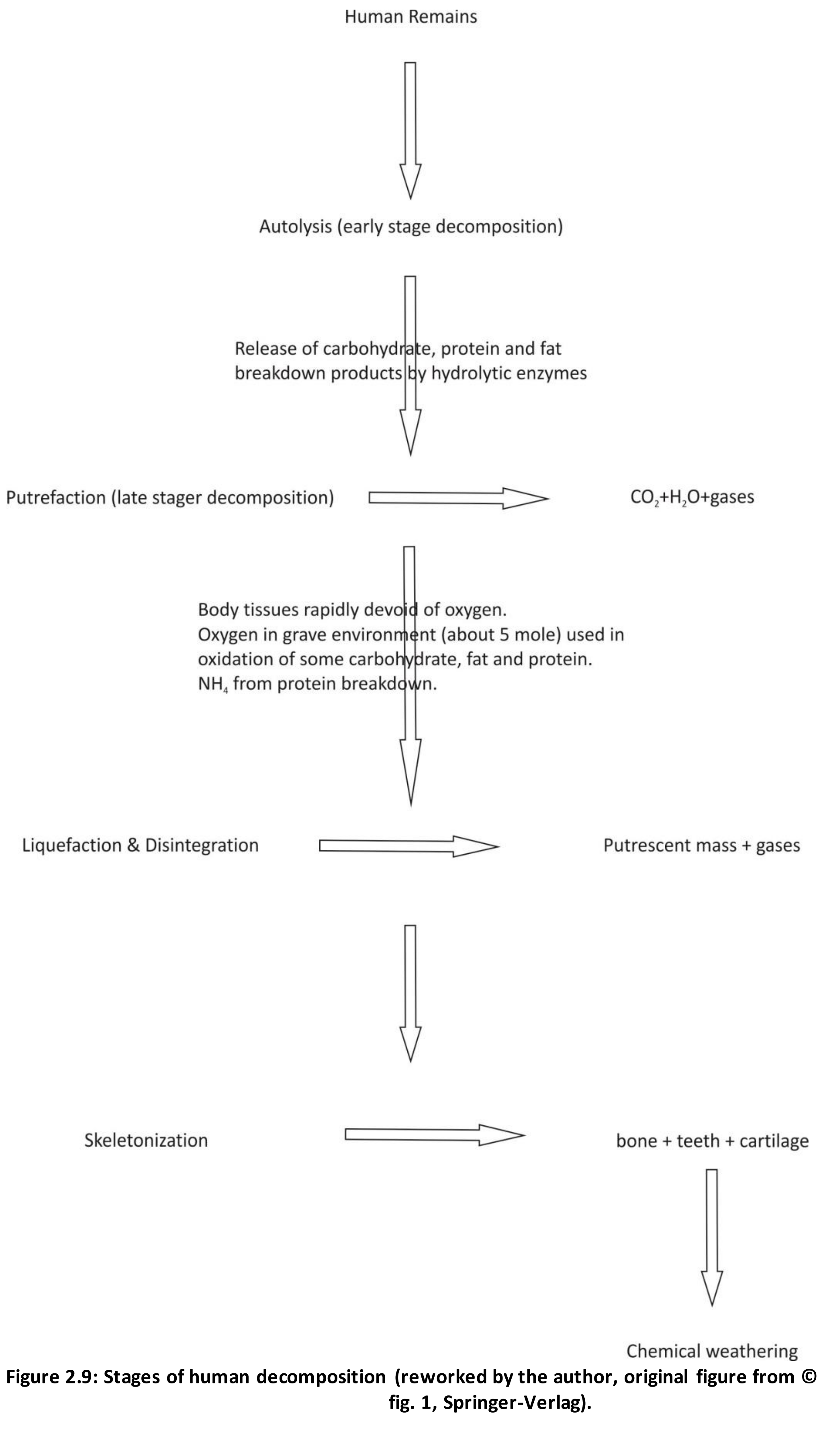


Figure 2.9: Stages of human decomposition (reworked by the author, original figure from © Dent *et al.* 2004, fig. 1, Springer-Verlag).

The rate of body decomposition depends on several factors. For example, if a cadaver is exposed on the soil surface (Rodriguez and Bass 1983; Carter and Tibett 2008, 38-40) or buried (Rodriguez and Bass 1985; Carter and Tibett 2008, 40-43) decomposition stages occur in different times. The following list schematizes the influential factors for a buried body, from the experimental study of Rodriguez and Bass (1985).

1) **Temperature**. Through a complex relation soil temperature influences soil microbial community, decomposition of plant litter and mineralization of soil organic matter (Voroney 2007, 43-45). After death, the cadaver cools down to the ambient temperature. Under 21°C, the majority of internal anaerobic microorganisms stop their growth (Mant 1987, 66). Thus, the duration a cadaver is over 21°C is fundamental for decomposition. The anaerobic bacterium *Clostridium perfringens*, which breaks down sugars, proteins and lipids, is diffused in the human intestines and in the soils, but its temperature range is limited between 15°C and 45°C (Dent *et al.* 2007, 581).
The heat enhances organic decay (Carter and Tibbett 2008, 40-41; Prangnell and McGowan 2009). For example, the experiment of Carter and Tibett (2006) illustrates that increase in temperature of 10°C roughly causes a doubling of microbial activity.
Temperature influences directly the rate of proteolysis (Dent *et al.* 2007, 579). Moreover, soil temperature can influence decomposition indirectly (Prangnell and McGowan 2009, 104).Conversely, it has been reported that buried bodies slow decomposition because of the reduced activity of microorganisms and lower temperatures (Carter and Tibbett 2008, 40-41).
2) **Moisture** and **soil texture**. Primarily, moisture affects the metabolism of microorganisms, which are involved in decomposition. However this factor varies in relation to the soil texture. In fact soil particles determine the quantity of water available for the microorganisms. Generally, sandy soils, which have a coarse texture, with a low level of moisture desiccate bodies. Decomposition is prevented by desiccation or freezing and cadavers can be well preserved for long periods. This is the case in Egyptian, Peruvian and Siberian mummies.
Coarse soils associated with high water content may generate “shapes of human cadavers primarily in the form of sand” (Carter and Tibbett 2008, 42), which are called pseudomorphs or silhouettes. For example, human pseudomorphs were found at Sutton Hoo, England (Carver 1986, 146). The soil of Sutton Hoo is sandy, highly acidic pH 3.5, 5.0 and free-draining and limited evidence of dark stains were found (Bethell and Carver 1987, 13; Carver 1992, 152). For example, the excavation of Mound 1 (Bruce-Midford 1975, 688-690) did not found evidence of visible human remains, but the following chemical analyses found indicative levels of phosphate that there was buried a body originally (Barker *et al.* 1975, 550-572). The following excavations of Mound 2 (Bethell and Carver 1987) and flat grave cemetery discovered further dark organic stains that were revealing of human burials

(Carver 1986; Bethell and Carver 1987). The phosphorus of the bones and the manganese contained in the soil play a key role in the process of formation of burial pseudomorphs (Bethell and Carver 1987, 18).

The generation of skeleton pseudomorphs is likely the cause of high concentrations of calcium, phosphorus and manganese in these soils. Clay soils, which have a fine texture, inhibit deterioration of corpses. In fact, these soils reduce oxygen-carbon dioxide exchange, which affect aerobic microbial activity (Hopkins *et al.* 2000). Hence, only anaerobic decomposition takes place (Carter and Tibbett 2008, 42), but it is less efficient than its aerobic equivalent (Hogg 2005, 138).

Additionally, reducing conditions stimulate the development of adipocere from moisture and cadaver fats (Fiedler and Graw 2003; Forbes *et al.* 2004; 2005). Adipocere is set around the body and within internal organs and it considerably reduces decomposition. However, a human body has enough fats to produce adipocere also in coarse moist soils. It has also been noted that adipocere does not stop general decomposition at all, because the removal of a body from an anaerobic soil to an aerobic soil causes a new start to decomposition. The bacteria *Bacillus* spp., *Cellulomonas* spp. and *Nocardia* spp. are linked with this process (Fiedler and Graw 2003, 293).
3) **Soil pH** can affect body decomposition in different ways. It has principal role in the breakdown of proteins, especially in the mechanisms of nitrification and denitrification (Dent *et al.* 2004). The nitrogen released by the amino acids is turned into ammonia by chemicals present in soil and then it can follow different paths. Soil chemicals can convert ammonia into ammonium ions, which are ready to be absorbed by plants, or they are incorporated by microorganisms, or they can accumulate in the ground (Dent *et al.* 2004, 580). Conversely, in alkaline soil, a portion of ammonium ions can revert to ammonia and volatilize (Dent *et al.* 2004, 580).

Soil pH affects phosphorus which is an important element present in human tissues (Lide 2007, 7-18; Appendix 4). During body decomposition, phosphorus is combined in new compounds and oxidized in the form of orthophosphates, which is stable and mobile in a pH range between 6 and 7 (Dent *et al.* 2004, 580). In fact, out of this pH range phosphorus becomes insoluble.

Soil pH deteriorates skeletal remains (Brothwell 1981, 7-8; Collins *et al.* 2002). Acidic soil can decalcify bones (Dent *et al.* 2004, 584). Alkaline soil can conduce to bone collagen chemical breakdown (Collins *et al.* 2002, 385). An alkaline pH is suspected to facilitate collagen loss of bone structure and both high alkaline and acidic pH induce collagen swelling and intensify hydrolysis (Collins *et al.* 2002, 385). Essentially, low pH exposes collagen after consuming the mineral part of bone. Subsequently biodeterioration of collagen occurs (Hedges 2002, 321; Collins *et al.* 2002, 386).

2.20 Conclusions

Archaeological evidence and experimental studies prove that preservation of organic natural textiles occurs only under specific circumstances. The type of fibre and the surrounding environment are crucial for preservation. Several natural factors are involved in the preservation of textiles, and, some have a predominant role (fig. 2.10), such as:

- Time
- Water (H_2O)
- Oxygen (O_2)
- Soil characteristics
- Chemical elements (including soil elements and exogenous elements, like metallic artefacts)
- Temperature
- pH
- Biological activity

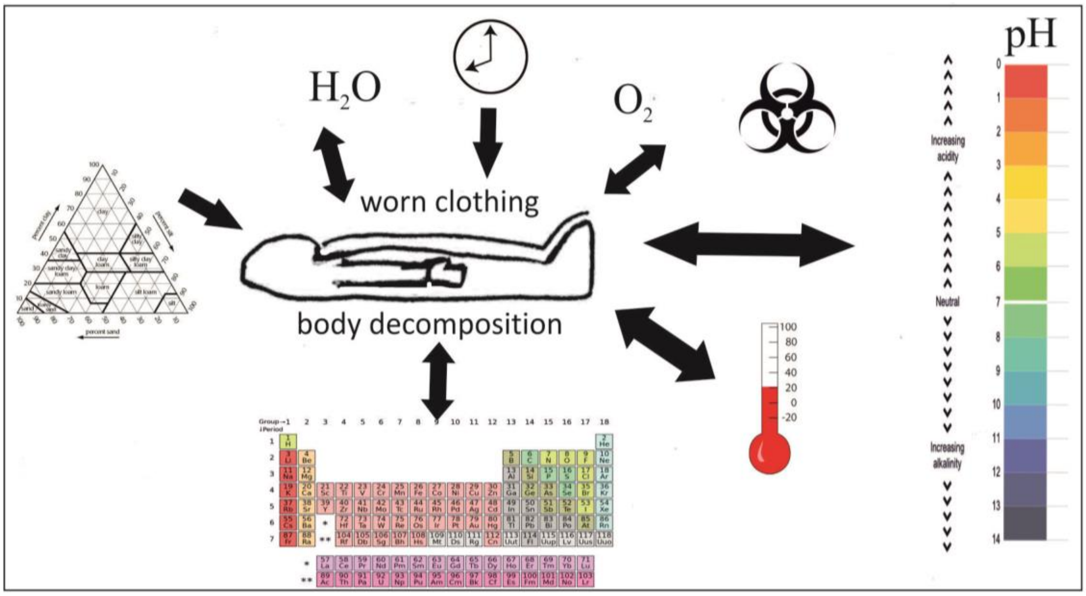


Figure 2.10: interactions between principal factors which play a role in the deterioration and preservation of textiles.

Textiles are found in extreme environments, such as bogs, deserts or arctic sites. Organic preservation is scarce in temperate climate, but there are mechanisms that can save fragmentary evidence of textiles. Some cultural factors can slow down degradation. For instance, the presence of metal objects, airtight coffins or calcium carbonate can preserve evidence of fibres (ch. 2.12-16).

The scientific methods currently applied to the study of archaeological textiles provide valuable progress in understanding textile diagenesis and information embedded in these materials (Andersson Strand *et al.* 2010). It seems worth to examine on a new light also clothing finds of old excavations, when such scientific methods were not developed. The following chapters analyse some published Anglo-Saxon and Roman cemeteries through some statistical calculations in order to understand how clothing remains can be informative of the past and how textile diagenesis limits the archaeological enquiry.

Chapter 3: Methodology

3.1 The purposes

This chapter illustrates the system of collection, recording and analysis of data applied in this thesis. In order to discuss clothing from a combined archaeological perspective, it encompasses facts that can be linked to taphonomic processes (ch. 2) and social values (ch. 1). Hence, this methodology is designed to examine both sides of this subject. The collected data gathers together some cultural and non-cultural factors (Schiffer 1987) included in burial contexts that can advance our understanding of the value of fragmentary textiles and grave objects related to the broader picture of archaeological clothing. In other words, textile fibres and other fragmentary evidence of personal clothing are examined to understand the cultural variation in clothing and how it is influenced by the preservation mechanisms of textile fibres and leather in burials.

As it has been outlined in chapter 1, during the last forty years, the principal concerns of funerary archaeology have been the investigation of the so-called four mortuary dimensions (ch. 1.2). These studies are extremely oriented to theoretical aspects, which derive from graves, such as the reconstruction of social models, personal identities, and gender issues. However, alternative theoretical approaches have been raised within the Anglo-American diarchy of processual and post-processual archaeology schools (e.g. Chapman 2005) and in European academia (e.g. Cornell and Fahlander 2002). Moreover, the physical features inherent in burials seem to be a matter of interest for field archaeology, forensic science and taphonomy (Schiffer 1987; Haglund and Sorg 2002; Tibbett and Carter 2008; Duday 2006; Duday *et al.* 1990; Nilsson Stutz 2003, 131-2).

Hence, variation in funeral costumes will be investigated based on clothing related objects and other personal equipment and ornaments and their changes between male, female and immature individuals. This part of the investigation deals with the transition between Roman and Anglo-Saxon cultures in Britain (Dickinson 1980 and 2011; Philpott 1991; Pearce 2000; Quensel-Von-Kalben 2000; Meaney 2003; Hope 2009).

This chapter considers in more detail the social aspects of Roman and Anglo-Saxon clothing (Sebesta and Bonfante 1994; Croom 2000; Crowfoot *et al.* 2001; Owen-Crocker 1986 and 2004; Coatsworth and Owen-Crocker 2007; Walton-Rogers 2007; Olson 2008; ch. 1.6). This previous archaeological work on clothing enables this research to reconsider published organic clothing data with two aims. The first purpose is to understand variation in terms of preservation of survived archaeological textile that has been reported in late Roman and Anglo-Saxon inhumations in Britain. This is a multifactorial issue because it involves the composition of textile fibres, the soil characteristics where the materials were buried, the decomposition of the body that was associated with the clothing and the presence of other objects in the grave (ch. 2).

The second intent was to evaluate and calculate the extent of variation in the archaeological mortuary dimensions: age, sex and culture. The following sections explain the analyses at the core of this investigation (ch. 3.2), the nature of data that is recorded (ch. 3.3) and the structure of their recording in a digital archive (ch. 3.4; 3.5). Finally, the statistical analyses will be undertaken on the data by Principal Component Analysis (ch. 3.6) and the innovative use of the Penrose formula (ch. 3.7; 3.8), with comments on the limitations of this methodology (ch. 3.9).

3.2 Research questions

The principal questions are whether the dead were buried accompanied by clothes or not and whether the archaeological record is influenced by cultural and non-cultural factors. Variation in funeral clothing among biological groups of several cemeteries is considered. Also whether human choices, taphonomy or both influenced the preservation of clothing. Consequently, this research is using the contrasting elements of late Roman inhumations in comparison with Anglo-Saxon burials.

Data are therefore collected in order to answer the questions below.

1. "What is the extent of preservation of clothing-related organic material in inhumation burials?"
2. "What are the preserved materials and where do they occur? Are there identifiable associations between organic clothing material, environment and cultural factors? What are the most effective textile preservative factors in Roman and Anglo-Saxon cemeteries?"
3. "What is the range of clothing indicators and other objects related to burial ritual? How are the clothing objects distributed by anthropological factors, such as sex and age?"

3.3 Sources and data collection

3.3.1 The case studies

The previous section cited the adoption of late Roman and Anglo-Saxon cemeteries in Britain as the selected archaeological contexts of this investigation. This choice offers contrasting cultural environments and a wide distribution of sites over different soil types. Below, the list provides the names of the cemeteries and their references, included in this research.

Roman cemeteries:

1. Lankhills, Winchester (Clarke 1979; Booth *et al.* 2010).
2. Eastern cemetery, London (Barber and Bowsher 2000).
3. Alington Avenue, Fordington (Davies, Bellamy *et al.* 2002).

4. Poundbury, Dorchester (Green 1987 and 1993).

Anglo-Saxon cemeteries:

5. Alton, Hampshire (Evison, 1988).
6. Butler's Field, Lechlade (Boyle *et al.* 1998).
7. Beckford A and B, Worcestershire (Evison and Hill, 1996).
8. Empingham II, Rutland (Timby 1996).
9. Sewerby, East Yorkshire (Hirst 1985).
10. Norton, Cleveland (Sherlock and Welch 1992).
11. Spong Hill, Norfolk (Hills 1977; Hills *et al.* 1984).
12. West Heslerton, North Yorkshire (Haughton and Powlesland 1999 and 1999a).

3.3.2 The grave goods: objects and cultural traits

Archaeological textile and other clothing materials are usually found in small quantities and in a poor state of preservation (Cronyn 1990, 294-292; Crowfoot *et al.* 2001). The majority of finds are fragmentary and associated with other grave goods, generally metal fasteners. The corrosion of these metal objects generates the process of mineralisation, which transforms the chemical structures of organic matter and helps its preservation (ch. 2). As already discussed in chapter 2, in a temperate country, like England, preservation of organic material is rare and mineralization is the most common preservative mechanisms for textiles, while the others occur less frequently. Consequently, this research will select primarily some crucial objects related with Roman and Anglo-Saxon burial costumes in order to detect evidence of clothing and organic textile remains. Selected grave objects will be used to evaluate the contrasts in funeral dressing between male, female and immature individuals and the influence of soils on organic textiles and leather.

The following sub-sections present the items associated with clothing and shoes in Late Roman and Anglo Saxon cemeteries. On the one hand, these objects will provide information on textiles. On the other hand, they will be considered as cultural traits and will be used in the Penrose analysis (ch. 3.6).

3.3.3 Selected objects associated with clothing and costume

Funerary clothing can change significantly between different cultures and within the same archaeological context. Numerous influential factors take place, status, gender, sex, age. In addition, local traditions, religions, philosophical beliefs, legal laws and personal tastes can determine a substantial impact on costumes. All these aspects have been observed in Roman and Anglo-Saxon contexts (Sebesta and Bonfante 1994; Walton-Rogers 2007). Unfortunately, this extreme variability associated with the scarcity and poor quality of preserved material can be confusing from an archaeological point of view.

Funerary dressing accessories can change, but fundamentally they are maintained because of their functionality, which is mainly to fasten together pieces of clothing, to decorate and to reinforce them. Generally, the fasteners preserve because they were made of metal, which may be corroded or mineralised but they last longer than other materials. Brooch, buckle and belt fittings, clasps, pin and footwear are discussed in more detail in appendix 3 (14-18), because they are categories that are more likely to preserve textile or leather fragments. Moreover, these categories were more commonly in use and more strictly link with personal dress. Additionally, another ten categories will be considered, because their inclusion supports the analytical distinction between the anthropological categories of male, female, adult and immature. These object categories are "girdle hanger, fabric fibre, bracelet, comb, finger ring, knife, spearhead, shield boss, key, and other ring". These objects are not as frequent as the first five categories in Roman and Anglo-Saxon burials, but they are worth including because they are related also to personal equipment and adornment (Croom 2000; Swift 2000; Owen-Crocker 1986 and 2004; Walton-Rogers 2007).

The object category of "fabric fibre" needs further explanation. This category includes all fragments of textiles or leather that were not found directly associated with another object, assuming that it might be part of a garment, which did not have metal objects, or the fragment was far from any possible related metal fastener.

3.4 The structure of the database

Selected data (ch. 3.3), which are collected from published sources, are stored in a relational database. This section explores the structure of the digital archive and defines the nature of collected data. The digital database has been planned after following courses and studying material provided by the University of York and the Department of Archaeology (Archaeology Data Service 2012).

Digital databases have a technical nomenclature, which may be confusing to those who are not familiar with them. Microsoft Access 2010 is the software used to create the database for this thesis (ch. 3.8). Here, a short guide is provided of technical terms in use in this thesis.

1. **Field** is a basic unit of a database. Field includes one type of information that is defined and distinguished by other fields. Each field may contain one or many **records**. Fields are arranged in columns in the **tables**.

2. **Record** is a basic unit of a database. Each record includes a unique fact, according to the field which it belongs to. Records are arranged in rows in the **tables**.
3. **Table** is a tabulation which includes one or many **fields** and one or many **records**. Fields are in columns and records in rows. As more fields and records are included in a table, the more detailed and complex it is. In a relational database, tables can be linked by **relationships** to cross and match fields and records of different tables. Here, the table are hierarchically distinguished. **Primary tables** include fields and records of crucial importance. **Lookup tables** are linked to a field of a principal table and provide options that describe each record in that field.
4. **Relationship** is the link between one or many **tables** in order to create cross and match **fields** and **records** of different tables.
5. **Query** is a temporary dataset, which contains information from different **tables** linked by **relationships**. Query is a method to interrogate the database combining data from different tables, selecting **fields** and **records** and sorting the order of data.

This digital archive is based on six principal tables: “grave”, “grave object”, “skeleton”, “soil”, “cemetery” and “bibliography”. Additionally, there are also fourteen lookup tables, which provide further information related to the main ones (fig. 3.1). All main tables hold a primary key, which is a unique number to identify the information in the database.

Additionally, it is worth noting the process of consolidation of data that has been mentioned above (ch. 3.3.2). As in all studies that deal with data with different standards, the present research collected information from several reports by different authors, and these had a lack of consistency about technical terminologies, descriptions and measurements. Subjects like bones and soil reports appeared to be the most affected by this variation. Because of that, it was decided to strengthen the data, providing a unique standard of description. The new standard is shown in the following sub-sections about the database structure. Hence, it is important to remember that the present work has re-organized data from original reports.

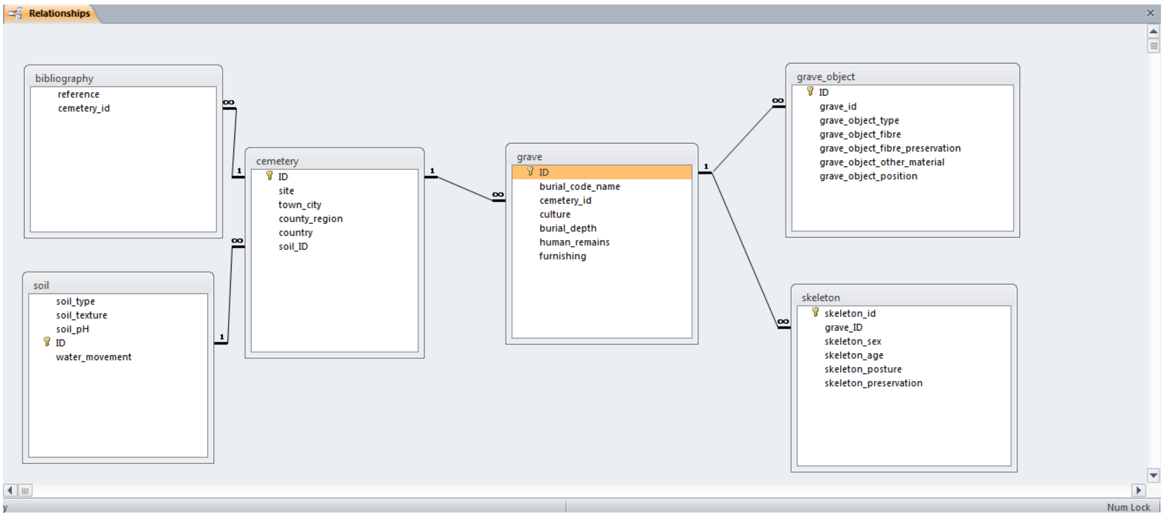


Figure 3.1: database structure and relationships between six principal tables.

3.4.1 Grave

Grave is the basic table of the catalogue. The term grave means hole for inhumation. This table is defined by these specific attributes: name, cemetery, culture, burial depth, soil origin, soil texture, soil composition and soil pH (tab. 3.1).

1 Name

It is the name of the singular grave according to the publication where it is reported.

2 Cemetery

This is the link to the “Cemetery” table.

3 Culture

This feature is usually provided in the publication and it helps to understand the cultural context which is under analysis. The cultures will be mostly Roman and Anglo-Saxon.

4 Burial depth

This attribute describes the depth of the grave in meters, converted into the metrical system if the original publication is in the imperial system. Where burial depth was not reported, it has been recorded as 0.00. It is worth remembering that this measure does not often correspond to the original depth of the burial, but it can be the depth that diggers recorded at the moment of the excavation.

5 Human remains

It is an attribute that records whether the grave contained visible bones at the time of the excavation.

6 Furnishing

This attribute records the presence of burial furnishing and the different types.

Table 3.1: database grave table.

Grave						
ID	burial_code_name	cemetery_id	culture	burial_depth	human_remains	furnishing
1	grave_1	1	anglo_saxon	0.10	No	no_evidence
2	grave_2	1	anglo_saxon	0.10	No	no_evidence
3	grave_3	1	anglo_saxon	0.08	Yes	no_evidence
4	grave_4	1	anglo_saxon	0.15	No	no_evidence
5	grave_5	1	anglo_saxon	0.10	Yes	coffin
6	grave_6	1	anglo_saxon	0.08	Yes	no_evidence
7	grave_7	1	anglo_saxon	0.08	No	no_evidence
8	grave_8	1	anglo_saxon	0.29	Yes	no_evidence
9	grave_9	1	anglo_saxon	0.16	No	no_evidence
10	grave_10	1	anglo_saxon	0.22	Yes	coffin

3.4.2 Furnishing reference table

The presence of 'furnishing' may influence the process of preservation. The intent is to record any evidence that may be interpreted as structural protection of the corpse in the grave. The possibilities are restricted to options: coffin, slab, tile, chamber, mausoleum or a combination of these factors, or no evidence. The table "Furnishing" is linked to "Grave".

3.4.3 Cemetery

This table collects details about the cemetery where the graves are placed (tab. 3.2). The table is concerned with geographical distributions. It is linked to the table "Grave" with a one to many relations. The attributes, which describe the table, are listed below.

- Site refers to the name of the site.
- Town or City refers to the geographical position of the cemetery; it records the town or city.
- County or Region records the region or county.
- Country takes into account the country where the site is located.

Table 3.2: database cemetery table.

Cemetery					
ID	**Site**	**town_city**	**county_region**	**country**	**soil_ID**
1	West_Heslerton	West_Heslerton	North_Yorkshire	England	1
2	Butler's_Field	Lechlade_on_Thames	Gloucestershire	England	2
3	Norton_on_Tees	Norton _on_Tees	Durham	England	3
4	Spong_Hill	North_Elmham	Norfolk	England	4
5	Sewerby	Bridlington	East_Yorkshire	England	5
6	Alton	Alton	Hampshire	England	6
7	Beckford_A	Beckford	Worcestershire	England	7
8	Beckford_B	Beckford	Worcestershire	England	8

3.4.4 Soil tables

Characteristics of the soil, where a burial is placed, are extremely relevant to the understanding of taphonomic processes (ch. 2). Nevertheless, the description and interpretation of soils is not a subject that may be easily simplified because of the numerous variables intrinsic in the study of soils (French 2003; Rapp and Hill 2006). Moreover, archaeological reports do not use a unique standard of soil description.

In order to describe consistently the soils of the burials, their descriptions are simplified in this archive as six macroscopic features: type, texture, pH, water movement and rainfall average (tab. 3.3). Soil details are taken from the original reports, when they are provided. Additionally, Soilscapes database (Cranfield University 2012), NERC database (2011), Met Office (2015) and general handbook of British soil by Avery (1990) implement all database fields and the written sections related to soils. In the following chapters, soil data from Soilscapes web site is referred only as Soilscapes, while soil data from NERC soil portal is referred to only as NERC.

- Soil origin is the link to the “Soil origin” table.
- Soil texture is the link to the “Soil texture” table.
- Soil composition is the link to the “Soil composition” table.
- Soil pH is the link to the “pH” table.
- Water movement is the link to the “water movement” table.
- Rainfall average is the link to the “rainfall average” table.

Table 3.3: database soil table.

Soil					
Site	**soil_type**	**soil_texture**	**soil_ph**	**water_movement**	**Rainfall average**
West Heslerton	brown soil	sand	neutral_alkaline	free_drainage	751.1
Butler's Field	lithomorphic soil	loam	acidic	good_drainage	684.7
Norton on Tees	gley soil	loam	acidic	obstructed_drainage	574.2
Spong Hill	gley soil	loam	acidic	impeded_drainage	652.5
Sewerby	brown soil	loam	acidic	free_drainage	620.8
Alton	brown soil	loam	acidic	free_drainage	755.5
Beckford A	brown soil	loam	neutral_alkaline	impeded_drainage	843.4
Beckford B	brown soil	loam	neutral_alkaline	impeded_drainage	843.4
Empingham II	gley soil	loam	alkaline	free_drainage	608.9
Poundbury	brown soil	chalk	alkaline	free_drainage	730.3
Lankhills	brown soil	chalk	unknown_not_described	free_drainage	746.5
Alington Avenue	brown soil	silt and chalk	acidic	free_drainage	730.3
Eastern cemetery London	man-made soil	sand	acidic	free_drainage	557.4

Soil types table classifies the soils where cemeteries lie. Hence it seems relevant to provide a short description of those soils that are at the sites included in this work. There are several soil classifications over the world, which have their own terminology, purposes and logic. Sometimes they may be similar, but they are always slightly different (Krasilnikov *et al.* 2009). In the United Kingdom, there is a national soil classification, which includes Great Britain, including Northern Ireland. Originally, British classification has agricultural aims and its final form was published by Avery (1973; 1980 and 1990). In academia, Avery's system is a valuable reference and a scale of evaluation. The hierarchical structure of the British soil classification is organised into four levels. Ten major groups are divided into several groups each, which contain further subgroups and lastly each group includes soil types. Descriptions of soil types include their sequence of soil horizons and the processes of formation.

This work describes soils of all considered case studies referencing to Avery's soils classification (1990) at a major group level of classification. Moreover, specific descriptions refer to Soilscapes (Cranfield University 2012) and to the archaeological reports, when they provide information on soils. The sites included in this research involve four of the ten major soil groups according to Avery's soil classification (Avery 1990). The main characteristics of the four soil groups are described below.

Gley soils: these are the wet mineral soils that are common in depressions in humid climates. They form from unconsolidated material exclusive of recent alluvium and show mottling and reduction within 50 cm of the surface. They have an ochric, mollic or umbric A horizon, a histic H, cambic B, calcic or gypsic horizon. They are poorly drained soils, but when drained they can be very successful for agriculture. The features of these soils may preserve organic matter better than other soils, especially when the water content is elevated and it produces an anaerobic environment.

Brown soils: this group is widely diffused and it often shows early stages of soil development. Brown soils have several horizons with different characteristics, but most of them are suitable for agriculture, orchards, farming and dairying. Hence, most of brown soils may be heavily exploited. Many brown soils include iron oxides and organic matter. They are not favourable to preserve buried organic matter.

Lithomorphic soils: these are shallow soils of mountainous areas, fairly recent volcanic lava flows and areas scraped bare by ice. They are less than 10 cm deep and rest on hard rock. They have little potential for crop production but in humid areas they may produce enough vegetation for light grazing. These soils usually do not offer suitable conditions for human activities, but at the same time they do not offer strong protection to buried organic matter.

Man-made soils: formation of these soils relies on human practices. They are the result of activities such as the addition of earth containing manures or refuse, unusually deep cultivation, or the restoration of soil material following mining or quarrying. The characteristics of these soils and all human processes appear to be extremely detrimental to the persistence of buried remains.

The table soil texture defines the soil according to the different type of texture. Soil texture is a physical classification related to the size of the soil particles. In the present table is provided a glimpse of this characteristic. There are included the following attributes: “sand”, “clay”, “loam”, “silt”, “gravel”, “peat”, “chalk” and “not described”. Obviously, in nature it is hard to find a pure texture of 100%, while the occurrence of mixed texture is frequent (Avery 1990). Therefore, this field is intended to describe the main texture which characterises the soil of graves.

Moisture has impact on the diagenesis of textiles (ch. 2). Thus data of precipitations and water drainage are included in the database. Precipitations vary across the regions of United Kingdom. Some of sites are placed in wetter regions than others. Data of average rainfall are recorded by the Met Office (Met Office 2015). This study considers the rainfall period between 1981 and 2010 (Met Office 2015) as representative of the rainfall in the sites and data are included in the field rainfall average of the soil table with the values that correspond to the area of the sites.

The movement of water in soil is described in the table water movement. This feature can influence physically the taphonomy of organics (ch. 2). Moreover, water can affect chemical reactions by its presence, like corrosion of metals, and can promote or limit biological activity. The scale of value is that provided by Soilscapes (Cranfield University 2012). Water movement is described as “free_drainage”, “good_drainage”, “impeded_drainage” and “obstructed drainage”.

Soil pH table has been included to record the probability of pH because it is a fundamental factor in degradation and preservation of material (ch. 2). Soil pH can change quickly through time and space (Frank and Tölgyessy 1993, 651-653). The soil pH is subject to seasonal changes related with the moisture. During dry seasons pH is lower, while during wet seasons pH is higher. Moreover, fertilization changes the natural soil pH significantly (Frank and Tölgyessy 1993, 651-653; Conklin 2005, 82-83). Field experiments showed changes of soil pH in burial sites. For instance, scientific investigation of the role of different microenvironments on cadaveric decomposition (Wilson *et al.* 2007) showed that soil pH had significant increase from the measurement taken at the time of burial to the pH values recorded at the disinterment (Wilson *et al.* 2007, 10). However, it seems worth taking note at least of the probability of the pH if there are any clues which can help to identify it. For example, chalk parent material is a probable source for an alkaline soil. “pH” is described as “acidic”, “neutral_alkaline”, “alkaline” and “unknown or not described”. When it was not possible to detect soil pH from the original report, the NERC (2011) report has been used to find the pH measurement of the site under analysis.

3.4.5 Grave objects

This table is one of the main tables because it will include fundamental information about the objects: type of artefact, position of the artefact in the grave in relation to the body and possible microscopic analyses on textiles and leather. The grave objects are selected because of their significance with clothing and personal adornment. Thus, these objects had high probabilities to be in contact with textile fibres.

This table describes the selected objects which can give information about the presence of clothing:

1. Brooch
2. Buckle and belt fitting
3. Clasps
4. Pin
5. Hobnail and footwear
6. Girdle hanger
7. Fabric fibre
8. Bracelet
9. Comb
10. Finger ring
11. Knife
12. Spearhead
13. Shield boss
14. Key
15. Other ring

Fragmentary objects will be considered as one object, unless the publication suggests that the fragments may belong to separate objects. Raw data, descriptions and figures of grave objects are reported in Appendix 3, 1-13.

Further data are collected about the position of the objects. These are the tables, which link artefacts to the human remains, so it seems really important to the purposes of the current research to establish what kinds of objects were buried with the dead. The position of the object on the body may reveal the function of the object in itself (fig. 3.2). It is interesting to note if there is variation in the degree of preservation of organic material in respect of the position on the body (ch. 2; Lowe *et al.* 2013). In theory, there may be a reasonable difference in preservation of clothing evidence on the body in comparison with that left at the side of the grave. Unfortunately, not all reports here considered have enough detail regarding artefact position in comparison with the bones. Hence, this analysis has been reduced to recording whether the artefacts were found on bones or not. The table of the database dedicated to this topic classifies the positions of artefacts as "on the body", "not on the body" and "unknown", when the position is not reported.

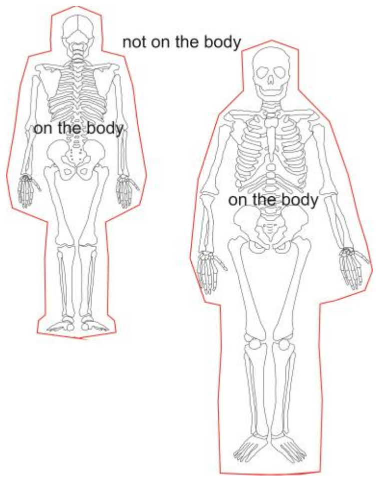


Figure 3.2: object positions (drawing of the author).

Two tables are dedicated to describe the material, which composes the objects. They are divided into "fibre" and "other material". The list of fibre comprises clothing materials, both of plant and animal origin, in use during Late Roman and early Anglo-Saxon periods. Furthermore, the list includes general descriptions, such as animal fibre, plant fibre and not identified for all fibres, which cannot be identified more precisely:

1. Flax
2. Cotton
3. Hemp
4. Plant fibre: this includes all fibres of plant origin which are not better identified.
5. Wool
6. Silk
7. Seasilk
8. Leather and skin
9. Animal fibre: this includes all fibres of animal origin, which are not better identified.
10. Unidentified
11. Absent

This field describes only one type of fibre, assuming that the possible fibre finds were made by only one material. It is plausible that some textiles were made by more than one fibre. However, this occurrence is rare in the archaeological contexts here analysed. Consequently, the database will record the primary identified fibre in all records.

Another table describes the principal material that composes an artefact. For example, the main body of a brooch may be in copper alloy, but its pin may be in iron. In that case, the database will record a copper alloy brooch. Below is the list of other materials:

1. Iron
2. Copper alloy and bronze
3. Silver
4. Gold
5. Other metal
6. Calcium sulphate
7. Hard animal tissue: this voice includes bone, horn, hoof, teeth, ivory and shell.
8. Ceramic
9. Glass
10. Stone
11. Wood
12. Other substance
13. Unidentified
14. Absent

The table "fibre preservation" describes the level of preservation of organic clothing materials. A scale has been created with five values, from the best preservation to the level of not identifiable. The list below describes the five levels.

1. Preserved: when the fibre is possibly identified and is organic.
2. Mineralized: the fibre is subject to the process of mineralisation.
3. Impression: the actual fibre is gone, but it has left an impression on the surface of an associated object – e.g. a piece of plaster or gypsum.
4. Traces: it defines the minimal presence of organic material.
5. Not recorded: there is not organic material to record.

This scale of values suffers from subjectivity and lack of consistency across report descriptions. However, it seemed worth including in the analyses, as it is relevant to our general knowledge of textile preservation.

3.4.6 Skeleton

The third principal table (tab. 3.4) provides general information about the human remains when they are preserved. The selected data are described referring to biological anthropology (Sprague 1968; Brothwell 1981; Katzenberg and Saunders 2008). It is defined by four attributes; the posture, the age, the sex and the preservation. Like descriptions of soils, the characteristics of human bones may change hugely from one publication to another. Different anthropologists adopt different terminologies and methods for diagnosing human bones. Recurrent divergences occur in sex and age identification. The following sub-sections will describe how human bones are classified in the database and for the purposes of this research.

Table 3.4: database skeleton table.

skeleton_id	grave_ID	skeleton_sex	skeleton_age	skeleton_preservation
60	83	indeterminate	adult	poor
61	84	female	adult	poor
62	85	indeterminate	adult	poor
63	86	indeterminate	adult	poor
64	87	male	adult	poor
65	88	female	adult	fair

Skeleton age table specifies the age of bones, when this was possible. Anthropologists have provided various systems to estimate the age of skeletal remains. However, this database will record four distinct classes to keep simple the structure of the archive.

1. Adult: defines bodies from 18/20 years old, to mature adult and older adult.
2. Juvenile: defines bodies from 1 year old to 18/20.
3. Infant: defines new born until the complete first year.
4. Unknown: defines skeletal remains, which do not have any clear age indicator.

"Skeleton sex" defines the sex of the individual, which is a physical feature, and not the gender, which is a cultural trait. Consequently, the database will record as indeterminate all the burials that do not have clear physical traits to determine their sex. This means that burials sexed by grave goods, will be defined as indeterminate.

"Skeleton preservation" explains how much is still preserved of the remains. Six levels of preservation are listed below.

1. Excellent: the skeleton is 100% complete and it means virtually no fragmentation.
2. Good: the skeleton is complete from 95 to 75% and it indicates slight fragmentation.
3. Fair: the skeleton is complete from 75 to 50% and there is only moderate fragmentation.
4. Poor: the skeleton is complete from 50 to 5% and it describes most bones as fragmented.

5. Destroyed: the skeleton has only from 5 to 0% remaining. The last degree of preservation does not mean necessarily that total absence of bones. There are instances of small fragments or even teeth that have been found and have provided information about the burial, like the age.

Raw data and figures of human remains are reported in Appendix 1, 1-12.

3.4.7 Bibliography

This records basic references from the original source where the data was collected. It is linked to the "cemetery" and it includes the name of the author and the year of publication.

3.5 Analyses

The examination of the digital archive has a double aim. Firstly, it provides data for the quantitative evaluation of selected cultural traits. Secondly, it assesses associations of some cultural and non-cultural factors that can likely influence textile fibres and leather preservation – e.g. type of soil, metal presence, coffin presence, burial depth, position of the textile finds in respect of the body (ch. 4).

The quantitative evaluation, by the use of selected grave objects, works at different levels:

1. Examination of the population of a single cemetery. The population is combined into groups identified by biological traits as adult male, adult female, immature and indeterminate individuals. The indeterminate group includes those burials where the biological identification was uncertain or there were no bones left. The sexual identification produced only by grave goods is not taken in account in this research. For example, the **grave 85** of West Heslerton (Haughton and Powlesland 1999a, 135) is described as a young adult and male because of the associated artefacts. The immature group comprises burials of all infant and juvenile individuals.
2. Examination of the populations of groups of cemeteries gathered together by their cultural affinities – e.g. Roman cemeteries and Anglo-Saxon cemeteries.
3. Examination of all populations comparing the values of Roman and Anglo-Saxon groups.

Other studies have statistically examined Anglo-Saxon cemeteries (Arnold 1980; Pader 1982; Lucy 1998; Stoodley 1999), but with different calculations and purposes than those advanced here. Here, the quantitative analyses will be calculated with Principal Component Analysis and with the "size and shape" Penrose formula.

3.6 Principal component analysis of selected grave objects found in Anglo-Saxon and Late Roman cemeteries

The occurrence of fifteen selected grave objects (or cultural traits) is fully analysed with the principal component analysis (PCA), which is a well-established multivariate method applied in archaeology (Jolliffe 2002; VanPool and Leonard 2011, 285-304). The raw data of the occurrence of the selected objects are presented in Appendix 3.

The principal components are selected according with the rule of cumulative percentage of total variation (Jolliffe 2002, 112-114). The minimum number of principal components is established by the cumulative percentage of total variation which is between 70 and 90% (Jolliffe 2002, 112-113).

The correlation of data is illustrated by biplot graphs (Jolliffe 2002, 90-110). The biplot graph represents the first two components as orthogonal axes. The first component (PC1) is the horizontal axis and the second component is the vertical axis (PC2). The black points within the biplots are the variables, which are marked with abbreviations in the graphs (table 3.5). The vectors are the factor loadings. Variables highly correlated aims to the same vectors. The proximity between variables suggests observations with similar values (Jolliffe 2002, 90-110).

Table 3.5: abbreviations of Anglo-Saxon and Roman cemeteries in the graphs.

Alton	Al
Beckford A	BA
Beckford B	BB
Butler's Field	BF
Empingham II	EII
Norton	No
Sewerby	Se
Spong Hill	SH
West Heslerton	WH
Alington Avenue	AA
Eastern London	EL
Lankhills	La
Poundbury	Po

The significance level of factors, or grave objects, in variance is reported in factor loadings graphs. The range of values is set between ±1.0. The positive values mean that the grave objects participate to the variance positively, while negative values represent negative impact in the variance. However, it is more important the value rather than the negative and positive signs. High values mean high variance, while 0 represents the absence of variance. The figures are rounded to the two first decimal digits to the right of the decimal separator (VanPool and Leonard 2011, 22).

3.6.1 PCA all graves results and discussion

PCA of all graves reveals that the PC1 and PC2 explain 89% of the variance (tab. 3.6). The biplot (fig. 3.3) shows that the cemeteries of Alington Avenue and to lesser extent Poundbury, Lankhills and Eastern London contribute to most of the variation on the positive side of PC1, which is the horizontal axis.

Table 3.6: All graves, total variance of the first two principal components.

PC	Eigenvalue	% variance	% total variance
1	1038.74	75.24	89.05%
2	190.69	13.81	

Factor loadings of PC1 (fig. 3.4) are positively correlated between hobnails, bracelet, fabric textile, finger ring and comb. Hobnails represent the highest correlation. This is coherent with the raw data (Appendix 3). In fact, Roman burials have limited number of objects and they are strongly correlated. Hobnails are the most frequent finds. On the negative side of PC1, all Anglo-Saxon cemeteries are clustered very close. This suggests the strong similarity of Anglo-Saxon burials. The brooch, buckle, knife, spearhead and other ring are the factors (or grave goods) that assemble this cluster. The number of grave goods associated with these burials is higher than Roman burials (fig. 3.4). In fact, Anglo-Saxon burials include more categories of grave goods, but they are less correlated one to each other.

PC2 explains almost 14% of variation. The majority of groups are on the positive side and Alington Avenue is the cemetery that varies the most. On the negative side of PC2, there are Lankhills, Poundbury, Eastern London and Alton. The loadings plot (fig. 3.5) reveals that the absence of high correlation positive values, but low positive correlation link several elements. Conversely, objects, such as bracelet, finger ring and comb, are highly uncorrelated. The angle between hobnails and bracelet is almost a right angle. This means that there is no correlation between these factors (Jolliffe 2002, 90-95). This underlines the separation of Alington Avenue from the other Roman cemeteries. In fact, hobnails are common find in all four Roman cemeteries, while bracelets were absent only in Alington Avenue cemetery.

PCA of all graves suggests:

- Roman and Anglo-Saxon cemeteries are well differentiated by the PC1. The former cemeteries are on the right side and the latter sites are on the left side of PC1.
- According to PC1, Roman burials are represented by limited number of objects not correlated.

- PC1 also reveals that Anglo-Saxon burials are defined by a large number of objects and they are correlated.
- PC2 explains that decorative objects, such as comb, bracelet and finger ring, are correlated.
- PC2 separates Alington Avenue from the other Roman cemeteries. The bracelet and hobnails are not correlated.

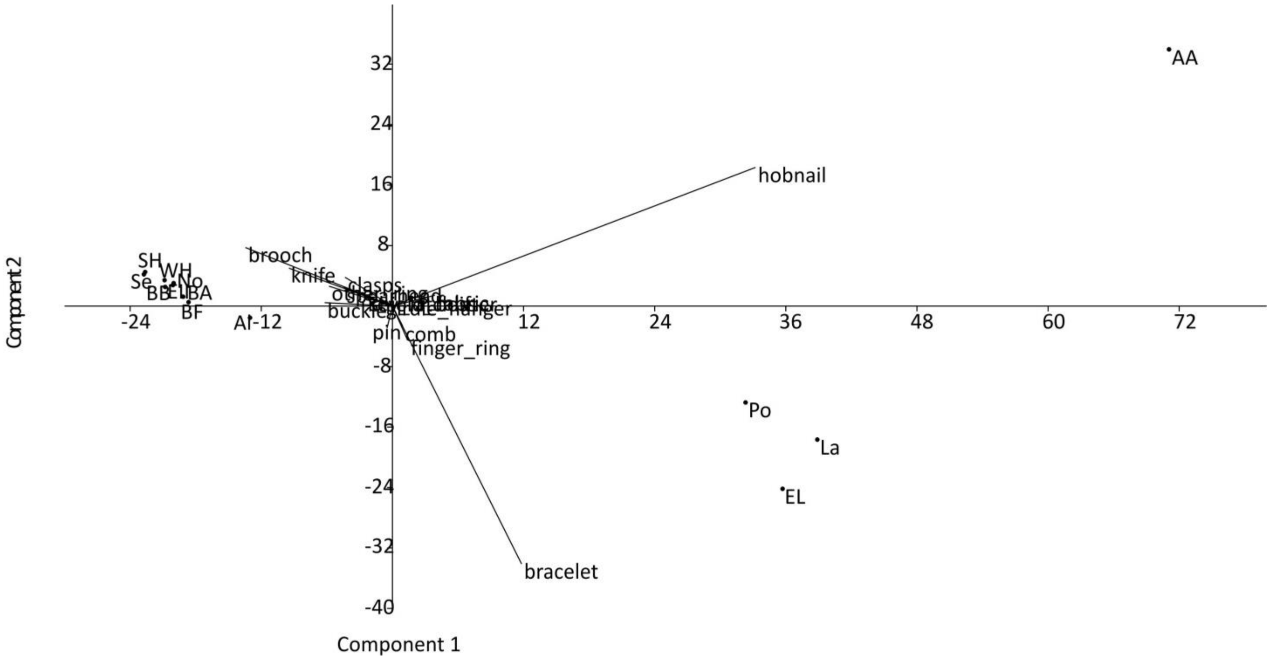


Figure 3.3: PCA biplot including all graves of all cemeteries.

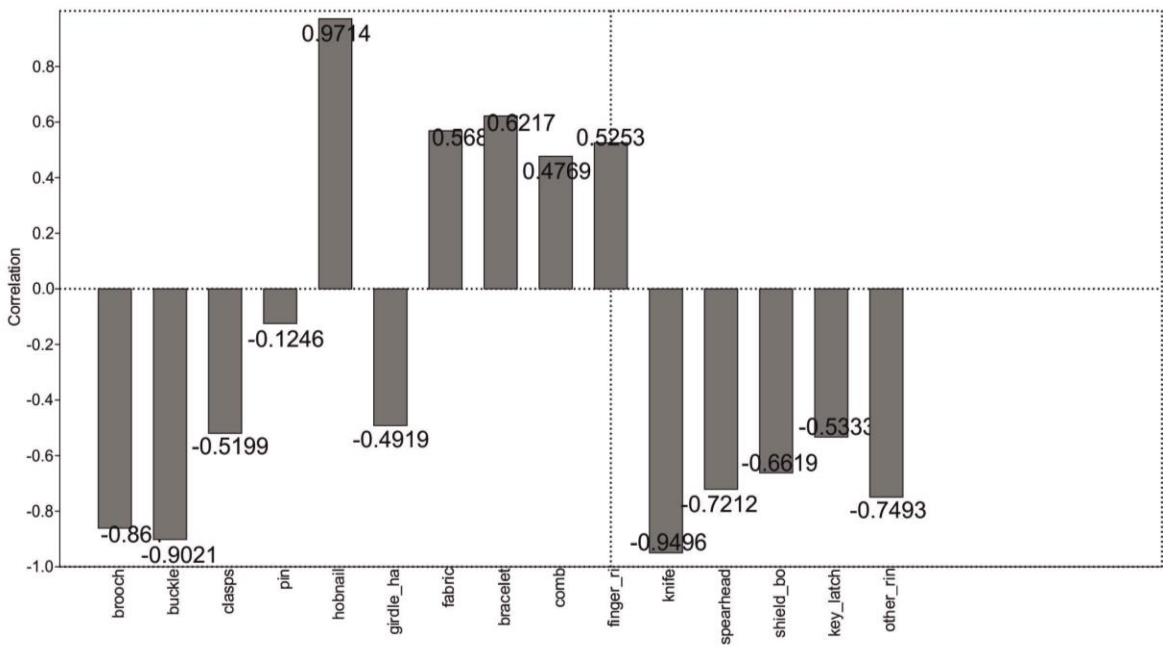


Figure 3.4: All graves PC1 factor loadings plot.

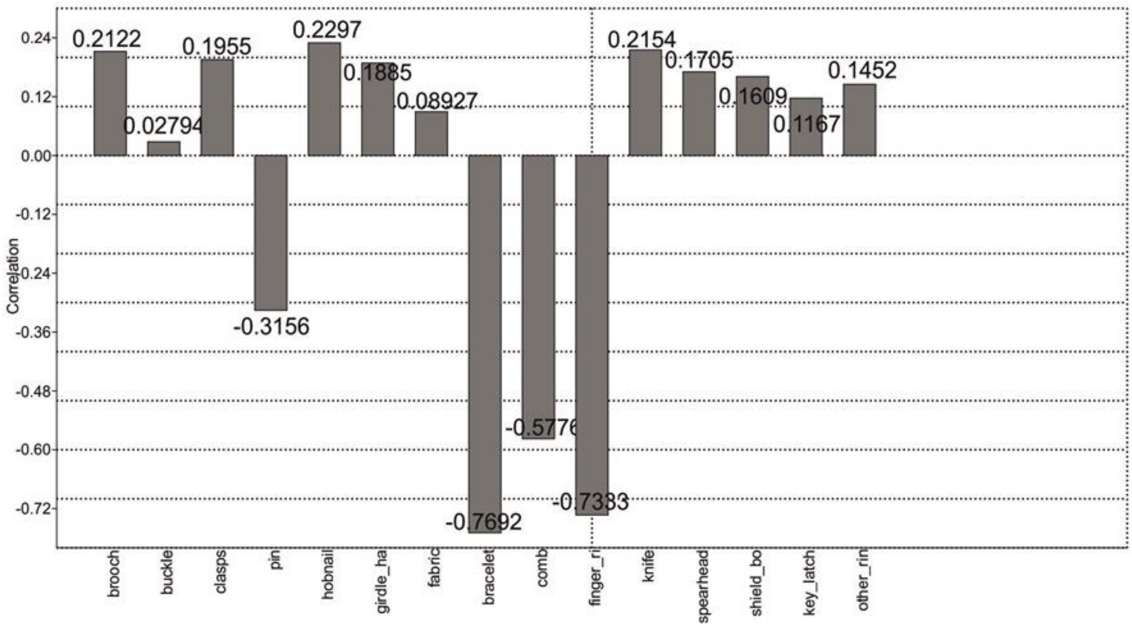


Figure 3.5: All graves PC2 factor loadings plot.

3.6.2 PCA male graves results and discussion

PC1 and PC2 explain around 89% of the variance (tab. 3.7). The biplot (fig. 3.6) shows a clear pattern. The male graves of Lankhills, Eastern London, Poundbury and Alington Avenue are scattered on the positive side of the PC1, while all Anglo-Saxon graves are close one to each other on the negative side of the component. There is a clear distinction between the Roman and the Anglo-Saxon graves.

Table 3.7: Male graves, total variance of the first two principal components.

PC	Eigenvalue	% variance	% total variance
1	1672.46	82.662	89.1461
2	131.19	6.4841	

The factor loadings (fig. 3.7) display that hobnails and finger ring and to lesser extent fabric textile, bracelet and comb are positively correlated, while the other objects are negatively correlated. Hobnail has the most variance and it is represented by the Roman cemeteries. The other factors, such as spearhead, shield boss and knife are common objects in Anglo-Saxon male graves and do not occur in Roman male graves. The graph also confirms absence of correlation between buckle and hobnails.

PC2 separates the sites differently. The Anglo-Saxon sites are split into two clusters along the second component axis, while all Roman sites are close in PC2. Spong Hill, West Heslerton and Butler's Field have positive variance that the graph of loadings correlates to buckles and knives (fig. 3.8). The other

Anglo-Saxon male graves are on the negative side of PC2 and Norton and Beckford B have the highest values. The elements with the highest negative correlation are brooch, shield boss, clasp and spear head.

PCA of male graves indicates:

- Roman and Anglo-Saxon inhumation burials are clearly different in the assemblage of grave goods.
- Hobnails occur positively correlated within Roman male burials.
- Fabric textile evidence is also correlated with Roman male burials. This result is likely linked with the Roman ritual of plaster burials at Poundbury, which can preserve textile impression.
- Elements, such as shield boss, spearhead and buckles are clearly distinctive of Anglo-Saxon male burials and are positively correlated.

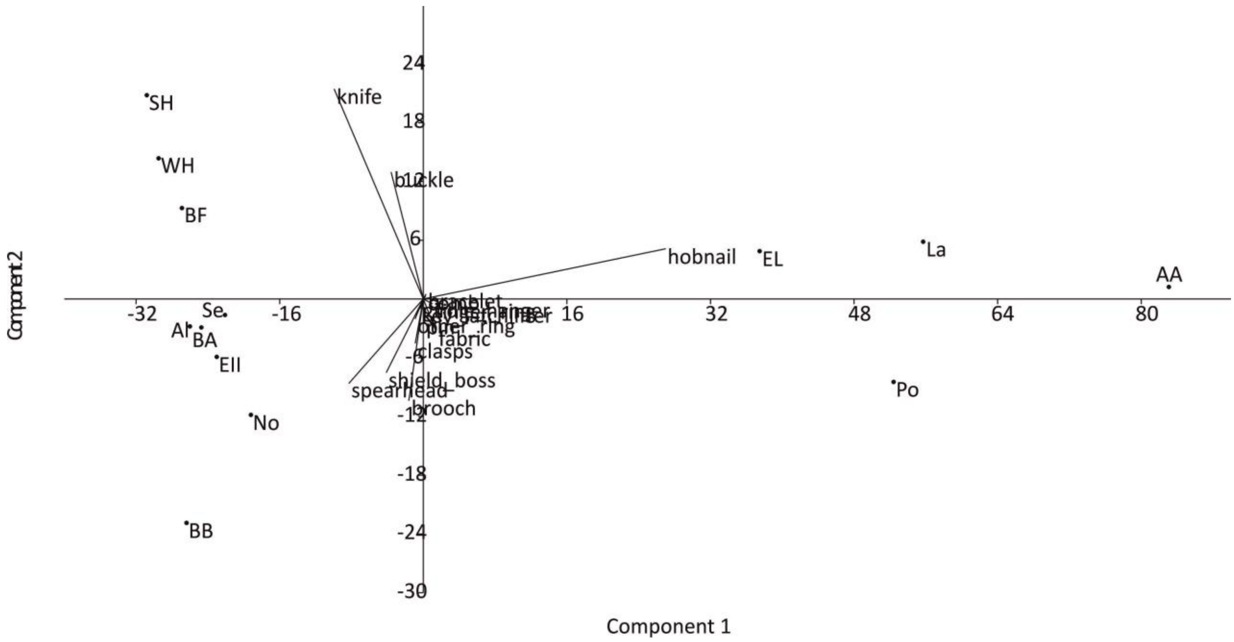


Figure 3.6: PCA biplot including male graves of all cemeteries.

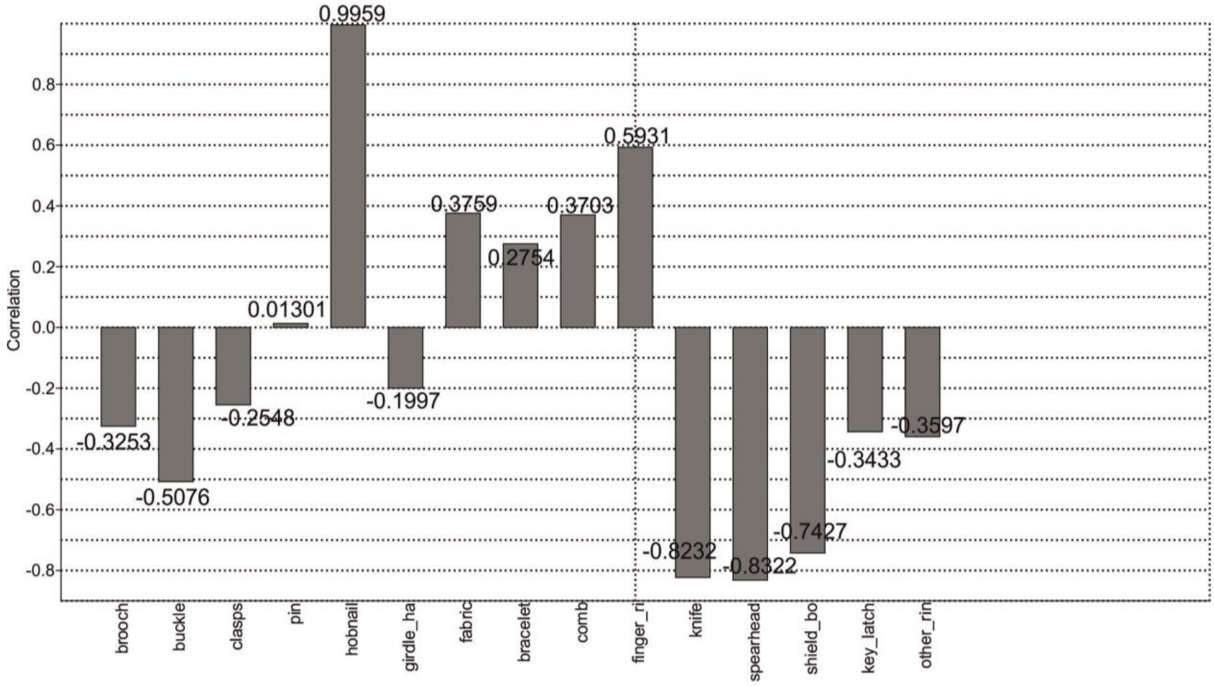


Figure 3.7: Male graves PC1 factor loadings plot.

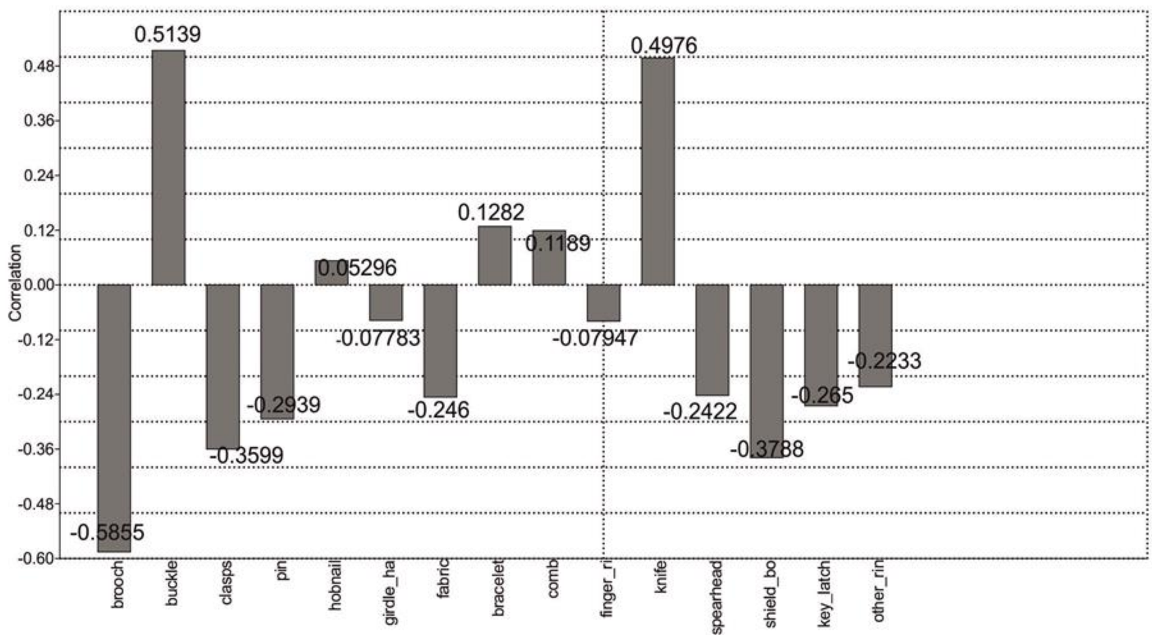


Figure 3.8: Male graves PC2 factor loadings plot.

3.6.3 PCA female graves results and discussion

PC1 and PC2 explain around 87% of the total variance of female graves (tab. 3.8). The burial groups are distinguished between Anglo-Saxon and Roman cemeteries (fig. 3.9). The Anglo-Saxon burials are on the positive side of PC1 and are very close to each other. Conversely, the Roman burials are on the negative side of PC1 and show great variation. The factor loading plot of PC1 (fig. 3.10) shows high positive correlation between the elements brooch, buckle, knife and other ring. Other elements have a moderate positive correlation, such as clasp, girdle hanger, spearhead and key. In fact, the former group of objects occur frequently within Anglo-Saxon female graves, while the latter group of elements is less frequent. Rarely, Anglo-Saxon female graves contain shield boss and pin. The negative correlated elements are hobnails, comb, bracelet and finger ring that can occur within Roman female graves.

All Anglo-Saxon female burials are positively correlated also in PC2, but they show little variation. The Roman burials are all but Alington Avenue on the negative side of PC2. The loadings plot (fig. 3.11) demonstrates that most of the elements are moderately correlated, while elements, such as bracelet and comb are strongly correlated and occur within some female burials of Lankhills, Poundbury and Eastern London.

PCA of female graves indicates:

- Anglo-Saxon and Roman female burials are clearly distinguished by grave goods assemblages.
- Anglo-Saxon female burials are very similar in their clothing assemblage and include a large number of objects.
- The most distinctive object of Anglo-Saxon female burials is brooch. Additionally, Anglo-Saxon female burials have a standard set of grave objects, related with clothing, which includes brooch, buckle, knife and other ring.
- The high number of objects, like buckles, clasp and brooch, buried within Anglo-Saxon female graves reflects the ritual of dressed burials
- Roman female burials have limited number of objects and only bracelet and comb appear correlated.

Table 3.8: Female graves, total variance of the first two principal components.

PC	Eigenvalue	% variance	% total variance
1	1199.12	72.23	87.17
2	248.028	14.94	

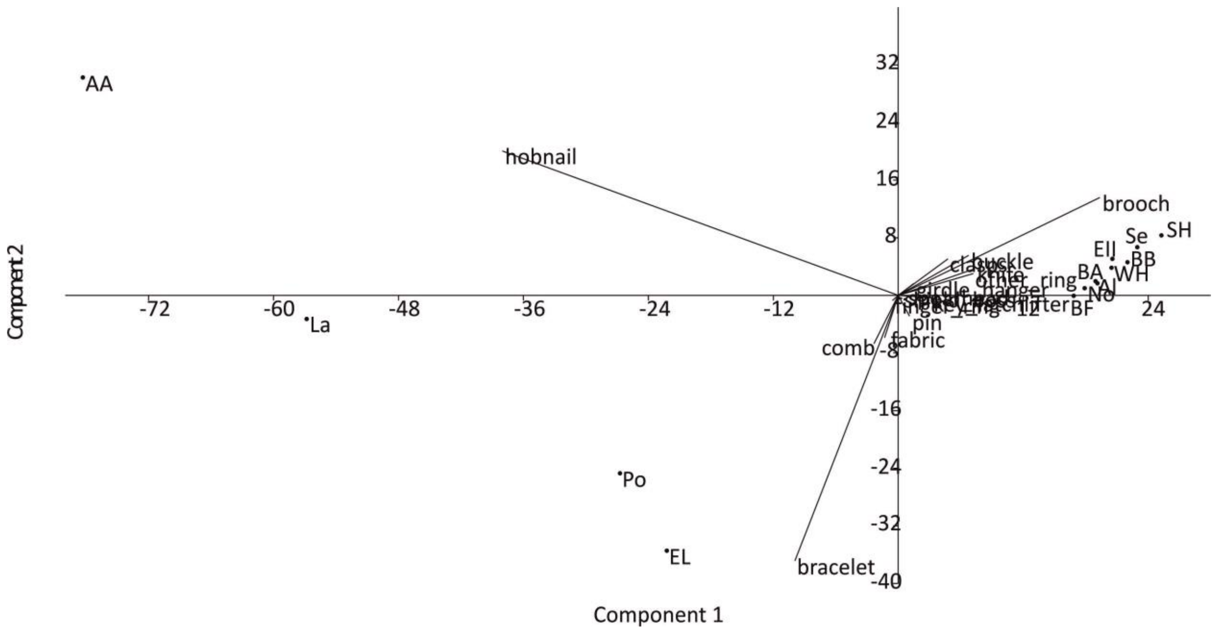


Figure 3.9: PCA biplot including female graves of all cemeteries.

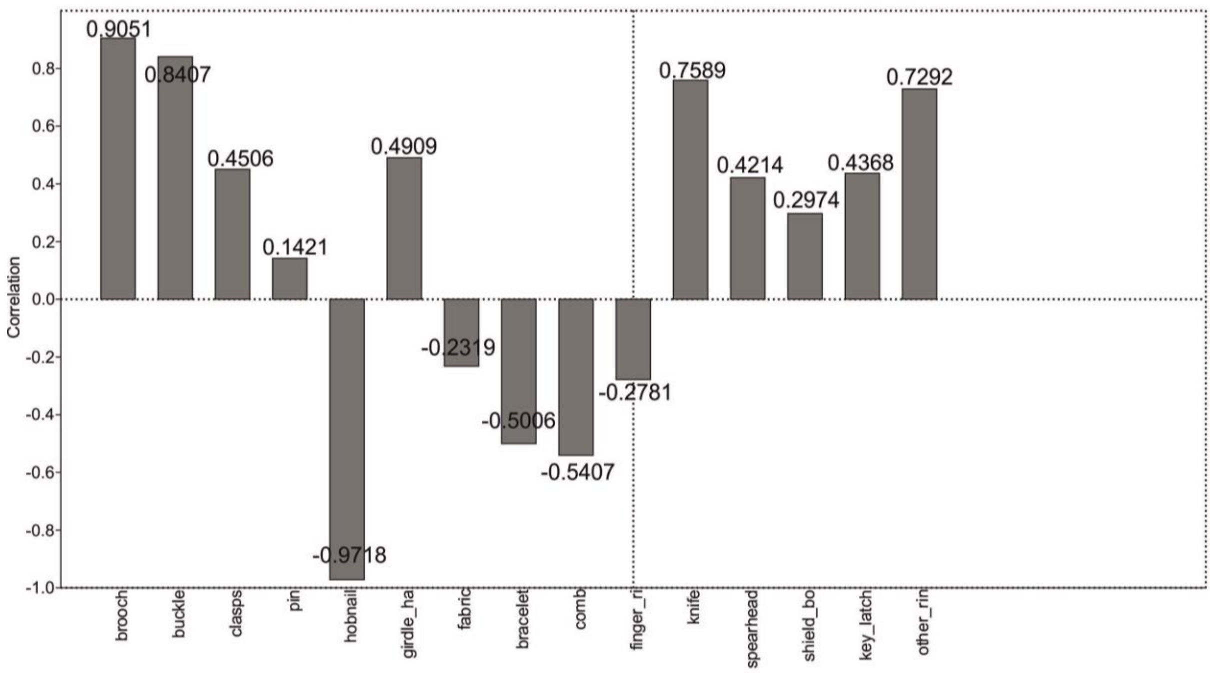


Figure 3.10: Female graves PC1 factor loadings plot.

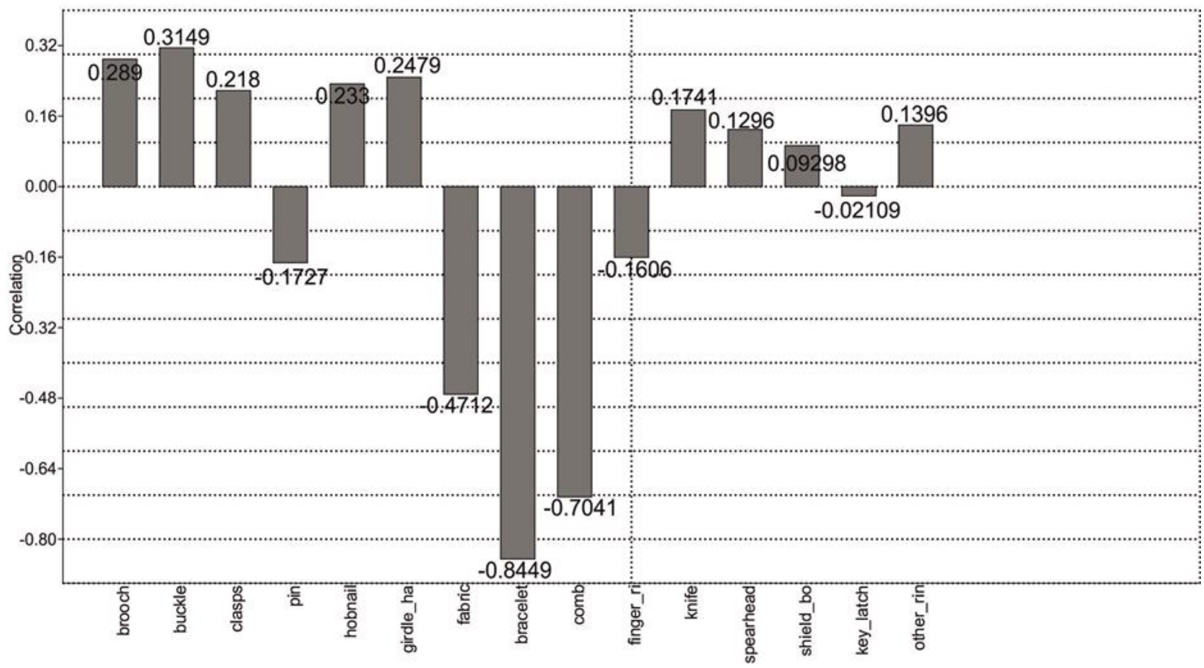


Figure 3.11: Female graves PC2 factor loadings plot.

3.6.4 PCA immature graves results and discussion

PC1 and PC2 explain 73% of the variance of immature graves (tab. 3.9). The Anglo-Saxon burial groups are distributed on the negative side of PC1 and they are clustered very close (fig. 3.12). The Roman burial groups are on the positive side of PC1. Alington Avenue is separated by the other Roman cemeteries and it is characterised by fabric fibre. The loadings plot of PC1 (fig. 3.13) shows negative correlation between hobnails, bracelet and finger rings, which occur within Roman immature graves. The Anglo-Saxon immatures are correlated with brooch, buckle and knife, which is similar trend to the adult Anglo-Saxon graves. The Anglo-Saxon burial groups are packed on the line of PC2, which means limited variance, while the Roman burials are scattered. Alington Avenue is the only Roman group on the negative side of PC2, while Poundbury, Lankhills and Eastern London are on the positive side of PC2. The loadings plot of PC2 (fig. 3.14) illustrates that other ring, shield boss and spearhead have high positive correlation. In fact, there are only two Anglo-Saxon immature burials that include all these objects. Elements, such as clasps, brooch and buckle are negatively correlated, which is explained by the limited number of these elements within immature burials.

PCA of immature graves suggests:

- Anglo-Saxon and Roman immature graves are clearly distinguished by grave goods assemblages.

- Anglo-Saxon groups are characterized by low variation of PC1.
- Roman sites show more variation and they have fewer objects than Anglo-Saxon immature burials.
- Lankhills immature burials are the most distinctive group, which is explained by the unusual high number of objects accompanying immature graves.
- The Anglo-Saxon immature burials are packed in PC2, this confirms the limited number of objects included in these burials.

Table 3.9: Immature graves, total variance of the first two principal components.

PC	Eigenvalue	% variance	% total variance
1	1045.08	52.067	73.065
2	421.467	20.998	

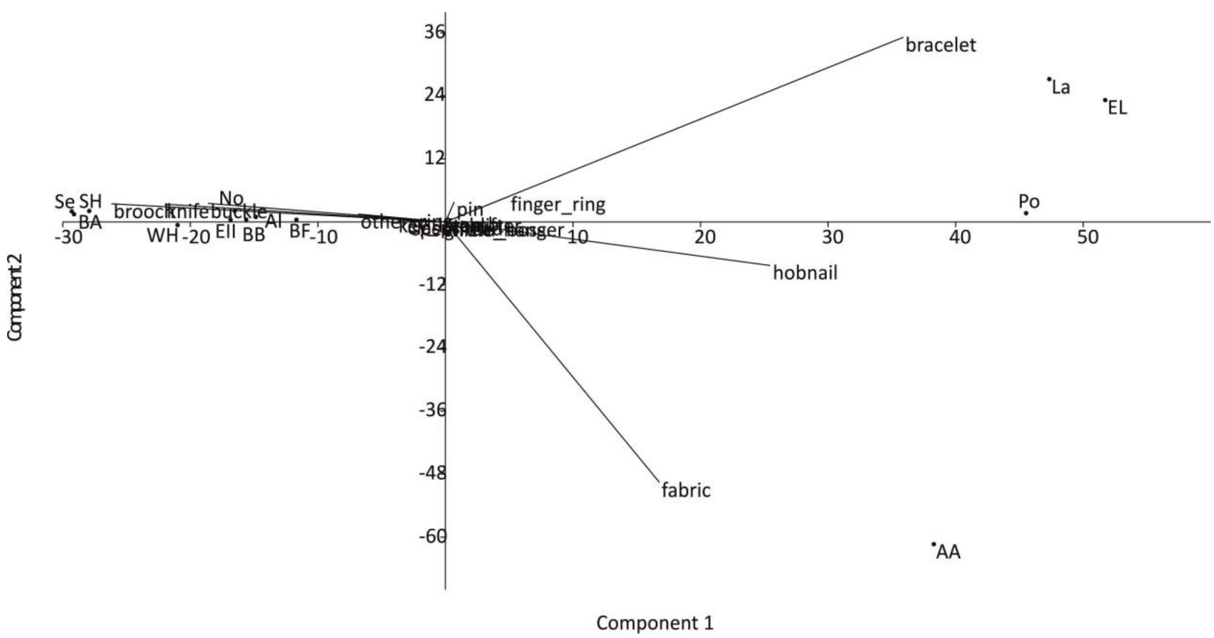


Figure 3.12: PCA biplot including immature graves of all cemeteries.

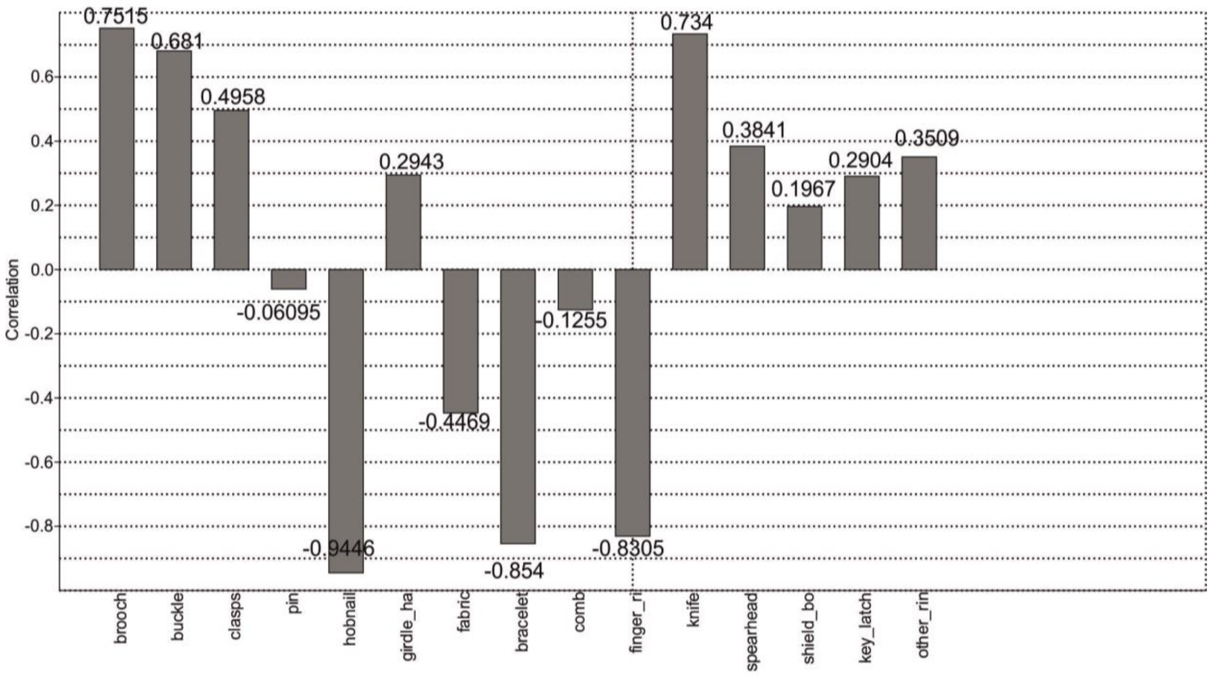


Figure 3.13: Immature graves PC1 factor loadings plot.

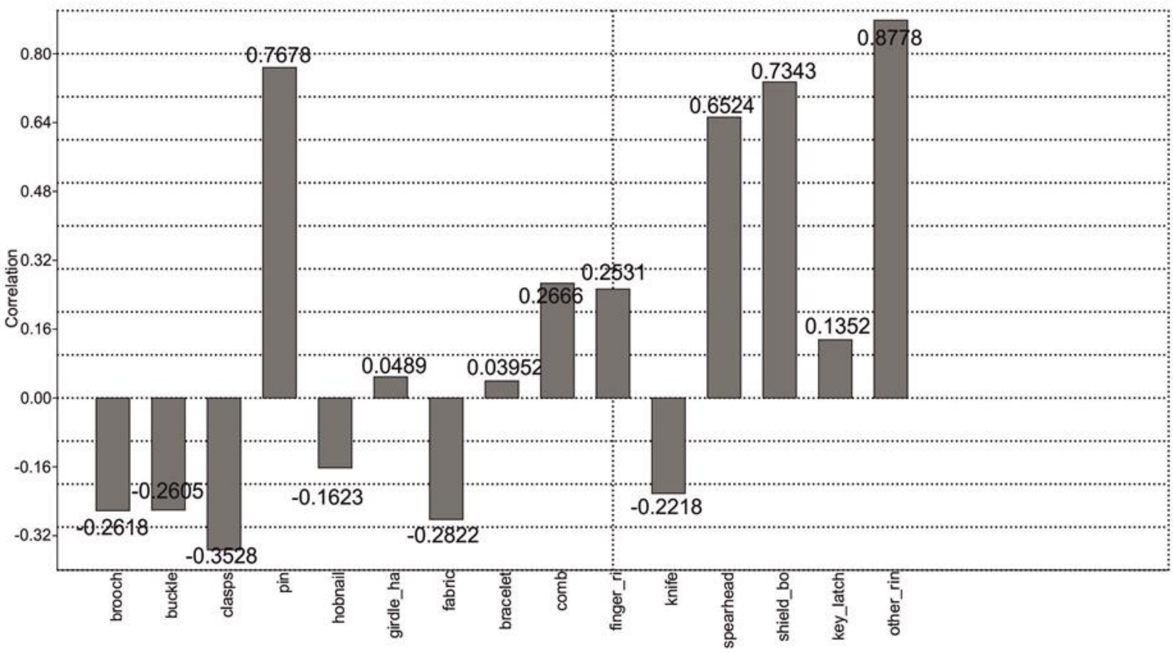


Figure 3.14: Immature graves PC2 factor loadings plot.

3.7 Modified Penrose statistics, ‘size and shape’ of cultural traits

This section aims to analyse data cultural traits with the “size and shape” statistic. This multivariate method is proposed as alternative exploratory data analysis to others already in use. This calculation was introduced by the formula originally devised by Penrose in 1954. This was formulated to evaluate biological variation of non-metrical bone characteristics within a population or between populations (Penrose 1954). The formula can be applied also to other fields where the occurrence of variables can be counted. Thus, this will be the first time that it will be used to analyse cultural traits. Hence, the aim of the formula is substantially changed and it is proposed that the size and shape analysis of cultural traits be called the Coefficient of Cultural Likeness (CCL). This research considers as cultural traits the 15 types of objects recorded in the burial database (ch. 3.3).

Because it is the first time that "size and shape" has been applied to cultural data, it is useful to explain briefly, what this formula was devised for and its original application. A previous coefficient was created by Pearson (1926) to evaluate the degree of divergence, called "distance", between individuals or groups by measurements. This determined whether the overall distance between groups was statistically significant or not. This coefficient needed adjustments for correlated variables, which in physical anthropology are the most frequent. Hence, it was replaced by other anthropological indices (Fisher 1936; Fisher 1936a; Mahalanobis 1936; Rao 1948) that can calculate correlations between numerous anthropological features.

Nevertheless, Penrose considered the formula still valuable, and improved the method, pointing out the concept of "distance squared" for measures of interrelated anthropological data and its utility in evaluating different non-metrical variables for several clusters (Penrose 1954). The formula was applied successfully in order to measure and define osteological non metrical differences among several populations (Brothwell 1958).

The new statistic named, "size and shape distances", is a multivariate statistic, which analyses the divergence in a series of selected characters between populations and it combines two factors. "Size" estimates the divergence in the overall incidence of the characters and "shape" computes the divergence in the relative incidence of the same characters.

Below, the two formulas outline the calculation of distances for size and shape. The first two formulas (A and B) are the original ones (Penrose 1954, 338 tab 1), while the two following (C and D) are the modified formulas applied in this research. The symbol "m" represents the number of traits included in the calculation. Hence, there are 15 cultural traits included in the current research, so "m" corresponds to 15. '*d*' is the difference between the mean Anglo-Saxon trait value and each cemetery for the 15 traits (d^1, d^2, d^3, …, d^{15}). The symbol '$\sum^m(d)$' represents the summation of the differences squared and divided by the square of the trait number, which is our cultural 'size' distance. In contrast, 'shape' is the summation of differences squared divided by the trait number and minus trait sizes.

(A) Size distance (Penrose 1954, 338 tab 1): $[\sum_1^m (d)]^2 / m^2$

(B) Shape distance (Penrose 1954, 338 tab 1): $\sum_1^m (d^2) / m - [\sum_1^m (d)]^2 / m^2$

(C) Size distance formula applied: $\frac{[\sum_1^{15} (d)]^2}{15^2}$

(D)Shape distance formula applied: $\frac{\sum_1^{15} (d^2)}{15} - \frac{[\sum_1^{15} (d)]^2}{15^2}$

These 'size' and 'shape' calculations will be visualised in scatter plot graphs where the X axis is the 'size' value, and the Y axis is the 'shape' value. The points on the graphs represent the examined groups.

In this research, size represents the overall variation of selected clothing objects. Shape is the relative variation of selected clothing objects. In theory, we may assume that ideal Anglo-Saxon male graves contain a buckle, a spearhead and a knife. We would expect to find these representative sets of objects in all Anglo-Saxon male burials. In reality, three types of change may occur within burial sets. Firstly, it can vary the overall number of objects in burials. For example, an Anglo-Saxon male grave may include a buckle, a spearhead, a knife but it also contains a shield boss. This variation is illustrated by size (fig. 3.15).

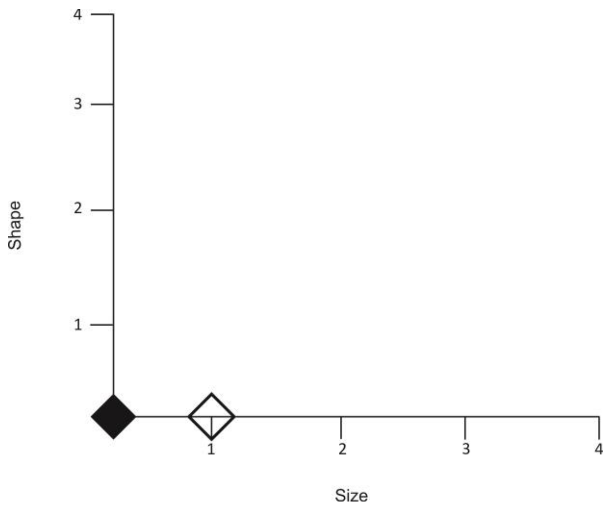


Figure 3.15: example of size. The black diamond represents an ideal Anglo-Saxon male burial including all expected objects. The white diamond represents an Anglo-Saxon male burial with different objects.

Secondly, the relative number of grave objects can change. For example, an Anglo-Saxon male grave contains two buckles, two spearhead and no knife. This is shape (fig. 3.16).

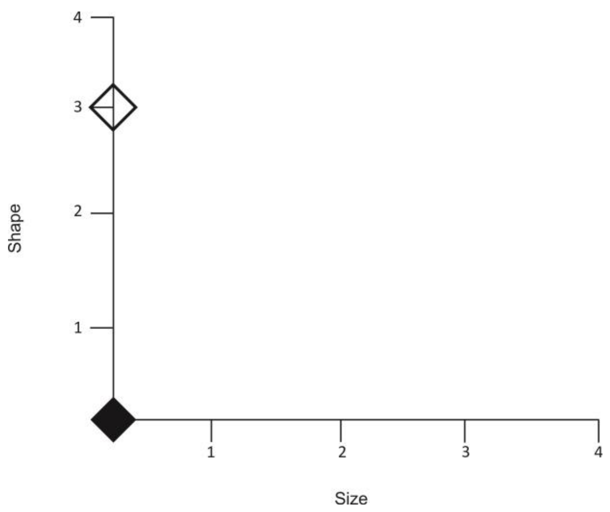


Figure 3.16: example of shape. The black diamond represents an ideal Anglo-Saxon male burial including all expected objects with the expected proportion. The white diamond represents an Anglo-Saxon male burial with variations in the proportion of objects.

Finally, it happen a combination of both changes, such an Anglo-Saxon male grave containing two buckles, a spearhead, a shield boss and two knives (fig. 3.17). In fact, The Penrose formula combines both size and shape in the same calculation (Penrose 1954).

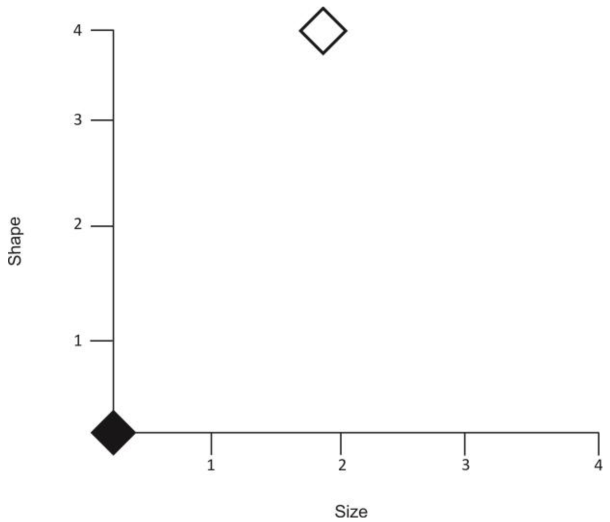


Figure 3.17: example of size and shape. The black diamond represents an ideal Anglo-Saxon male burial including all expected objects. The white diamond represents an Anglo-Saxon male burial with variations in the grave object set.

CCL will investigate the degree of divergence of selected cultural traits or grave objects, from different cemeteries. The evaluation will consider three groups of graves that are distinguished by age and sex. Hence, male and female groups are intended as older than 20 years, while immature groups comprise the dead from zero to about 20 years old. The identification of sex is more uncertain for people in that range of age (Scheuer and Black 2000, 15-17; Mays 2010, 47-50).

The CCL is calculated by the following steps. The percentage values of cultural traits were subtracted from mean values obtained from Anglo-Saxon cultural trait occurrences (tab. 3.10). This computation is then applied to the general comparisons between categories of all cemeteries considered in this research, Anglo-Saxon and Roman male, female and immature burial groups.

Table 3.10: Mean values of cultural traits from the Anglo-Saxon cemeteries analysed in this research.

Grave objects/Cultural traits	Male	Female	Immature
Brooch	8.7	61.5	13.9
Buckle belt fitting	32.3	37.4	14.2
Clasps	5.5	38.6	2.8
Pin	6.7	66.8	14.1
Hobnail footwear	0	0	0
Girdle hanger	6.2	54.8	2.5
Fabric fibre	11.1	0	1.1
Bracelet	0	7.4	3.7
Comb	3.7	21.5	8.1
Finger ring	2.8	24.8	5.7
Knife	32	33.4	16.2
Spearhead	13.5	4.5	9.3
Shield boss	73.7	3.8	1.9
Key latchlifter	19.1	55.2	12.1
Other ring	10.3	51.6	19

As given in the Penrose formula, in order to calculate "size", the values for each category, male, female and immature are squared, summed and then divided by 225, which is the square of the number of cultural traits. This results in "size". Then, the columns of the values are summed and the result is squared and divided for 15, which is the number of cultural traits. This outcome is subtracted from size and this is "shape". The passages of these calculations are schematised in the diagram below (fig. 3.18) and a worked example is also presented (tab. 3.11-14; fig. 3.19).

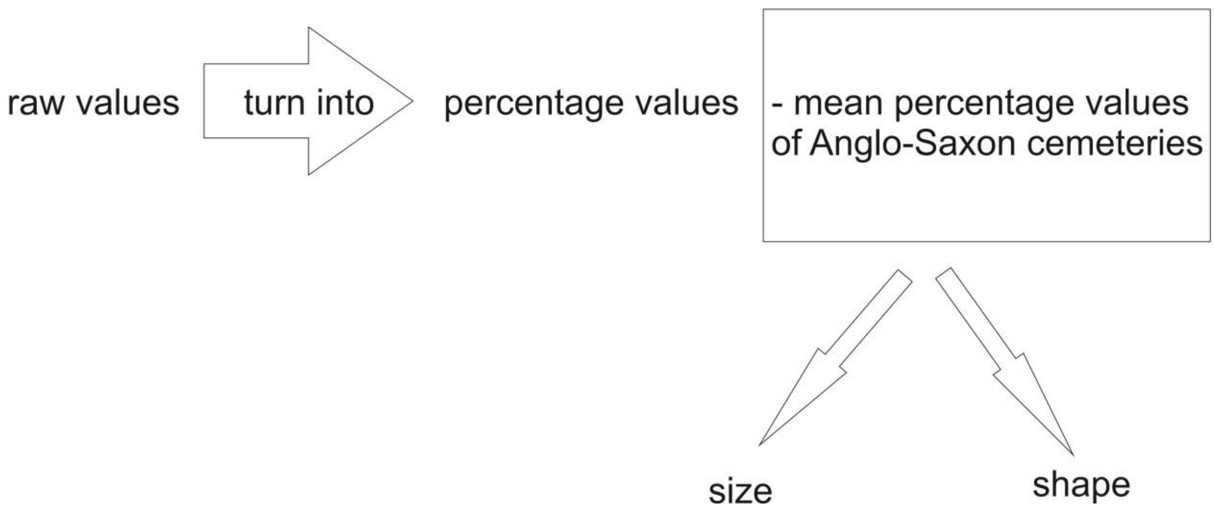


Figure 3.18: diagram from data collection, through computation of data and size and shape formulas.

For example, we would calculate CCL of male burials from three cemeteries: West Heslerton, Empingham II and Alington Avenue. We select the category of objects that we want use to compare the groups (ch. 3.4.5) and we calculate the occurrence of each object in all male burials of each cemetery. Then, we calculate the percentage occurrence of each object (Table 3.11).

Table 3.11: Example of CCL calculation. Percentage values of Empingham II, West Heslerton and Alington Avenue.

Grave object/cultural traits	Empingham II (EII)	West Heslerton (WH)	Alington Avenue (AA)
Brooch	9	0	0
Buckle	37	12.3	0
Clasps	11.6	0	0
Pin	0	0	0
Hobnail	0	0	42
Girdle_hanger	22.2	0	0
Fabric textile	0	0	0
Bracelet	0	0	0
Comb	33.4	0	0
Finger_ring	25	0	0
Knife	38.5	13.9	0
Spearhead	73.6	25.9	0
Shield_boss	100	37.5	0
Key_latchlifter	16.7	0	0
Other_ring	15.9	0	0

Then, we subtract the raw values from the correspondent mean values (tab. 3.12) of the selected cultural traits (tab. 3.10). The results are the differences or distances (d) from ideal values, the mean values, to the values of each group.

Table 3.12: Example of CCL calculation. Percentage values of Empingham II, West Heslerton and Alington Avenue are subtracted from the correspondent percentage mean values (MV).

Grave object/cultural traits	MV	MV - EII	MV – WH	MV - AA
Brooch	8.7	-0.3	8.7	8.7
Buckle	32.3	-4.7	20	32.3
Clasps	5.5	-6.1	5.5	5.5
Pin	6.7	6.7	6.7	6.7
Hobnail	0	0	0	-42
Girdle_hanger	6.2	-16	6.2	6.2
Fabric textile	11.1	11.1	11.1	11.1
Bracelet	0	0	0	0
Comb	3.7	-29.7	3.7	3.7
Finger_ring	2.8	-22.2	2.8	2.8
Knife	32	-6.5	18.1	32
Spearhead	13.5	-60.1	-12.4	13.5
Shield_boss	73.7	-26.3	36.2	73.7
Key_latchlifter	19.1	2.4	19.1	19.1
Other_ring	10.3	-5.6	10.3	10.3

The obtained distances are operated in two ways. Firstly, the distances of each group are summed and then squared. The result is divided by the squared number of cultural traits. This is size (tab. 3.13).

Table 3.13: Calculation of size (in bold the final result of size).

	EII Σd	EII $(\Sigma d)^2$	WH Σd	WH $(\Sigma d)^2$	AA Σd	AA $(\Sigma d)^2$
	-157.3	24743.29	136	18496	237.5	56406.25
$/15^2$	—	**109.97**	—	**42.25**	—	**250.69**

Secondly, the distances are squared and summed together. The obtained figure is divided by the number of cultural traits. This result is subtracted to the size and this is the shape (tab. 3.14).

Table 3.14: Calculation of shape (in bold the final result of size).

	EII Σd^2	EII	WH Σd^2	WH	AA Σd^2	AA
	6241.49		2996.72		14524.25	
	416.10	- 109.97	199.78	- 42.25	968.28	- 250.69
/15	—	**306.13**	—	**117.58**	—	**717.59**

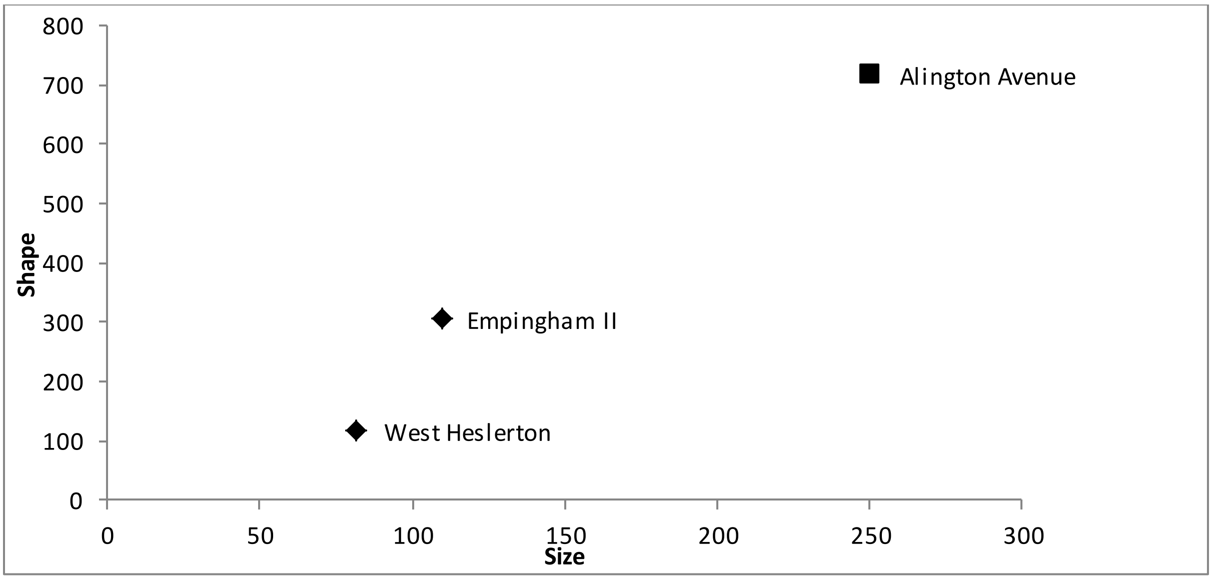


Figure 3.19: CCL of three male burial groups. Anglo-Saxon burials are diamonds. Roman burials are squares.

The scatter plot (fig. 3.19) is the illustrative result of CCL. It shows the groups of male burials of the cemeteries of West Heslerton, Empingham II and Alington Avenue and their variation in comparison with the origin of the axes and between themselves. The Anglo-Saxon groups are close one to the other and they are close to the origin of the axes. However, West Heslerton is slightly closer to zero than Empingham II. This suggests that Empingham II has more variation than West Heslerton in the set of selected grave object occurrence. Conversely, Alington Avenue is clearly at the edge of the plot, which represents the highest divergence among the three groups.

This methodology offers some advantages from an archaeological point of view. Firstly, it enables an evaluation of a wide range of data easily and accurately. Additionally, it may take into account the specific requirements of a research through the selection of the cultural traits of the most interest. For instance, it permits the investigation of the present topic, looking for change or continuity in burial tradition and comparisons among different archaeological contexts. The same method may explore the distance of values of all cemeteries of one specific historical region, such as Yorkshire, or it can compare cemeteries of different regions, such as Northern England and Southern England or it could evaluate the variances among the cemeteries of changing chronology, such as early Anglo-Saxon cemeteries and later Anglo-Saxon cemeteries. Consequently, the last analytical step will compare the results obtained by size and shape analysis of cultural traits of all selected cemeteries together, in order to detect possible patterns in variation in funerary cultural traits on a much larger scale.

3.8 CCL of Anglo-Saxon and Roman cemeteries

Anglo-Saxon and Roman male burials are plotted together after CCL calculation (fig. 3.20) and some considerations are required. The majority of Anglo-Saxon burials are very close to the origin of the axes, while the Roman burials are more distant from the zero.

When Roman male burials are examined together, it appears clear at first glance that most of the groups tend to be close to the mean of size value, but they do not form a clear cluster as the Anglo-Saxon burials do. There are Poundbury, Alington Avenue and the Eastern cemetery of London, which are close to the size average, but in contrast, Lankhills is separated from the other groups by a large size. Lankhills is the most distant cemetery on the size axis, while it is the closest of Roman cemeteries in shape. This position is linked with the low occurrence of grave objects and uniformity of grave object assemblages is indicated by the use of the Penrose formula in the analysis of the population.

Variation in shape is even more marked than in size. All the groups are distant from the Anglo-Saxon shape average. Lankhills and Alington Avenue are relatively closer groups to Anglo-Saxon shape and they show almost the same distance, which is considerable, if compared with the Anglo-Saxon values. The Eastern cemetery of London and Poundbury are more divergent in shape. Hence, these figures suggest that generally Late Roman male burials are mostly closer to the Anglo-Saxon male average in size, while they are extremely different in shape. The exception of Lankhills, which is distant in size seems of most interest, especially when compared with the other biological groups of the same cemetery.

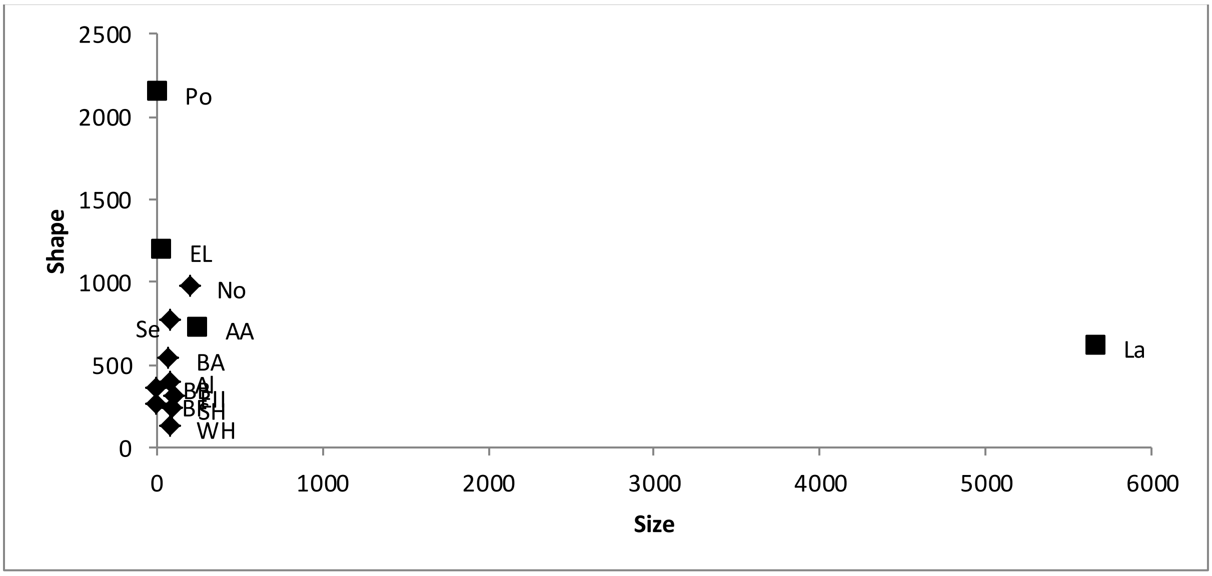


Figure 3.20: CCL of male burials. Anglo-Saxon burials are diamonds. Roman burials are squares. Abbreviations are reported in table 3.5.

More in detail, a cluster of Anglo-Saxon male burials shows very little divergence in size and shape (fig. 3.21). The male burials of the selected cemeteries are mostly placed very close one to the others, with some size and shape variation. Norton is the most distant male group from zero of size and shape. These cemeteries are encompassed in a narrow space on size axis, while they span a wider length in shape axis. This means that these groups have similar total values total mean occurrence of cultural traits, but they vary greatly in proportional representation. Incidentally, Sewerby and West Heslerton, which are two northern cemeteries geographically close, are at the extreme positions of the shape. Another cluster gathers together the cemeteries at Beckford B and Butler's Field. They overlie size and are similar in shape values. These two male groups are also very close geographically. The affinity in shape does not imply similarity in the whole funeral costume, but it reflects the similar values of relative variation of cultural traits.

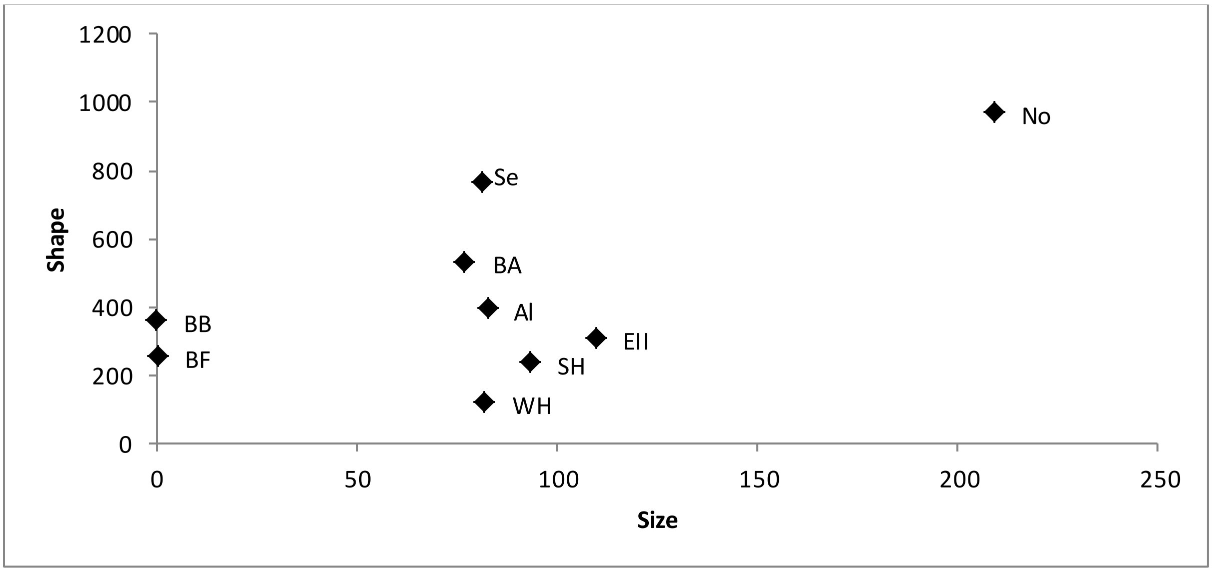


Figure 3.21: detail of CCL of Anglo-Saxon male burials. Abbreviations are reported in table 3.5.

The female burial groups present similar division between Roman and Anglo-Saxon burials (fig. 3.22). The Roman female groups are the most distant from the origin of the axes, while the Anglo-Saxon groups are clustered. Poundbury, the Eastern Roman cemetery of London and Alington Avenue are relatively closer to Anglo-Saxon averages of size. Lankhills females are extremely distant from the Anglo-Saxon size average. All the groups are quite distant from the shape average. The female group of Lankhills is the closest in shape, having values similar to its Anglo-Saxon counterparts. The other three groups have higher values in shape.

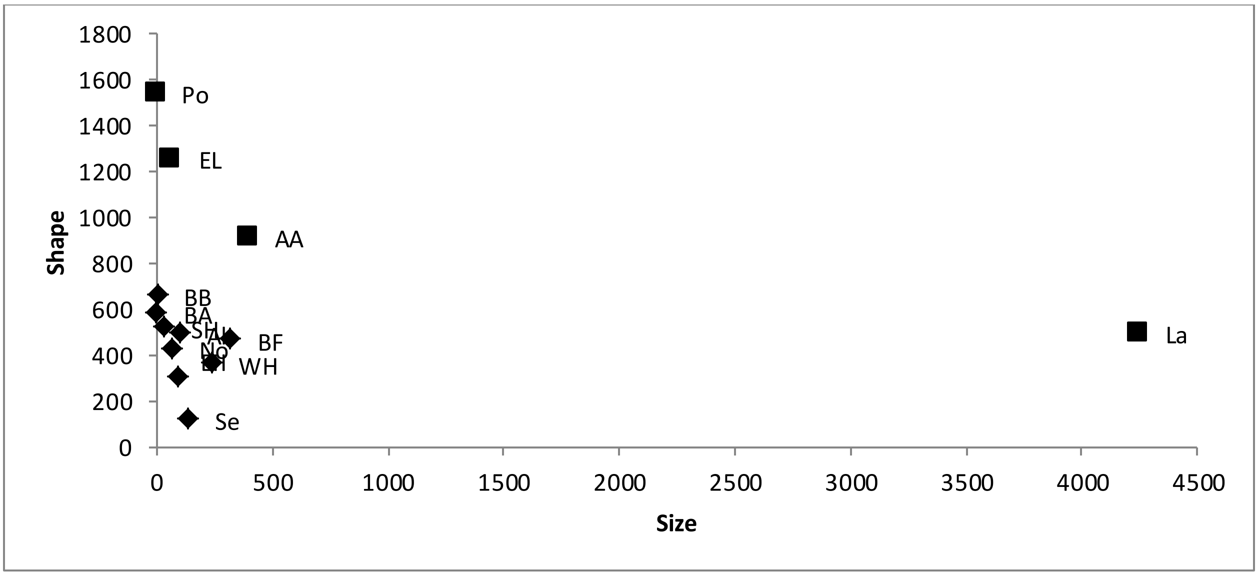


Figure 3.22: CCL of female burials. Anglo-Saxon burials are diamonds. Roman burials are squares. Abbreviations are reported in table 3.5.

Anglo-Saxon female burials (fig. 3.23) show less divergence than their Roman counterparts. This suggests that the standard set of selected grave objects was widely applied in these burials. On the size axis, Beckford A group is the closest to zero while Butler's Field is the furthest. In shape, the spread is also evident. Another cluster may include Beckford B, West Heslerton and Sewerby with variation in selected cultural objects. Two of these cemeteries are in Northern England, geographically close. Hence, their proximity in size value may indicate a regional trend. However, the suggested trend is not confirmed by the variations in the occurrence of object categories (shape). The positions of the western female groups have a different trend. In fact, female burials of Beckford A, B and Butler's field occupy extreme positions in the graphs. Beckford A is the closest, among the female burials, to zero in size, while it has the highest value in shape. This means that this group is close to the Anglo-Saxon mean for the amount of clothing objects, but not for individual object frequency. Beckford B female group has almost the same values as Beckford A.

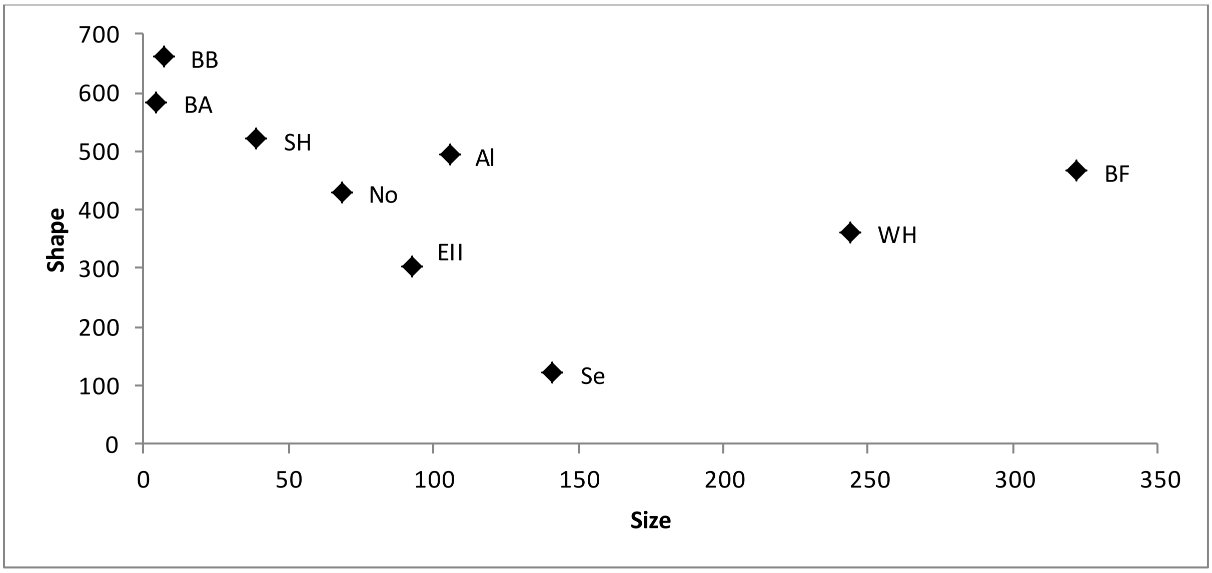


Figure 3.23: detail of CCL of Anglo-Saxon female burials. Abbreviations are reported in table 3.5.

The result of CCL of sub-adult burials displays clear separation between Roman and Anglo-Saxon burials, similarly to adult counterparts (fig. 3.24). The Roman immature burials have a similar pattern to adults groups. In fact, the sub-adults groups from Alington Avenue, Poundbury and Eastern cemetery London are close to the size zero value. Lankhills has the most distinctive divergence in size. The different position of Lankhills in size is based on the higher number of objects contained in the burials. Conversely, the other Roman immature burials include limited amount of objects. This limitation of objects influences also shape. All of the groups show marked variations in shape values. This is because of the internal variation in grave objects, which is limited to few objects.

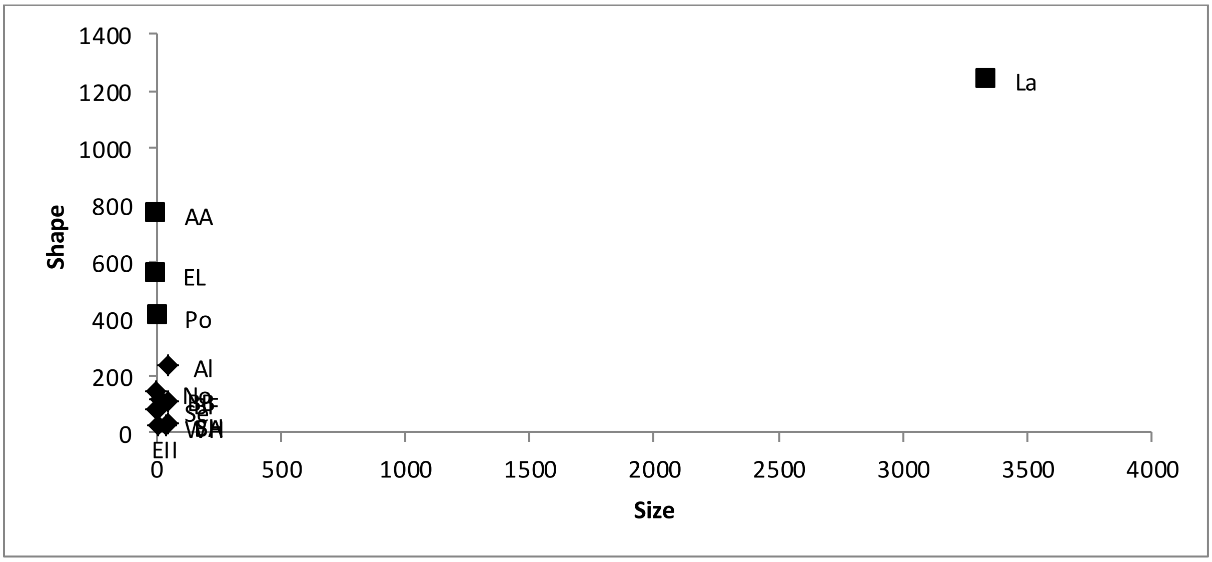


Figure 3.24: CCL of immature burials. Anglo-Saxon burials are diamonds. Roman burials are squares. Abbreviations are reported in table 3.5.

Generally, sub-adults groups (fig. 3.25) are the closest to the Anglo-Saxon mean values, if compared to adult burials. These graves were often poor in objects. Hence, their values of total occurrence and proportional variation are relatively small. Considering differences in size values, cemeteries can be clustered into two major groups. The first gathers Norton, Empingham II, Sewerby, West Heslerton and Beckford B. The second brings together Alton, Butler's Field, Spong Hill and Beckford A. Alton's immature group is separated from the others with a shape value higher than 230. The immature group of Alton was only nine burials, with two having more than five cultural objects (**grave 27** and **41**). On the other extremity, the immature group of West Heslerton includes 21 graves and only one grave has nine selected objects (**grave 132**), which is a considerable figure if compared with the other immature graves. These results suggest the incidence of these selected objects are not simply linked to wide geographical patterns, but may have other causes, like more localised traditions.

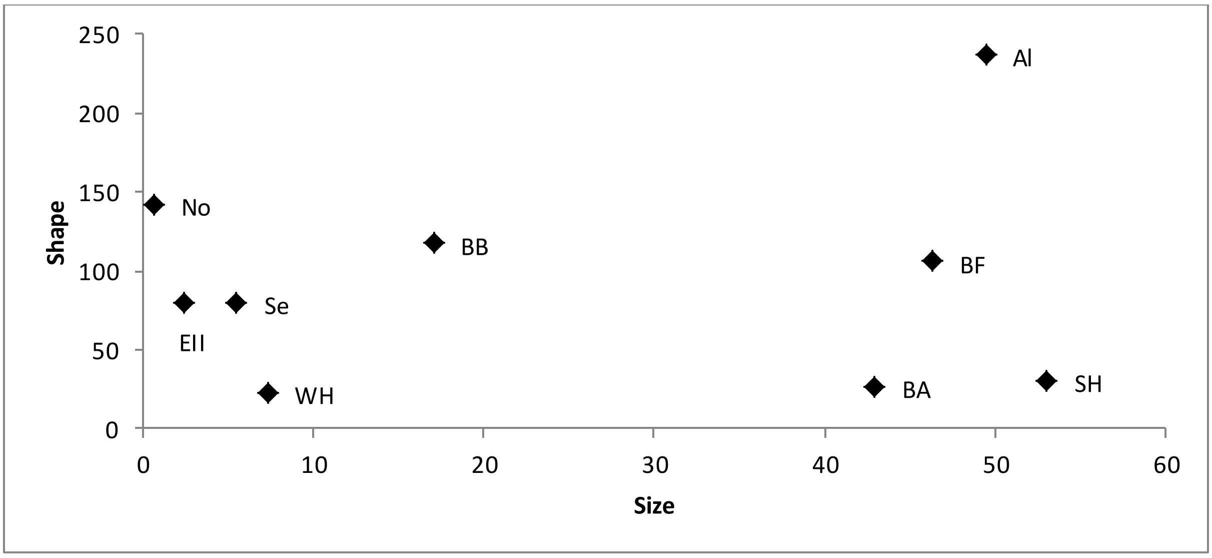


Figure 3.25: detail of CCL of Anglo-Saxon immature burials. Abbreviations are reported in table 3.5.

As general discussion, when considered by the size and shape statistic, all the biological groups of Roman cemeteries analysed in this work show some common patterns. Firstly, the proximity to the Anglo-Saxon size values, which is linked to the occurrence of grave objects, is usually low. Secondly, all Lankhills groups are always separated by long distances from the other cemeteries. This may be linked to the greater presence of grave objects in Lankhills groups when compared with the other Roman cemeteries. Moreover, size and shape show how the Lankhills cemetery is somehow different. This variance may be linked to the strong similarities of grave object assemblages found in some burials. In this way the result is in agreement with Clarke's interpretation that some graves could contain immigrants from the Continent, who kept their original costume in contrast to the Roman tradition (Clarke 1979). After the OA excavation (Booth *et al.* 2010) and the isotope analyses, the hypothesis of a great presence of immigrants was less certain. In fact, most of the inhumations with "exotic" grave objects, such as belt buckles, had local isotope values (Booth *et al.* 2010). It is obvious that the geographical origin is not always linked to the cultural background of an individual. For example, a professional soldier raised in the Mediterranean region, who served in Central

Europe and died in Britain, might had been buried with German military insignia, while keeping in his bones chemical traces of his original birth place. Conversely, a burial of Lankhills with local isotopes and exotic grave objects might have retained cultural objects for reasons of tradition (Booth *et al.* 2010). Finally, all Roman groups show marked variation in shape, which may be interpreted as evidence of significant uniformity in cultural elements.

The Anglo-Saxon burial groups analysed by the size and shape statistic showed different patterns in divergence in both distances. Male burials show certain similarity in size, while they have marked divergence in the relative incidence of the cultural traits (shape). Female groups diverge widely in both size and shape. Even if the two cemeteries of Beckford almost lay on the same low size value, they diverge in shape. Immature burials have another distributive scheme. They are the closest to the origin of the axes and show the least divergence in both size and shape. However, even if immature divergence of cultural traits is limited, they have more marked separation in shape rather than size.

This analysis reveals wide variation among Anglo-Saxon male, female and immature groups, which supports view that burial clothing, and perhaps ritual, was by no means standard and homogeneous in Anglo-Saxon England. The immature group closely show the least variation from the Anglo-Saxon means, both for size and shape. Female burials appear to be better represented by dressing assemblage for death, although males still show considerable variation, especially considering West Heslerton and Norton cemeteries.

The PCA and CCL results show clear separation between Roman and Anglo-Saxon burial groups and also differences between male, female and immature groups. However, PCA and CCL do a different work. PCA underlines the significant relationships of the burial groups with the grave objects, while CCL highlights the differences and similarities of the burial groups in the overall and relative occurrence of the grave objects. Thus, it is recommended the application of CCL in combination with PCA as exploratory data analyses to a given set of data. The variations in burial clothing, highlighted by PCA and CCL, require further investigations in order to define the possible causes of the variations that could be linked to ritual or social factors.

3.9 Limitations of the digital archive

This digital archive also needs to be considered as regards its limitations. The present database holds some possible limits, which need to be taken into account. There is the potential, for instance, in the use of “grave”, “grave object” and “skeleton” for confusion. Secondly, the archaeological reports, which are the main source of data for this research, do not have a consistent style in recording data. Often a poor terminology occurs in the excavation reports. The main problem is the description of the soils and their characteristics. Even less data is given concerning the nature of the possible fills of the graves. So this aspect has been abandoned because of the extreme difficulty of describing equally all the fills.

The following chapter provides a discussion of data collected in the digital archive. Raw data and brief descriptions of populations and skeletal remains are reported in tabulations and graphs in appendix 1, 1-12, while raw data of grave objects are reported in tabulations in appendix 3, 1-13.

Chapter 4: Discussion, evidence of preserved textile fibres in the archaeological record

4.1 Introduction

The present chapter includes discussions on the selected grave objects found in some Roman and Anglo-Saxon cemeteries. Data come from published reports and the author did not access directly to any of the referred materials. The sites were selected according to the following characteristics:

- Cemeteries include inhumations burials.
- The cemeteries have contrasting chronology and cultures, such as Roman and Anglo-Saxon sites.
- The sites are distributed on different soil types.
- The reports of the sites provide sufficient information about the graves and the grave good assemblages.
- The sites include a range from 27 (Beckford A) to 1404 (Poundbury) of graves.
- The cemeteries are related to single settlement.

These choices present some limitations:

- Some cemeteries may be not entirely excavated, such as the Eastern Roman cemetery of London.
- The reports are different in the way they refer information of the sites.

The first part of the chapter contains general descriptions of the sites, including soil characteristics, human remains and a catalogue of selected grave goods. Hence, there is an analytical part which comments on preserved organic textile evidence.

This chapter examines four Roman (fig. 4.1a) and nine Anglo Saxon (fig. 4.1b) cemeteries in the order provided by the following list:

1. Eastern cemetery of London (ch. 4.2)
2. Poundbury (ch. 4.3)
3. Alington Avenue (ch. 4.4)
4. Lankhills (ch. 4.5)
5. West Heslerton (section 4.6)
6. Alton (section 4.7)
7. Beckford A and B (section 4.8)
8. Butler’s Field (section 4.9)

9. Empingham II (section 4.10)
10. Norton (section 4.11)
11. Sewerby (section 4.12)
12. Spong Hill (section 4.13)

NB the Appendix 1 contains data regarding general background of the sites, both Roman and Anglo-Saxon, and data about skeletal remains and anthropological identifications.

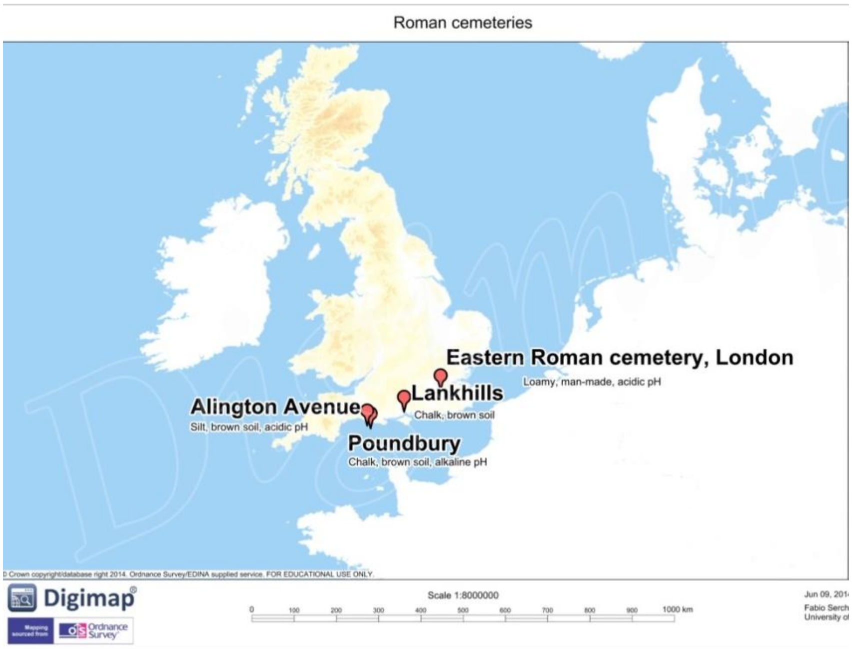


Figure 4.1a: distribution map of the selected Roman cemeteries. Sites are provided with soil description.

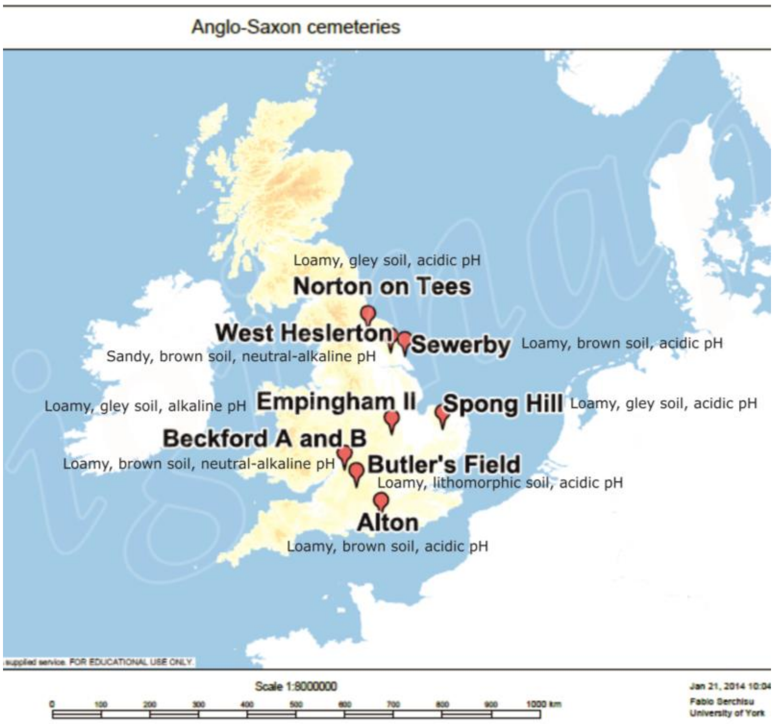


Figure 4.1b: distribution map of the selected Anglo-Saxon cemeteries. Sites are provided with soil description.

References for grave names are written in bold style (e.g. **grave 10 2**), while numbers close to the grave name indicate the grave object number according to the original report (e.g. **grave 10 2**, 1).

4.2 Eastern Roman cemetery, London: description, analysis and discussion

4.2.1 Site introduction and soil description

It is an urban cemetery that was partially excavated through scattered sites between 1983 and 1990 (Barber and Bowsher 2000). It includes around 608 inhumations and some cremation burials, which are dated to the early stages (Appendix 1.1). This site is interesting because its extended chronology, spans from the 1st to the 5th century AD (Barber and Bowsher 2000), with contrasts in the limited of grave objects and the absence of textile finds. This may indicate a uniform funeral ritual, which appears unlikely considering the number of graves and the prolonged use of the site. More variation across the burials is suggested, which indicates changes in ritual, and a poor organic preservation which affected the archaeological record.

The original report provides an accurate description of the soil (Barber and Bowsher 2000, 50). The sites are on a sandy and gravelly terrace covered by a brickearth layer at around 500 metres on the current line of the River Thames. The human activity has an important impact on this soil. A layer of brickearth, which covers sand and gravel, is the topsoil. According to Soilscapes (Cranfield University

2012), this area is described as having a naturally wet and acidic soil. Therefore, free drainage of water is facilitated and the acidic pH content is elevated. These are not ideal conditions for organic preservation. Hence, textiles and leather are not supposed to have good preservation. There were no finds of these materials and limited finds of other organic remains, like pollen, seeds and wooden fragments. Therefore, textile and leather fragments were not found in these inhumations, as will be reported below.

4.2.2 Textile fibres and leather. Occurrence and preservation

Except for a few unidentified fibres found on an iron bracelet in **grave B291**, the inhumations of this cemetery did not preserve textile evidence. Conservators collaborated with archaeologists in soil block sampling, but the observations in the field and analyses in the laboratory did not show any preserved traces of such organic material. It may be argued that all the burials were unclothed, but it seems unlikely because some inhumations were accompanied by jewellery and personal equipment, like hairpins, pins, bracelets, combs and other objects that were worn. Hence, this suggests that at least those burials were actually clothed. Presence of pins in other burials indicates possible shrouds, which covered the body (Barber and Bowsher 2000, 118-119). Moreover, the skeleton found in grave **B202** had an attitude that indicates a possible shroud (Barber and Bowsher 2000, 91).

Conservators observed that mineral salt replacement occurred for small fragments of wood (Barber and Bowsher 2000, 378). This implies that a toxic environment caused by metal objects and their reaction with the soil influenced the chemistry of some burials. However, the preservative mechanism of mineral replacement did not save fragments of textile or leather, and possible textile finds have not been recorded.

4.2.3 Grave objects and clothing reconstruction

Nine out of fifteen object categories were found in this cemetery (fig. 4.2) and the overall occurrence is scarce. Female and male graves are the best represented but the raw numbers reflect limited grave objects (appendix 3.1, tab. 1). No attempt to reconstruct local costume was produced due to the paucity of grave objects, except for two graves (**B538; B374**) that contained sufficient clothing objects to raise questions about the identity of their dead (ch. 4.2.6).

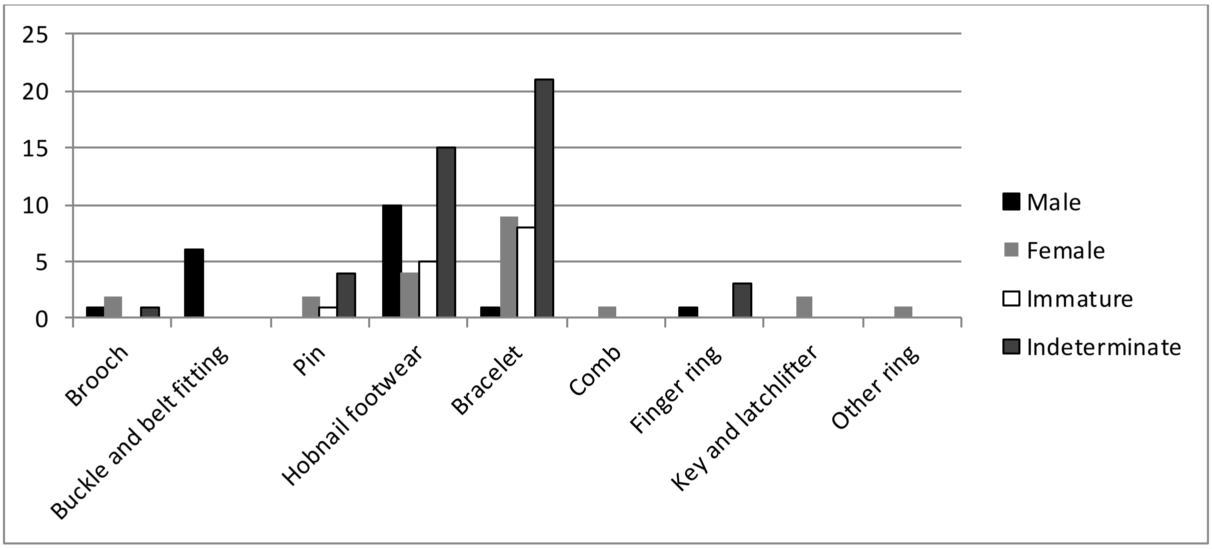


Figure 4.2: Eastern Roman cemetery of London. Bar chart of cultural traits actual numbers.

4.2.4 Discussion

The Eastern Roman cemetery of London is limited by its incompleteness, but it is still a valuable source of information and a valid case study to compare with other archaeological sites. Little can be said about personal clothing. Preservation of organic materials was extremely poor and preserved textile or leathery patches were not found. Skeletal remains are poorly preserved as well and the analyses on preserved bones revealed biological homogeneity. It is interesting to underline that in this cemetery there were practises that in other cemeteries allowed limited organic preservation, like coffined and chalky burials. Conversely, this site did not preserve organic remains. Therefore, there is a strong indication of the role of taphonomic processes in degrading completely all organic goods buried with skeletons.

This cemetery is defined as a Roman one, whether its population was mostly of immigrants from the western provinces of the Roman Empire, or native Britons highly Romanised. Because of its long continuity in use, it may appear as an ideal case study to find changes in burial practises. Despite its chronological span, this cemetery does not provide enough detail to identify strict boundaries between rituals. In other words, archaeological finds have not been considered sufficient to distinguish cultural diversity, which may reveal different ethnic origins, except for two controversial burials.

Six burials contained displaced skulls **B103, B661, B666, B707, B733** and **B821** (Barber and Bowsher 2000, 84 tab. 33 and 316-317). Removal of the head from the rest of the body was a Celtic practice recorded by classical authors and found in some Celtic Iron Age burials (Whimster 1981, 184-188). However, the likely native head displacements may be limited only to **B103** and **B821**, which are dated to the earlier phases of the cemetery. The other burials, **B661, B666, B707** and **B733,** are later.

Therefore, it seems unlikely they belonged to a Celtic tradition, unless they might be a revival of native practises or they referred to different beliefs with similar results.

The 81 chalk burials have not shown any difference with burials without chalk in terms of ritual, but they are more frequent among immature than adult burials. The coffined burials also have not revealed any specific pattern. Possible differences in religion are elusive as well. The use of lead coffins, in two cases, and chalk burials may reflect the will to preserve the corpses, but this does not imply a belief in the afterlife. Grave objects related to divinities are rare, so it is difficult to associate burials to a specific cult or religious belief. Christian evidence is not present at all, Christians might be present in this cemetery, but there are no archaeological traces of them.

The last phases also do not reveal sharp changes in grave object assemblages. Some of the later burials may be dated between the end of the 4^{th} and the early 5^{th} century AD and so they fit in the open debate on the nature of the dead at the end of the Western Roman Empire. Few graves can be dated with a certain degree of accuracy around the fifth century: **graves B557**, **B538** and **B374**. The latter two are of interest for this research because they contained grave objects related to clothing.

Grave B538 is a male burial containing two glass bottles, an elaborate metal *cingulum* or belt set and a brooch, which originally was worn (Barber and Bowsher 2000, 206-208). This chip-carved belt is common in Northern European regions for its technology and decoration, but this burial suggests a German origin for this individual (Barber and Bowsher 2000, 305). In fact, the belt set and brooch are likely associated with a military individual, but a military uniform is not necessarily linked to ethnic origin.

Grave B374 (Barber and Bowsher 2000, 183-184) is the only grave, which may contribute in this discussion. It is an adult female burial accompanied by a flagon, two silver brooches and a comb. The later three artefacts belong to a Germanic style. Therefore, this woman could be a Germanic immigrant who was buried in her traditional costume, but all the other aspects of her burial adhere to the configuration of this cemetery, without significant changes. Hence, the presence of this burial is not entirely surprising considering that London had a long tradition of immigration.

Finally, this cemetery has such homogeneity that differences in status, religion or cultural identity were not visible. Moreover, burials without any grave objects were the common practice in this cemetery. Those burials with grave objects represent the minority. As it was expected, no controversial association between grave goods and the sexes were detected.

The absolute degradation of organics associated with the low occurrence of selected grave objects influences the interpretation of this site. The burials appear characterised by cultural homogeneity.

However, the proportions between adult male, adult female and immature burials do not appear representative of an entire population. Differences in status, religion and ethnic origin of buried individuals was too complicated and it was not possible to draw any conclusive interpretation. Few burials showed elements that did not belong to the ordinary Roman tradition. For example, grave **B374** interpreted as a Germanic immigrant and **B538** was likely a professional military officer of Germanic origin or that served in a German legion. However, these exceptions did not influence the general trend in the statistics.

4.3 Poundbury cemeteries: description, analysis and evaluation

4.3.1 Site introduction and soil description

Poundbury is a Roman urban cemetery with a long continuity of use, which served the city of *Durnovaria*. Burials and other archaeological features of the late Iron Age are also present (Farewell and Molleson 1993). Iron Age ritual of crouched burials continues until the beginning of the 2nd century AD. Roman inhumations were separated into different cemeteries, which show some differences in chronology and other aspects. For example, some inhumations were originally included in *mausolea* and others are aligned distinctively along the main cemetery's sides (appendix 1.2). Regardless of relative limitations in textile finds, the presence of different burial rituals provides information of preservation mechanisms of organic materials, including textiles.

Soil characteristics and geological characteristics were described in the report (Farewell and Molleson 1993, 2). Upper Chalk formation includes all cemeteries and it is their geological bedrock. Soil exploitation is demonstrated by the presence of lynchets and ploughing activities from the Bronze Age until the Middle Ages. It was recorded that erosion is a common process and it affects topsoil variously. Erosion damaged some graves and it is not excluded that other graves were completely lost because of that. According to Avery, local soil is calcaric brown soil with associated brown soil (Avery 1990, fig 2.5). The cemetery lies on shallow lime-rich soils over chalk (Cranfield University 2012) and the pH of the soil is alkaline (NERC 2011).

This soil is damaging to textiles. The alkaline pH may preserve cellulose material to some extent (Cronyn 1990, 28-29) but not proteinaceous fibres and leather (Huisman *et al.* 2009, 84-85) and it facilitates biota activities, but this factor appears not to be correlated with the preserved human hair and woollen hair band found in several burials (Appendix 1.2). Conversely, free draining starts a quick breakdown of all kinds of materials. Moreover, the topsoil human activities and the long use of this land for agriculture eroded the top level and it has likely affected the subsoil. Even if it is not possible to quantify the damage, it is suggested that there was an acceleration of all degradation processes underneath, including of burials.

Further details on the taphonomy of the soil were provided by the report in the descriptive sub-sections dedicated to the late Roman cemeteries (Farewell and Molleson 1993, 14-45). All funeral areas are described as generally uniform. The only exception is site C, which is reported to have deeper burials than the other sites. This was because it was in a "slightly protected down-slope position" and it retained some 0.46 m of occupation material from the Bronze Age, Iron Age and early Roman phases" (Farwell and Molleson 1993, 15). Moreover, it was observed that site C burials were deeper than the other graves because their subsoil was crumbled chalk loamy fill, while the other sites lay on solid chalk. These conditions may promote a quicker water drainage compared with the other sites. Hence, poor organic preservation can be expected in site C more than in other cemeteries.

4.3.2 Textile fibres and leather. Occurrence and preservation

The cemeteries of Poundbury revealed marks of preserved textiles and leather in small quantities but still significant enough evidence to investigate preservative processes of organic fibres (Crowfoot in Farwell and Molleson 1993, 111-113 and Determan, microfiche 1 tab. F11-G3). Textiles were preserved both as fragments (**graves 6**, **9**, **49**, **99**, **114**, **376**, **478**, **513** and **530**) and impressions (**graves 8**, **478**, **513**, **517**, **525**, **529**, **530**, **817**, **858**, **862**, **864**, **867**, **868**, **869**, **1012**, **1060**, **1127** and **1215**) (tab 4.1). All textiles whether as fragmentary finds or impressions on gypsum all occurred in graves of the main cemetery, except for one find in site C (**grave 376**) and one find in the outlying late Roman burials (**grave 6**). Crowfoot stated that these remains were residues of shrouds and not evidence for garments (Farwell and Molleson 1993, 111). Even if identification of original fibres was not possible because of the strong mineralisation, it was suggested that flax was used. This is likely based on the assumption that Roman shrouds were usually made with flax. The only positive fibre identification is the woollen hairband found in **grave 530**. This artefact had a damaged and faded fibrous structure and microscopic examination noted destructive microbial activity. **Grave 99** produced a coiled fragment of golden filament, which was hollow and might originally have included a silk strand. This find was reported to be close to the left foot (Farwell and Molleson 1993, 112), and is unusual in Britain, but more numerous in Europe (Wild 1970, tab. H, 1-11). It may imply high social status of the dead associated with the golden decorated dress.

Leathery fragments were not found. However, some corroded clusters of hobnails may indicate the original presence of leather in footwear. In fact, it was suggested that the mineralised matter, which clustered together three or more hobnails was originally shoe leather (Farwell and Molleson 1993, 99). There is the chance that leather was encapsulated within the corrosion products but no analysis was done to verify this possibility. Therefore, the current database does not include any leather finds from this cemetery because of the absence of clear leather finds.

Two major organic preservative mechanisms likely worked at Poundbury: mineral replacement and impressions on gypsum or plaster. Distribution of preserved textiles is not clear. As it has already been noted, most of the finds were in the main cemetery.

As it has been underlined above, soil is almost constant for all funeral sites. Limited differences in the soil are found in site C, which is described as having a different soil texture (Farwell and Molleson 1993, 15) that may accelerate water drainage. This might cause rapid degradation of textiles, like all the soft organic tissues. However, it is not sufficient to understand the reason for the concentration of textile finds in the main cemetery and the overall low number of textile finds.

Impressions of textiles are always correlated with graves filled with gypsum or plaster. However, not all the graves that were filled with plaster or gypsum preserved textile impressions (Farwell and Molleson 1993, tab. 1 and 2). Filling coffins with gypsum was a funeral practise found also in some Roman burials at York (Railway excavations and Clementhorpe, Wild 1970, tab. A 36-42) and Trier, Germany. Both sites revealed evidence of textile impressions (Wild 1970, tab. b 43-45 and 48). Filling graves with gypsum was a ritual attributed to Christianity (Toynbee 1971; Henig 1995, 180) and linked to the idea of immortality. Whether or not this hypothesis is correct, there is a high correspondence in textile impressions on gypsum or plaster. The reaction between organic fibres and calcium sulphate is likely to have produced durable prints of the same textiles. It is important to note that the method of fibre identification was not reported, but it was written that the fibre was likely to be flax. Hence, this textile identification cannot be entirely reliable without further examination of the imprinted fibres.

Another correlation is observed between preserved textiles and burial environment. Mineralised fibres occurred in the presence of lead in the coffin. In fact, the inner lining in some 26 coffins was made from lead (Farwell and Molleson 1993, 63-65, tab. 1 and 2). Like the case of gypsum/plaster filled burials, not all coffins with lead linings preserved textiles, but mineralised textiles occurred in coffins with some original lead present.

Table 4.1 highlights associations between the two preservative mechanisms and the likely agents of preservation. It is clear that textile evidence is mostly in graves protected by coffins, whether they were made in wood with lead linings or stone with gypsum fillings. However, the table reveals also a few cases of preservation in graves without coffins, lead or gypsum (**graves 6, 9, 49, 114, 525** and **864**). In the absence of further soil examinations, it is hard to trace back to the actual preservation process. However, soil characteristics had a likely impact on limited preserved textiles.

One single case of identified fibre textile was wool, in the hairband already described above. This is more exceptional if it is considered that the rest of the unidentified fibres were suggested to be of plant origin, namely flax. The woollen hairband was found in **grave 530**, which included other textile fragments impregnated by gypsum and preserved human hair. Even if the general condition of the woollen fibres and human hair were poor, it is clear that this burial provided better preservation than other graves, and effectively slowed down degenerative microbiological activity.

Table 4.1: Poundbury, correlation between preserved textiles and textile impressions, plaster/gypsum presence and lead linings, with notes on the fibre conditions. X = present.

Grave	Golden thread	Fragmentary textiles (number of fragments)	Textile impressions	Wooden coffin with lead linings and plaster fill	Stone coffin and plaster fill
6	0	X (1)			
8			X		X
9		X (1)			
49		X (39)			
99	X				X
114		X (2)			
376		X (?) earth replacement		X	
478		X (? more than one fragment) gypsum replacement	X	X	
513		X (2) impregnated with gypsum	X	X	
517			X		X
525			X		
529			X	X	
530		X (? four groups of fragments, hairband not included) + woollen hairband and other fragments impregnated with gypsum	X	X	
817			X	X	
858			X	X	
862			X	X	
864			X		
867			X	X	
868			X	X	
869			X	X	
1012			X	X	
1060			X	X	
1127			X	X	
1215			X	X	

Most of the textile evidence was found in the main cemetery and only two cases were discovered in the other cemeteries. One was in the outlying burials and the other in site C (tab. 4.2). This outcome can be interpreted in two different ways. It appears that higher amounts of textiles are correlated with the elevated number of graves and also with greater presence of graves filled with plaster or gypsum. Therefore, it is suggested that a ritual choice of including a preservative agent containing calcium sulphate, helped the preservation of some, mostly unidentified, textiles, both as actual fibres (a rare event) and as impressions on gypsum or plaster fragments.

Table 4.2: Poundbury, preserved textile evidence on selected objects.

Site	Grave	Type of fibre	Possible preservative agent	Preservation
Main cemetery	8	unidentified	calcium sulphate	impression
	9	unidentified	absent	poorly preserved
	49	unidentified	calcium sulphate	poorly preserved
	114	unidentified	absent	poorly preserved
	478	unidentified	calcium sulphate	mineralized
	514	unidentified	calcium sulphate	mineralized
	517	unidentified	calcium sulphate	impression
	525	unidentified	calcium sulphate	impression
	529	unidentified	calcium sulphate	impression
	530	unidentified	calcium sulphate	wool poorly preserved
	817	unidentified	calcium sulphate	impression
	858	unidentified	calcium sulphate	impression
	862	unidentified	calcium sulphate	impression
	864	unidentified	calcium sulphate	impression
	867	unidentified	calcium sulphate	impression
	868	unidentified	calcium sulphate	impression
	869	unidentified	calcium sulphate	impression
	1012	unidentified	calcium sulphate	impression
	1060	unidentified	calcium sulphate	impression
	1127	unidentified	calcium sulphate	impression
	1215	unidentified	calcium sulphate	impression
Site C	376	unidentified	absent	mineralized
Outlying burials	6	unidentified	calcium sulphate	poorly preserved

Below, figure 4.3 visualises the occurrence in graves of preserved textiles and how they are associated with preservative substances. The majority of preserved textiles occur in coffins with internal lead linings and filled with plaster or gypsum.

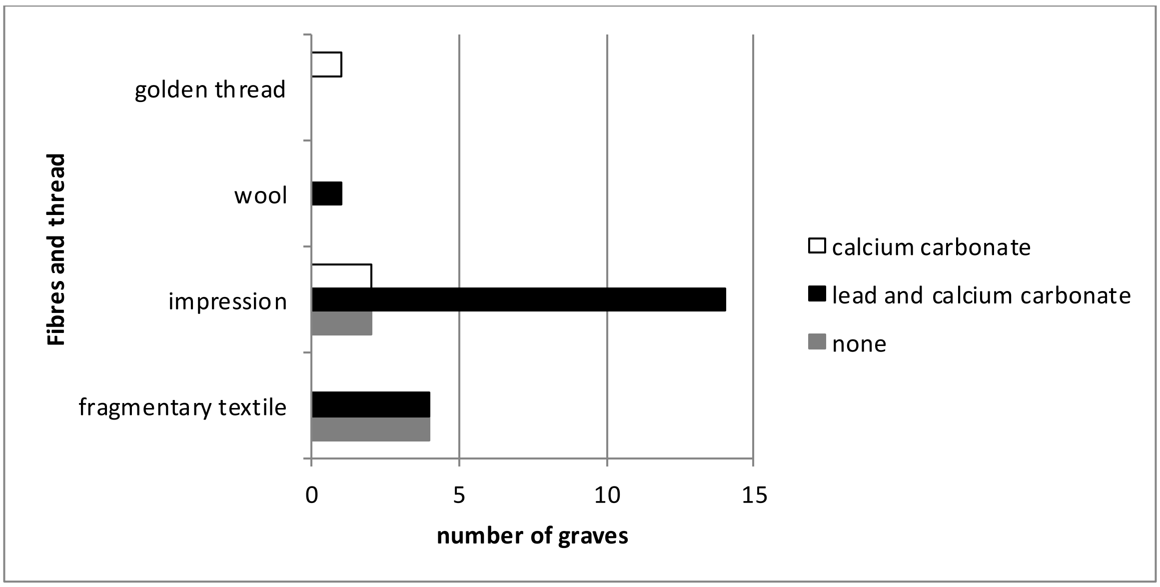


Figure 4.3: occurrence of preserved fibres and textile impressions in graves of all cemeteries of Poundbury and their association with preservative materials.

4.3.3 Grave objects and clothing reconstruction

Generally, the selected grave objects are not numerous (fig. 4.4) and this low incidence may be explained by a preference for shrouded burials rather than clothed bodies. However, the local community during the later phases of the cemeteries showed improved attention to their dead. Archaeologically, hairdressing is the most visible evidence, revealed by the presence of combs, hairpins and preserved hair. Hairpins indicate possible presence of a veil on the head. The textile impressions on the plaster are not sufficient to understand whether the dead were buried dressed or shrouded, but there are clear indicators of the presence of textiles within the grave.

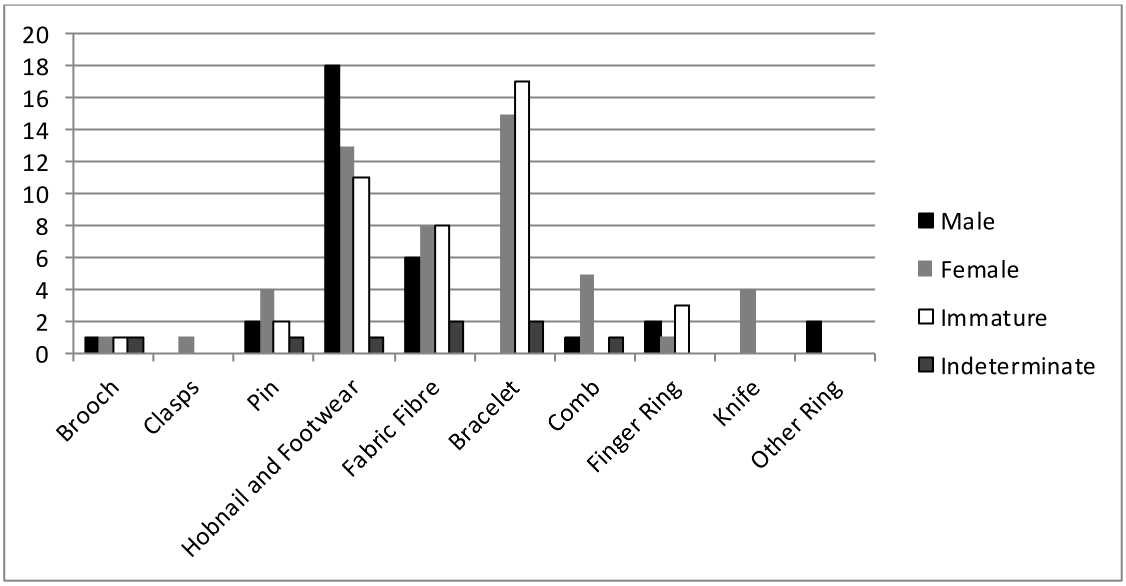


Figure 4.4: Poundbury cemeteries. Bar chart of the actual numbers of cultural traits.

4.3.4 Discussion

Poundbury was an interesting challenge as a case study. The site has a long continuity of use, but the chronology could not be assessed entirely, because of the low number of artefacts. However, the effort of field archaeologists and post-excavation examinations established a reasonable chronology of burials that spans from an isolated Bronze Age burial, to the Late Iron Age – Durotrigian – through to Roman graves until the AD 4th century. Here, only the Roman graves have been examined.

The site was distinct in five main areas because they appeared spatially distinguished. The main cemetery also had remains of *mausolea* buildings, likely related to family linkage. The soil does not have special preservative characteristics, but some graves kept evidence for textiles and other organic tissues, like human hair. These proofs were mostly found in the main cemetery, where the funeral practice occurred of using lead lining in some coffins and filling coffins with gypsum or plaster. The presence of calcium sulphate started a reaction that preserved textile as impressions or fragments. It is not likely that textile indicated clothing, but rather was the remains of shrouds left on the bodies. Calcium salts contained in gypsum and plaster helped also in preserving human hair in some burials. This revealed that even if the graves had scarce goods, the local community paid attention to their dead. The presence of other perishable grave objects can only be speculated on.

The high number of graves does not correspond to the small number of selected cultural traits. Regularity in funeral customs can be evaluated by size and shape calculations. Even if the occurrence of grave goods is limited to few graves, this statistic shows some trends. The main cemetery had more grave goods and the calculations are more significant. There was a preference in offering objects in adult female burials in the main cemetery, while in site C and outlying graves, men have a better representation and in the eastern and northern periphery sub-adult individuals received more attention.

4.4 Alington Avenue, Fordington: description, analysis and discussion

4.4.1 Site introduction and soil description

Alington Avenue is a rural cemetery close to the urban centre of *Durnovaria* (Davies *et al.* 2002) that likely served farming communities. It is a good contrasting example with the close cemetery of Poundbury. The site has 30 early Roman burials and 77 Late Roman inhumations, which are generally poorly furnished with grave objects (Appendix 1.3). Limited but significant exceptions of well-furnished burials showed interesting preservation of textiles.

The report dedicated an entire chapter (Allen in Davies *et al.* 2002, ch. 2, fig. 3) to describing the local environment. The site lies on a ridge of the Upper Chalk formation and it is between the floodplain of the River Frome and the dry South Winterborne valley. There was no deposit over the Chalk topsoil. The erosion of parent material was evident during the study, even if the estimation of chalk loss was not possible.

The area had been involved in cultivation for a long time, while pasture was a common practise in the more recent past. The topsoil is characterised by shallow calcareous silty grey rendzina of the Upton 1 Series but varied in thickness across the site. It averaged between 0.3-0.4 m in depth (Davies *et al.* 2002, 9). The description provided by Soilscapes (Cranfield University 2012) coincides with that provided by the archaeological report and defines the local soil as rich in lime and freely draining.

Soil samples were collected and analysed from some ditch sections. The most interesting feature revealed was the high content of calcium carbonate in soils. Content of calcium carbonate is correlated with human activities affecting the soil. Tillage lifts up chalk from the parent soil and it enriches topsoil with calcium carbonate (Staines in Davies *et al.* 2002, 47-48, tab. 9). The agricultural activities started in the Bronze Age and were concentrated on chalky soils for all the time there were in use. However, during late Roman and post-Roman times, cultivation was extended to cover grassland as well (Davies *et al.* 2002).

Hence, it is to be expected that higher carbonate contents in this locality are in arable soils rather than grassland. Consequently, the areas of the site, which were not affected by agriculture, are lower in carbonates. Unfortunately, soil samples were not taken from the burials and thus the role of calcium carbonate in potential textile and leather preservation is not known.

Intense use of this land for agricultural activities changed the soil profile significantly. The high presence of chalk promoted quick drainage and alkaline pH (Allen in Davies *et al.* 2002, 185-186). These conditions are not suitable for the preservation of soft organic textiles, especially those of animal origin, while this environment seems appropriate to create textile impressions.

4.4.2 Textile fibres and leather. Occurrence and preservation

Little evidence of fibres and leather were found in this site. However, some interesting finds came out from **grave 4378**, which was a burial coffin lead lined and packed with a white substance initially defined as gypsum (Davies *et al.* 2002, 135) (fig. 4.6). Recent FT-Raman spectrography analysis identifies that white substance as lead carbonate or cerussite (Schotsmans *et al.* 2014b, 1305). Cerussite is produced by the corrosion of lead which is in a damp and calcareous environment (Schotsmans *et al.* 2014b, 1305) as the case of **grave 4378**.

The grave contained the remains of a Late Roman 4-6 years old juvenile burial with preserved woollen fragments. These fragments (fig. 4.5) were found at three adhering patches on the shoulders (Crowfoot 1989). Crowfoot and Walton-Rogers (Davies *et al.* 2002, 158-159) examined the fragments. The analyses revealed that the body was buried fully clothed. Clothing was made of wool of exceptional fine quality, likely imported from the Mediterranean area (Crowfoot 1989; Davies *et al.* 2002, 158-159). Four textile samples were collected. Sample 1 and 2 were picked from the left clavicle. Sample 1 was undyed, while sample 2 had traces of decayed purplish-brown dye. Pink-purple threads were found in sample 3, which was taken from the left scapula. Sample 4 came from masses of threads on the right scapula and humerus and was brownish and mauvish (Davies *et al.* 2002, 158-159).

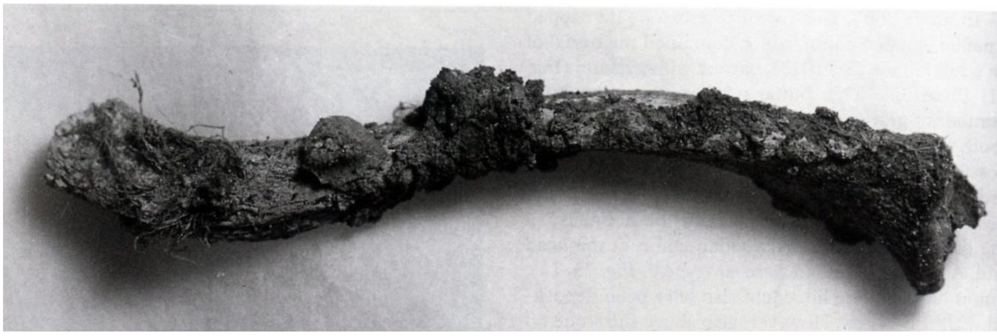


Figure 4.5: Alington Avenue. preserved textiles on a clavicle found in grave 4378. © Wessex Archaeology, Davies *et al.* 2002 pl. 33, 134.

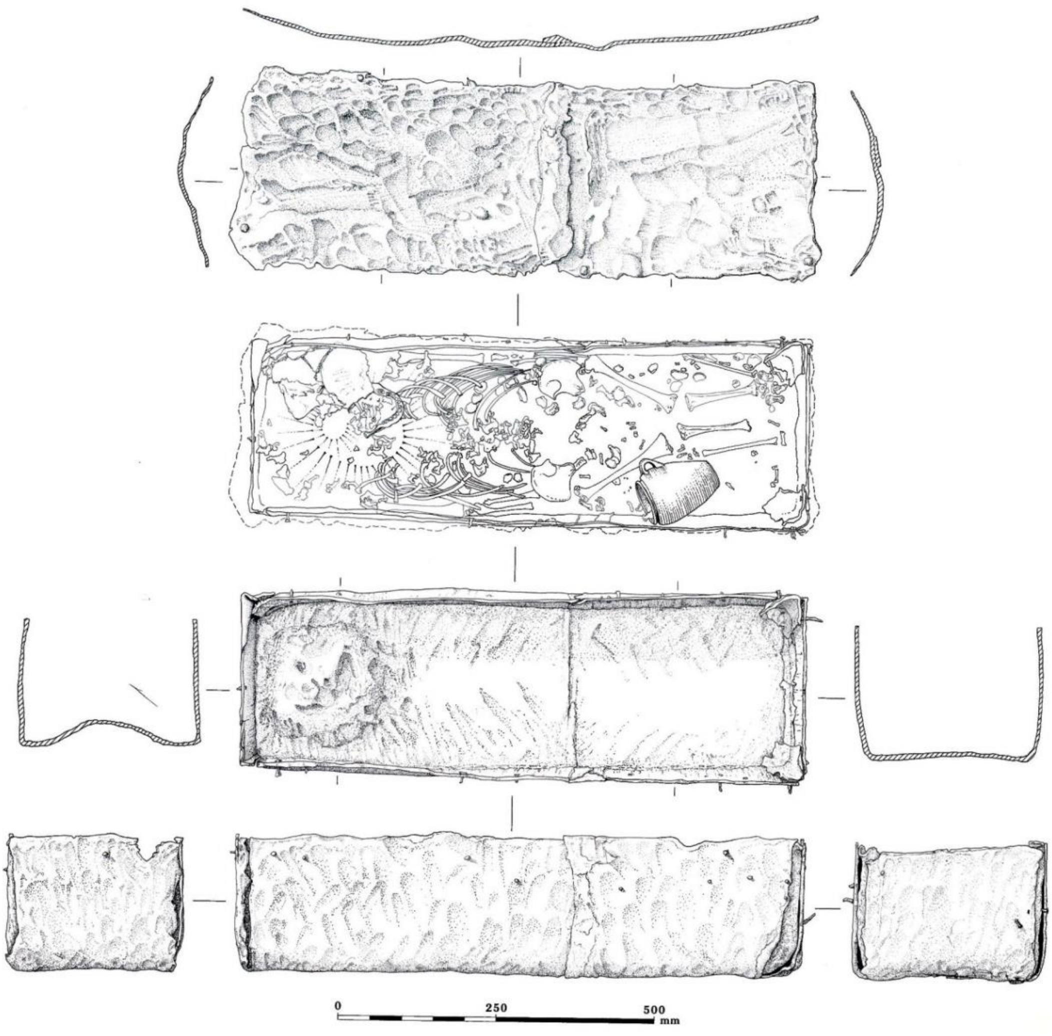


Figure 4.6: Alington Avenue. Lead coffin of grave 4378. © Wessex Archaeology, Davies *et al.* 2002 fig. 63, 141.

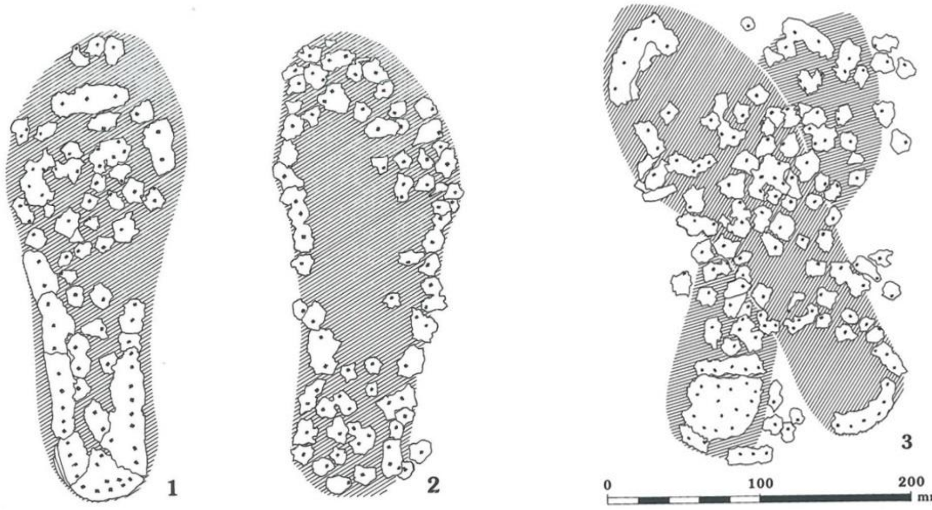


Figure 4.7: Alington Avenue. Hobnail shoes found in grave 3664b and 785. © Wessex Archaeology, Davies *et al.* 2002 fig. 62,140.

The preservation of these fibres is most interesting. Any evidence of likely mineral substitution of organic material was recorded (Davies *et al.* 2002, 158-159). Hence, it is assumed that these fibrous fragments were preserved by a different mechanism, which was not associated with corroded metal objects. Textile specialists did not make any suggestion about this preservation and did not record any replacement in the fibres (Davies *et al.* 2002). Therefore, in the absence of concrete proof and more details, it may be suggested that the role of the soil had a preservative action. However, chalky soil and carbonates had possibly produced a hostile environment for some biota, but this type of soil is also characterised by high water movement, which affects soft organic tissues. The textile preservation found in **grave 4378** is not replicated in other burials.

The most likely influential factor of textile preservation might be the coffin itself. Sealed lead lined coffins may offer a protective barrier from all bioturbation outside the coffin. Lead lined coffins may create an anaerobic environment that obstructs the activity of aerobic microorganisms. For instance, similar circumstances have been observed at Christ Church, Spitalfields (Janaway 1993, 93).

However, the coffin did not prevent from autolysis and putrefaction of the corpse. When ammonia is released (Dent *et al.* 2004, 583), it damages chemically the proteins of hair and textile fibres covering the body (Wilson *et al.* 1999; 372). Moreover, the presence of lime can accelerate the process of collagen loss from bones because of the high pH (Collins *et al.* 2002, 385). Traces of mineralised leather were found on a group of copper alloy studs and rivets associated with hobnails in **graves 785** and **3664b** (fig. 4.7).

4.4.3 Grave objects and clothing reconstruction

Only four object categories were found in this site. They are unevenly distributed among the biological groups (fig. 4.8; Appendix 3.3, tab. 3) and their figures are generally low. Reconstruction of local clothing is hard, but **grave 4378** shows preserved textiles that suggest the dead was buried dressed (ch. 4.4.2).

A reconstruction of clothing of this inhumation was suggested. The young person was likely buried with an undyed woollen costume with an ornamental purple band on the shoulders. These bands were called *clavi* in Latin, and they were on clothes of aristocrats. Undyed fibres of sample 1 were also interpreted as part of a separate piece of the costume, like a scarf or a shawl. The dye was confirmed to be extracted from the shellfish *Murex sp* (Davies *et al.* 2002, 158-159). This substance was in use in antiquity to dye precious garments and the colour was known as "Tyrian purple" (Davies *et al.* 2002, 158-159).

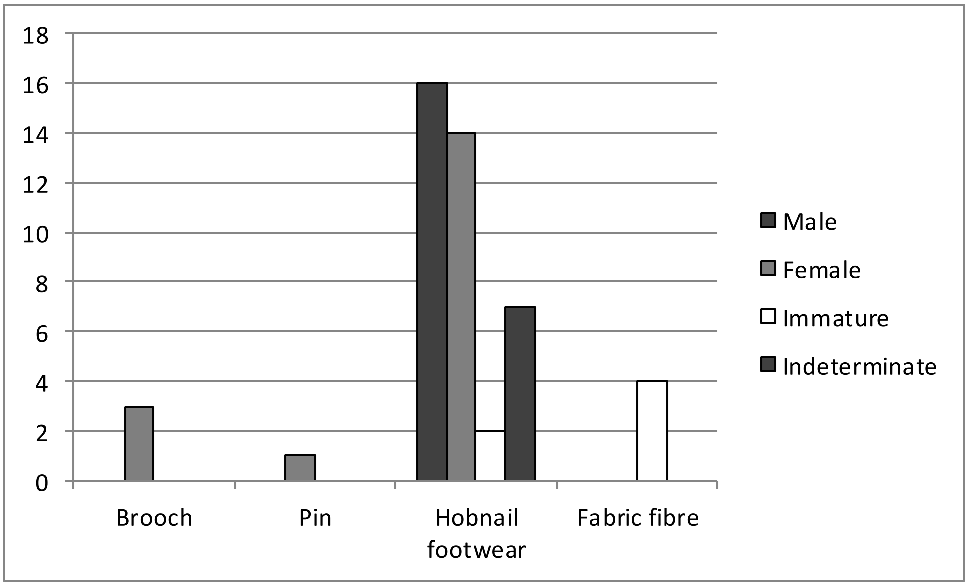


Figure 4.8: Alington Avenue Roman inhumations. Bar chart of the actual numbers of cultural traits.

4.4.4 Discussion

Finally, Alington Avenue was a rural cemetery likely serving a farm. This is a different funeral context from the other Roman cemeteries analysed in this thesis. The limited number of grave objects found, suggest that the local population was not able to leave durable grave objects. Moreover, it is likely that the Alington Avenue community could not afford elaborate burial rituals. Finally, the site was in use for a brief time, which is another likely reason for the scarcity of cultural traits.

Nevertheless, some fragmentary textiles were discovered and all of them were contained in immature burials. The soil is rich in chalk and calcium carbonate, but the soil texture allowed free drainage (Cranfield University 2012). Some of the textile and leather finds were not directly associated with metal artefacts. Consequently, it is assumed that different mechanisms of replacement took place, likely linked to the calcium carbonate. Only leather and wool were identified, but this cannot exclude the possible presence of plant fibres. In terms of taphonomy,

grave 4378 was the most interesting, because four organic fragments were discovered there (Davies *et al.* 2002). The burial had a lead lining that affected the preservation of textiles, even if in small patches, textiles were preserved.

4.5 Lankhills, Winchester: description, analysis and discussion

4.5.1 Site introduction and soil description

Lankhills is an urban cemetery, which was excavated by two main campaigns (Clarke 1979; Booth *et al.* 2010) and it served the city of *Venta Belgarum*. The cemetery comprises both cremations and inhumations, but the latter are more numerous than the first. It is considered a referential excavation for Roman archaeology (Appendix 1.4). The site is of interest to this research because of the suggested presence of immigrant burials, which can be analysed in terms of variation of funeral clothing and the occurrence of textile preservation.

The site lies on the Upper Chalk formation and the area is covered by brown soil (Avery 1990, fig. 2.5). The subsoil was described as chalky and covered by a topsoil layer, which has been only partially disturbed by gardening activities and the construction of school buildings (Clarke 1979, 1). Soilscapes (Cranfield University 2012) describes local soil as shallow lime-rich soils over chalk or limestone. It has a loamy texture and water can freely drain. Soil pH was not reported, but considering that the site lies on an urban context, pH may be changed multiple times by all the modern activities. It is hard to suggest which pH was at the time of the burials. However, there was probably an alkaline pH when the burials were originally dug, because of the high level of chalk and low amount of organic matter.

The Late Roman cemetery soil was investigated even by specific micromorphological and chemical analyses. Buried soil was the first interest of these analyses (Booth *et al.* 2010, 447-8). For the purposes of this research, it is important to underline that soil samples were high in chalk content and poor in humus. The calcareous fills contained both coarse and fine material due to human activities. Biota activity and organic matter were identified, but unfortunately, results were still debatable, so no detailed inference can be made on their role in organic degradation. Interestingly, soil analyses suggested that the organic content in this soil was the result of dumping rather than humus. These characteristics may be indicative of relatively good preservation conditions and the possible organic and textile finds will be discussed below.

4.5.2 Textile fibres and leather. Occurrence and preservation

Organic and textile finds were present in both excavations and were examined by textile specialists (Crowfoot in Clarke 1979, 329-31; Walton-Rogers in Booth *et al.* 2010, 309-11). The extent of fibre preservation was extremely limited and most of the textile fragments were replaced by mineralisation (e.g. fig. 4.9-11). However, some fibre identifications were possible, especially by the analyses of weaving technique that were still recognisable by microscopic examination. Leather, wool and flax were identified attached to some metal objects (tab. 4.3).

Figure 4.9: wool extended tabby (half-basket weave) pierced by pin of penannular brooch 1853 from grave 780. Left back, right front (Booth *et al.* 2010, fig. 4.9: Copyright Oxford Archaeology. Photo The Anglo-Saxon Laboratory).

Figure 4.10: linen tabby repp on catch of crossbow brooch 2744 from grave 1075 (Booth *et al.* 2010, fig. 4.10: © Oxford Archaeology. Photo Hilary Cool).

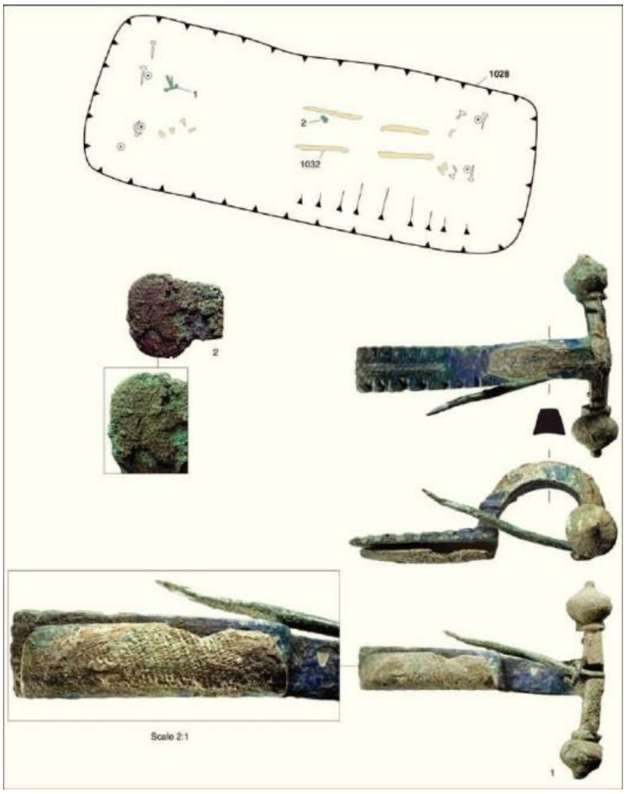


Figure 4.11: plan of grave 1075; a copper alloy brooch and fragmentary strap end with preserved textile fragments (Booth *et al.* 2010, fig. 3.142: © Oxford Archaeology).

Footwear and boots had a superior presence to other clothing accessories. This occurrence is linked to the superior resistance of iron hobnail to decay. In fact, the leather parts, which are the main component of Roman shoes, were not found, while iron hobnails were discovered. The hobnails are considered to be minimal occurrence of footwear, because shoe models made only with leather and other organic materials did not leave visible traces for the diggers (Powell in Booth *et al.* 2010, 311-318).

Table 4.3: Lankhills, associations between preserved textile fibres, leather fragments and other materials. Data from Clarke 1979 and Booth *et al.* 2010.

Reference	Grave	Fibrous material	Associated material	Object type
Clarke 1979	23	leather and flax	copper alloy	buckle belt fitting
	33	leather skin	iron	hobnail footwear
	55	leather skin	copper alloy	buckle belt fitting
	81	wool	iron	knife
	106	wool	iron	brooch
	125	leather skin	iron	hobnail footwear
	131	leather skin	iron	hobnail footwear
	134	leather skin	iron	hobnail footwear
	155	flax	silver	finger ring
	155	flax	silver	finger ring
	155	flax	copper alloy	finger ring
	155	flax	copper alloy	finger ring
	155	leather skin	absent	fabric fibre
	227	leather skin	iron	hobnail footwear
	322	flax	copper alloy	brooch
	323	leather skin	copper alloy	bracelet
	323	leather skin	other substance (shale)	bracelet
	323	leather skin	iron	bracelet
	323	leather skin	copper alloy	bracelet
	323	leather skin	copper alloy	bracelet
	323	leather skin	copper alloy	bracelet
	323	leather and flax	iron	bracelet
	323	leather skin	copper alloy	bracelet
	323	leather skin	hard animal tissue	bracelet
	336	leather skin	copper alloy	other ring
	336	leather skin	copper alloy	other ring
	373	flax	copper alloy	brooch
	431	leather skin	iron	hobnail footwear
	438	flax	copper alloy	bracelet
	443	leather and wool	copper alloy	buckle belt fitting
	443	leather skin	copper alloy	other ring
Booth *et al.* 2010	745/2	leather skin	copper alloy	buckle belt fitting
	780/2	wool	copper alloy	brooch
	1075/2	flax	copper alloy	brooch
	1075/2	unidentified	copper alloy	brooch
	1175/2	unidentified	copper alloy	buckle belt fitting
	1440/2	unidentified	iron	brooch
	1846/2	flax	copper alloy	brooch
	1866/2	unidentified	copper alloy	bracelet
	1921/2	leather and unidentified	copper alloy	buckle belt fitting
	1921/2	leather skin	copper alloy	buckle belt fitting
	1925/2	unidentified	copper alloy	brooch
	1925/2	leather skin	iron	buckle belt fitting
	3030/2	leather skin	copper alloy	brooch
	3030/2	unidentified	copper alloy	buckle belt fitting
	3030/2	unidentified	copper alloy	other ring

Below, figure 4.12 illustrates the incidence of textile finds. Among the identifications, leathery fragments are the most numerous and then flax and woollen fibres. However, the identification of fibres found in Lankhills inhumations relies mostly on the weaving technique, because as it has been underlined above, mineralisation had often covered the structure of the fibres. Keeping in mind this bias, flax appears to be more frequent than wool and unidentified fibres. Textiles woven with the basket technique (Walton-Rogers in Booth *et al.* 2010, 309-310) were a Roman import or were produced in public factories, which stopped production when the Empire lost control of Britain.

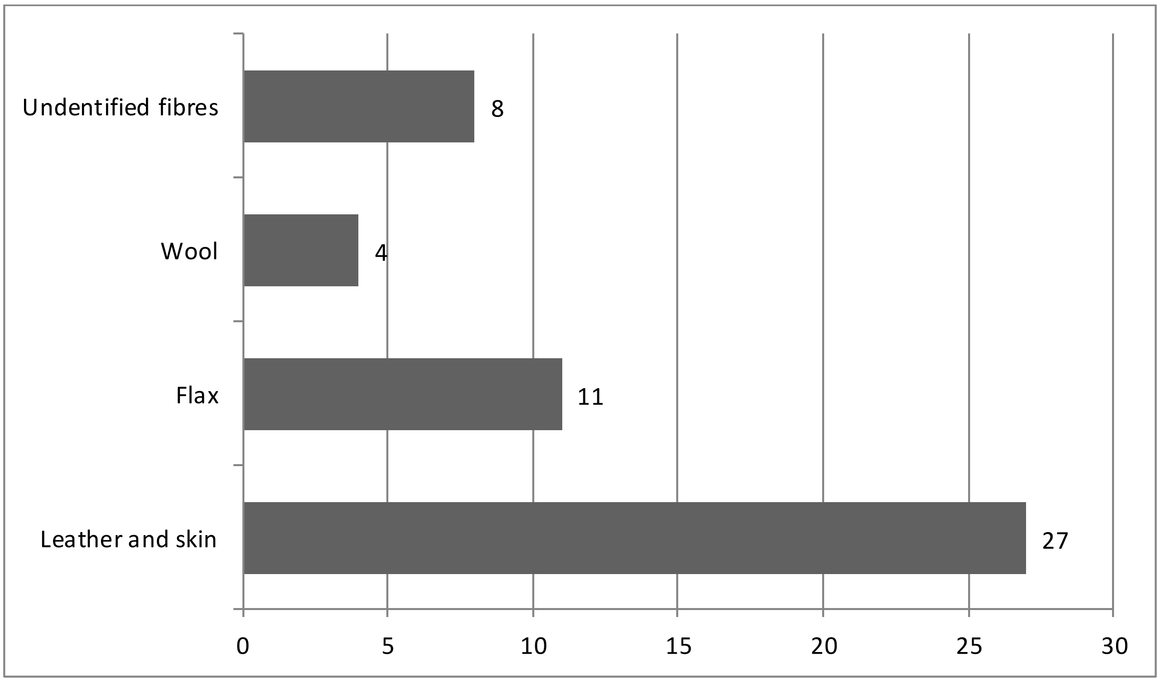


Figure 4.12: Lankhills cemetery, frequency of textile fibres and leather.

The process of metal replacement is the main preservative process at Lankhills (fig. 4.13). Copper alloy objects had most of the textiles and leathery fragments attached, followed by corroded iron objects. There are also two finds of flax fibres attached to two silver rings (**grave 155**), which is not a common occurrence. Only a few other cases were found on non-metal artefacts. A piece of leather not directly in contact with other objects was found in **grave 155**. This inhumation was a coffined burial, which preserved the highest quantity of organic matter (Clarke 1979, 45). Two out of three bronze bracelets had kept traces of flax fibres and two silver rings were tied together with a likely flax thread (Crowfoot in Clarke 1979, 330). The fragment of leather was close to the bracelets and rings. Moreover, this burial included a wooden comb. Likely copper ions of the bracelets created a toxic environment in a wider area, which allowed the preservation of a certain number of organics, like the comb, the flax thread and the piece of leather. The coffin that slowed down water drainage possibly helped preservation.

Generally, flax fibres preserved more than woollen fibres, but most of the flax fibres are preserved in association with iron rather than copper alloy objects, while the occurrence of preserved woollen fibres is similar in preservation in both iron and copper alloy artefacts.

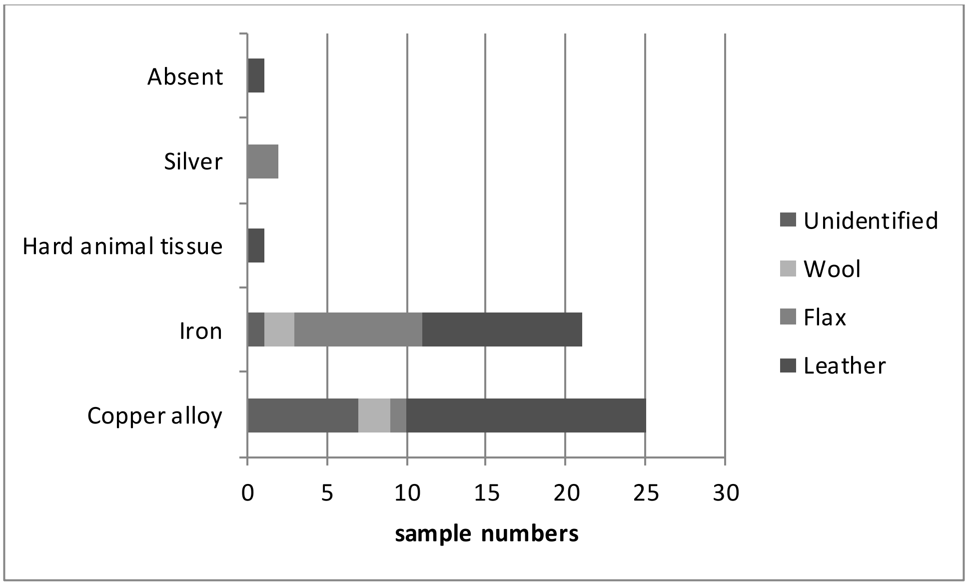


Figure 4.13: Lankhills association between preserved fibres and associated materials.

4.5.3 Grave objects and clothing reconstruction

The grave objects categories are well-represented (fig. 4.14; Appendix 3.4, tab. 4) and distributed across the burial groups. However, the actual occurrence is limited and the grave objects suggest the presence of a common funeral costume with few metal fasteners and a preference for shrouding bodies but providing shoes.

The tradition of weapon burials did not occur in Lankhills. It is interesting to note the chronology of furnished burials, which dated mostly from the second half of the 4th century AD, close to the first "Anglo-Saxon wave". Distribution patterns may imply an initial change in funeral tradition with the rise of clothed inhumations in the Roman funeral tradition. Lankhills may represent a starting point of transformation before the migration of Anglo-Saxon people into Britain. However, this site does not represent faithfully all of the population because male burials are more numerous than female and immature.

Some differences are shown in clothing in comparison with the other Roman cemeteries. For example, fasteners and personal ornaments are more common, as it is a kind of innovative tradition, or maybe a return to earlier funeral traditions. Mere presence of some objects related with clothing, such as belt assemblages – buckles and plates – and hobnails and straps, do not suggest directly that those burials were clothed. Most of the burials were probably shrouded. However, some inhumations might be dressed entirely or partially (Crowfoot in Clarke 1979, 327-328).

The position of fasteners on the bones implies the burials were clothed. For example, the brooch found in **grave 322** and the plate of a buckle found in **grave 23** preserved fibres that indicate tunics. Crowfoot (Clarke 1979, 329) suggested that the textile of those tunics was flax, but actual identification was not done because of the excessive mineralisation of the fibres. In other graves fibres were found on bracelets (**graves 323** and **438**) that might be the remains of veils or gowns, but it seems more likely that corpses were buried covered by shrouds and the other clothing related objects were placed close to the body. The woollen fibres found on a knife in **grave 81** were also inferred as a fragment of a tunic dressing the body of the dead man buried there. All clothed burials, which were a minority, were dated to the 4th century AD, most of them after the second half of the century. This occurrence suggests the development of a new minor trend in funeral tradition (Clarke 1979, 170-171).

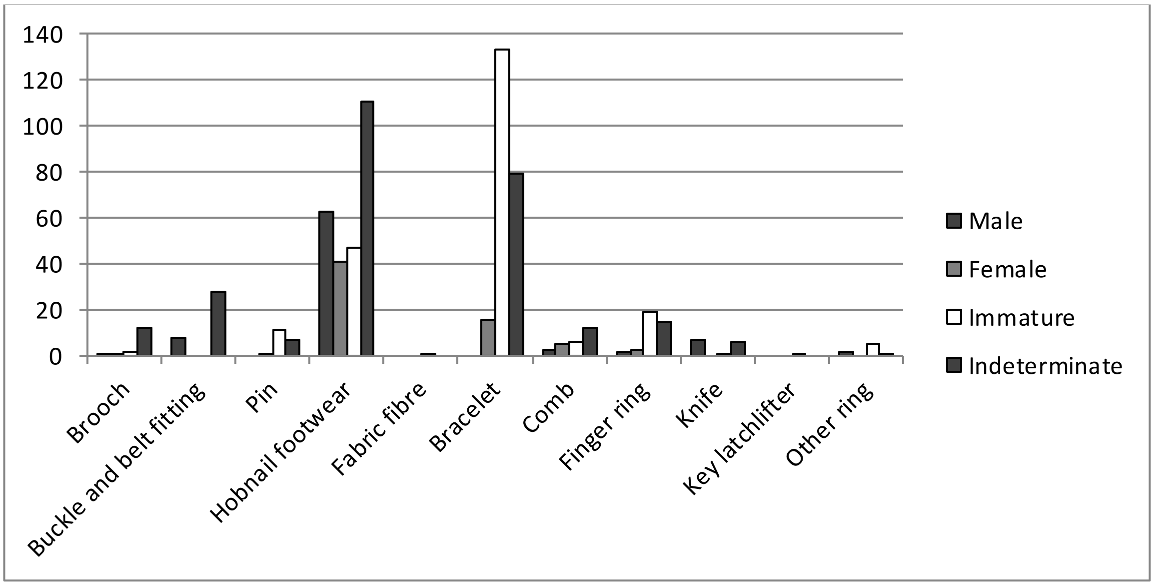


Figure 4.14: Lankhills, selected grave objects. Bar chart of the actual numbers of cultural traits.

4.5.4 Discussion

Lankhills was an urban cemetery, with a great number of graves, but furnished graves were still a minority. The objects found in the graves set Lankhills between the 2nd and 4th century AD (Booth *et al.* 2010, 453-455). Radiocarbon dating of selected inhumations describes chronological range between the earliest inhumation 141-152 AD and the latest 255-414 AD calibrated with 95% of confidence (Booth *et al.* 2010, 455-456, tab. 6.15). Christianity, which is considered, a crucial factor in late Roman cemetery studies, was diffused in the western provinces of the Empire. However, Booth was uncertain about Christian influence in the burial traditions of Lankhills (Booth *et al.* 2010, 518-522). Here, we reasonably agree not to overestimate the role of beliefs and religions in funeral practises, in the absence of further data. However, the cemetery excavated, which is only a portion of the entire northern funeral site of *Venta Belgarum*, showed that a significant minority of burials were clothed, whereas the normal ritual was of shrouded burials. The presence of grave goods, indicating clothed burials, demonstrates that Roman funeral ritual was changing. This shifting trend was likely linked to a return of Paganism (Watts 1998).

Soil characteristics and the extensive presence of coffins and other burial linings had likely a role in the generally good preservation of skeletons. Preservation of textile fibres is limited and there is a contrasting trend if compared with the good bone preservation. Most of the leathery and textile fragments were deeply mineralised. In fact, identification of fibres was more tentative and based on the position of fibres on the metal fasteners, especially in the finds of Clarke's excavation.

Even if fibre identification is influenced by other factors, it was interesting to note that the association of preserved flax fibres with iron objects was higher than that with copper objects. Janaway (1985) reported that usually copper ions tend to preserve flax and other plant fibres better than iron. These occurrences seem to demonstrate a different pattern in preservation. Leather is not well preserved, but it has a higher occurrence if compared to the other organic materials. Among all inhumations, **grave 155** was considered to have the most preserved organic matter (Clarke 1979, 45). This superior preservation suggests special conditions offered by the burial with the position of metal artefacts close to each other (a pile of metal bracelets and rings) and close to organic matter like leather and textile threads.

4.6 West Heslerton: description, analysis and discussion

4.6.1 Site introduction and soil description

West Heslerton is one of the major case studies of this research in several senses. The quantity and quality of data are a model which is hardly matched by the other cemeteries. The site belongs to the so-called Anglian area and included 185 inhumations that spanned from the late 5th to the first half of the 7th century AD (Haughton and Powlesland 1999; 1999a). Despite aggressive soil conditions, preserved fibre textiles were found, examined and published, making this site an example of excavation method and sampling strategy for textiles and more in general for organic finds (Appendix 1.5). The research project that leads to the excavation of West Heslerton seems to be a sensible guideline to recover, examine and publish textile finds.

The cemetery is characterised by chalky outcrops and the overlying soils are mainly sandy due to the sands and gravel derived from glacial outwash from the dominant soils along the southern border of the valley. Therefore, a layer of soft sand and gravel containing chalk and poor flinty chert covers the cemetery (Haughton and Powlesland 1999).

This soil has controversial aspects in terms of preservation. The sandy and gravelly textures make that soil free-draining. This condition affects negatively bone survival. Conversely, at the time of excavation, the pH was recorded as alkaline (Haughton and Powlesland 1999; 1999a). The presence of high alkalinity is consequent on agricultural activities both in the medieval period and in recent times. The soil was enriched with supplementary chalk to make it fertile (Haughton and Powlesland). Therefore, it is likely the pH was different when the Anglian site was settled.

Additionally, it has been reported that the soil and the geology of the cemetery was extremely susceptible to both natural erosion and deposition. Besides, intense animal burrowing occurs around the burials as a factor of disturbance. The report (Haughton and Powlesland 1999, 8 fig. 3) provides a general description of the geology and soil, which is more accurate than other archaeological reports, but does not provide soil sampling analyses from any of the graves.

According to the soil descriptions from Avery (1990, fig. 2.5), the cemetery of West Heslerton lays on calcaric brown soil (or rendzina), with associated luvic brown soils. Moreover, Soilscapes (Cranfield University 2012) describes the area as shallow lime-rich soils over chalk or limestone, freely draining.

The Anglo-Saxon graves excavated at West Heslerton are 185 and the soil features show strong similarities and few differences. The soil components, their origin and the pH are extremely consistent. Some differences have been recorded in soil texture. It is assumed that the composition of the soil is generally inorganic, while the occasional organic stains are derived from the body decomposition and coffin or other wooden artefacts degradation. The pH of the sand is generally described as acidic. However, alkaline influence may be assumed by the presence of chalky parent material.

The report (Haughton and Powlesland 1999) describes the soil texture for any grave, so it is possible to appreciate differences in data. Most of all the uniformity appears to be a characteristic of this cemetery. The majority of graves were excavated in the sandy soil, but fourteen graves were not dug in sand. **Grave 90**, **grave 95**, **grave 97**, **grave 100**, **grave 101**, **grave 102**, **grave 113**, **grave 158**, **grave 169** and **grave 170** were excavated in chalk. **Grave 71**, **grave 96** were in chalk gravel. **Grave 88** was prepared in sand and chalk and **grave 159** was made in sand and chalk gravel. Table 4.4 illustrates soil descriptions, which are expressed in raw numbers, while percentages are in brackets.

Table 4.4: West Heslerton, grave distribution in different soil textures as reported in Haughton and Powlesland 1999 and 1999a.

Texture	Graves
Sand	171 (92.4%)
Gravel (chalk)	2 (1%)
Chalk	10 (5.4%)
Mixed (sand and chalk sand and chalk gravel)	2 (1%)

This cemetery has contrasting soil characteristics like the dominant sandy texture combined with alkaline soil enrichment (Haughton and Powlesland 1999). These soil properties are normally expected to produce poor preservation of organic matter. Nevertheless, evidence of textile was found in some inhumations (Haughton and Powlesland 1999; 1999a; ch. 4.6.2).

4.6.2 Textile fibres and leather. Occurrence and preservation

West Heslerton Anglian grave assemblages have produced a significant amount of organic materials, mostly preserved by mineralisation. The team of archaeologists applied particular care in collecting organic stains and in their analysis. Due to the extreme corrosive nature of the sandy soil, it had been decided to recover soil blocks systematically from numerous graves (Haughton and Powlesland 1999a **graves 86**, **107**, **113**, **119**, **132**, **139**, **141**, **143**, **152** and **167**), attempting to recover delicate mineralised artefacts or –replaced organics. Then those blocks were analysed at the laboratory by X-radiography, Stereo X-radiography and Xeroradiography. Consequently, all materials such as metal, ivory, bone and also some kind of glass, which is denser than sand, were detected in the block before the actual excavation.

Consequently, the blocks were excavated and fully recorded in the laboratory. Systematic examinations of all objects were accomplished by binocular microscopy in order to identify any organic residues. The impregnation of metal salts, produced by corrosion of metalwork, was a crucial factor for the preservation of organic materials. The iron and copper alloy corrosion affect differently organic materials. The organic materials preserved by iron salt are deeply changed in their structure and some cases show a complete dissolution of the organic matter. Differently, copper corrosion may leave green stains but preserve organic materials, which often maintain their original resemblance. A peculiarly good preservation of woollen textiles was noted (Haughton and Powlesland 1999, 139).

The association between preserved fibres and associated materials is illustrated in figure 4.15. Unidentified fibres are dominant, but still preserved mostly because of the proximity to copper alloy and iron objects. However, some textile patches were preserved even if not immediately close to metal objects. Leather is organic matter most regularly preserved. It is normally associated with iron artefacts. West Heslerton shows the presence of preserved textile patches not directly close to any metal objects.

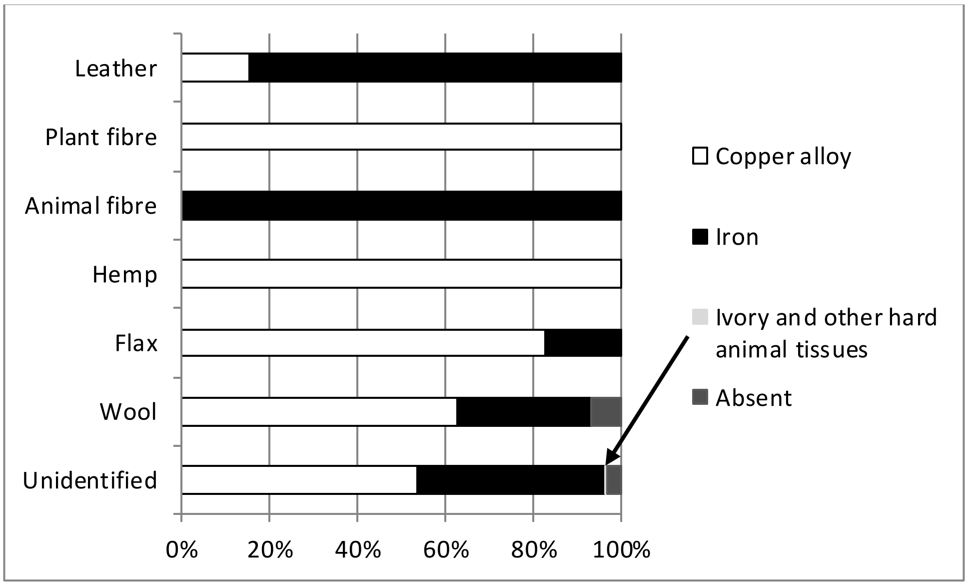


Figure 4.15: West Heslerton association between preserved fibres and associated materials.

G**raves 132** and **152** (fig. 4.16-18) show the extent of textile preservation that occurred in West Heslerton. No special examination was undertaken to understand the preservative processes, but it appeared to be mostly mineralization (Haughton and Powlesland 1999; 1999a). Nevertheless, these cases are exceptionally interesting because they provide at least two types of information. Firstly, they testify to the presence in graves of objects made predominantly of textile, such as possible purses, which cannot be considered as proper clothing. Furthermore, their retrieval has been possible by soil block sampling, otherwise it was extremely probable that the excavation would have destroyed the already decomposed remains of textile.

In the absence of further soil analyses, it is suggested that soil characteristics facilitated metal ion movements in these burials, which preserved all these textile finds. The high concentration of metal artefacts possibly started a reaction that influenced textile preservation an unusual distance from the metal artefacts.

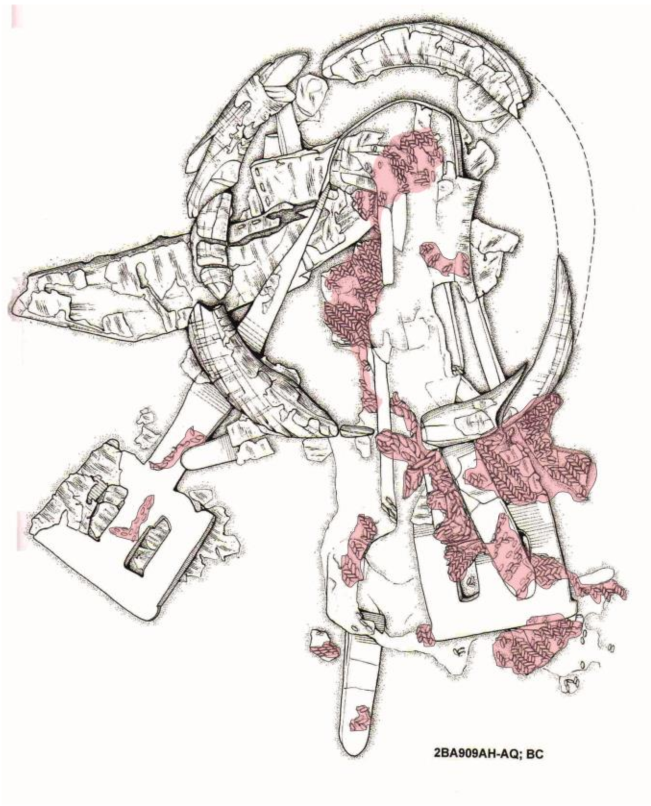


Figure 4.16: grave 152 block soil with highlighted fabrics and girdle hangers (© Haughton and Powlesland 1999, Haughton and Powlesland 1999a, 267).

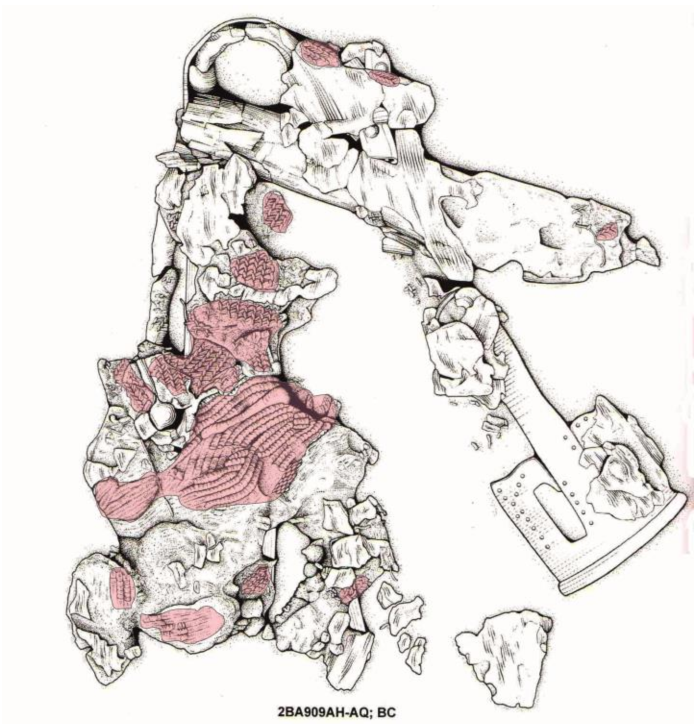


Figure 4.17: grave 152 block soil with highlighted fabrics and girdle hanger (© Haughton and Powlesland 1999, Haughton and Powlesland 1999a, 268).

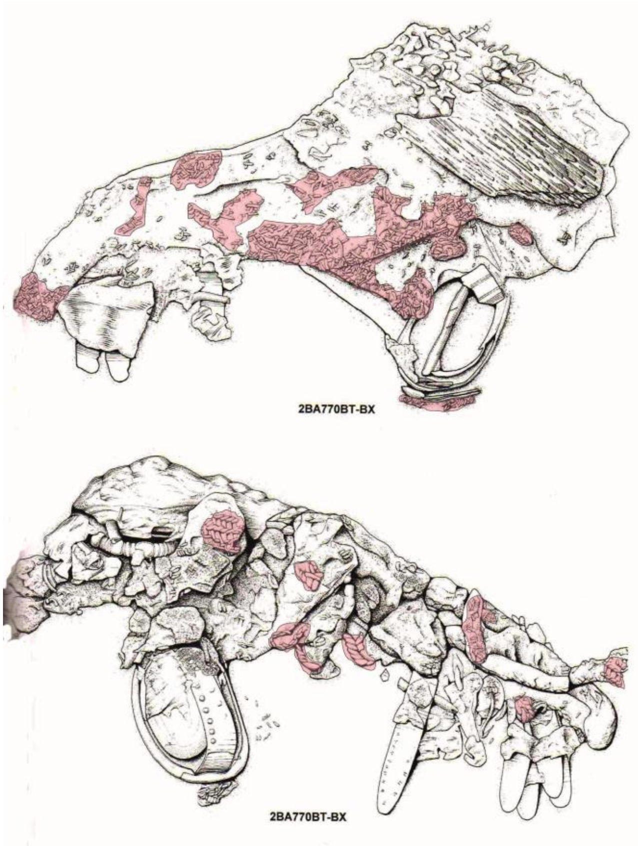


Figure 4.18: grave 132 block soil containing clothing related items, like girdle hangers and fragmentary textiles (highlighted) (© Haughton and Powlesland 1999, Haughton and Powlesland 1999a, 225).

The preservation of animal fibres, such as wool, and leather appears to be superior to the plant materials. This assumption derives from the presence of four finds of unidentified plant fibres and a possible case of hemp compared to only one case of animal fibre not identified fully. Furthermore, the wool has been identified in 47 cases, whereas the combination of flax, hemp and plant fibres reached only 24 identifications (fig. 4.19).

Preservation of organic materials thus has contrasting outcomes. Human osseous remains were often dissolved in the burials, while textile fibres and leather were preserved. For example, the human remains in **grave 14**, **78** and **103** were described as in poor condition, but there were distinguishable flax fibres. Conversely, **graves 72** and **96** maintained the skeletal remains in fair condition, but the fibres are described as poorly preserved. Additionally, some graves can associate human remains in poor condition, such as **78**, **28** and **119**, with different degrees of fibre preservation. Alternatively, human remains can be well preserved, such as in **graves 113** and **89**, but are associated with fibres in poor condition. Thus it seems right to agree with the comment of Walton-Rogers (Haughton and Powlesland 1999, 144) that organic preservation at West Heslerton "is not an obvious one".

Textile fibres were classified by microscopic identification. The high-power (magnification X 400) transmitted light microscope, fitted with polarising analyser was employed to distinguish wool from plant fibres by the structurally different appearance. SEM images were used to investigate the quality of West Heslerton fibres and it helped in identifying 63 difficult specimens. In total, 389 fragmentary textiles have been identified at West Heslerton (Haughton and Powlesland 1999).

The catalogue of graves (Haughton and Powlesland 1999a) confirms that the majority of textile remains were found in burials with numerous metal fasteners. Their corrosion inhibited the processes of physical decay and microbial attack. However, this assumption may also imply that likely textiles were present in graves without any current evidence of fibres.

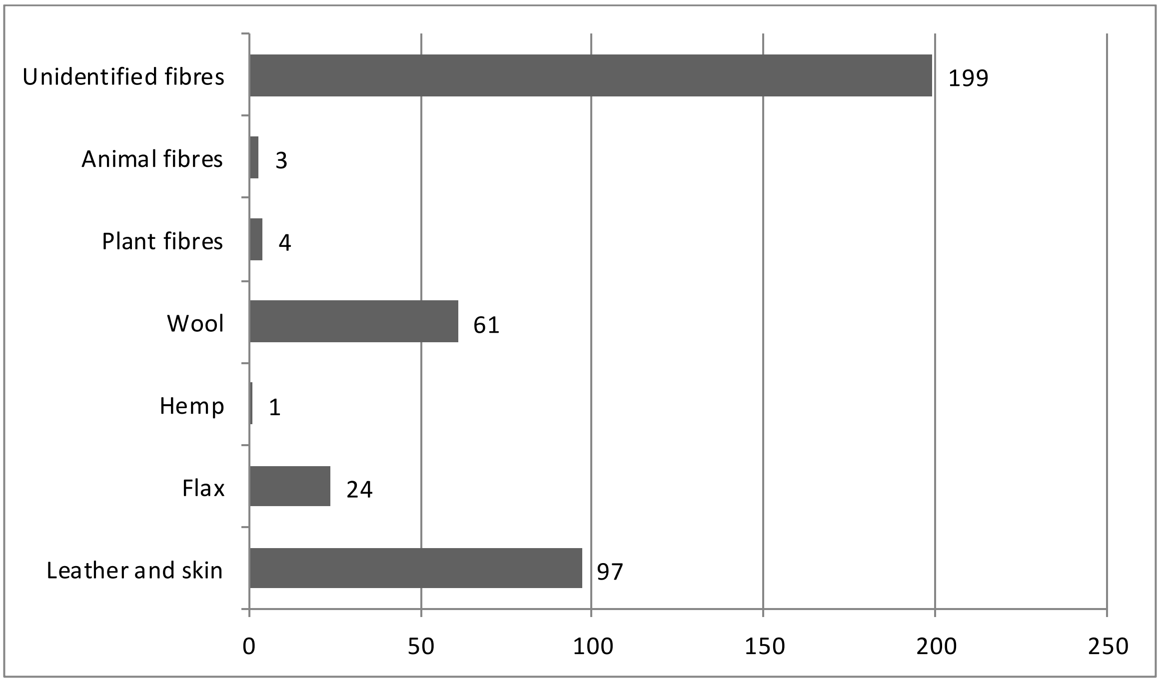


Figure 4.19: West Heslerton cemetery, frequency of textile fibres and leather.

In fact, the majority of fibres were not identified. Between the identified textile fibres, wool shows a predominant presence followed by flax. Hemp is present in just one case, even if its occurrence might have been more relevant. Fibres are mostly preserved by mineralisation. It does not seem there is a relationship between skeletal and textile preservation.

4.6.3 Grave objects and clothing reconstruction

Twelve object categories were found at West Heslerton (fig. 4.20; Appendix 3.5, tab. 5), they were mainly fasteners, such as brooch, buckle, clasp and pin, rather than adornments, such as comb and bracelet. Additionally, personal equipment like knife, spear and shield boss were also present.

Due to the detrimental environment, the occurrence of grave objects in the biologically indeterminate burials is significantly high. Among the identified burials, female inhumations have the main occurrence of finds.

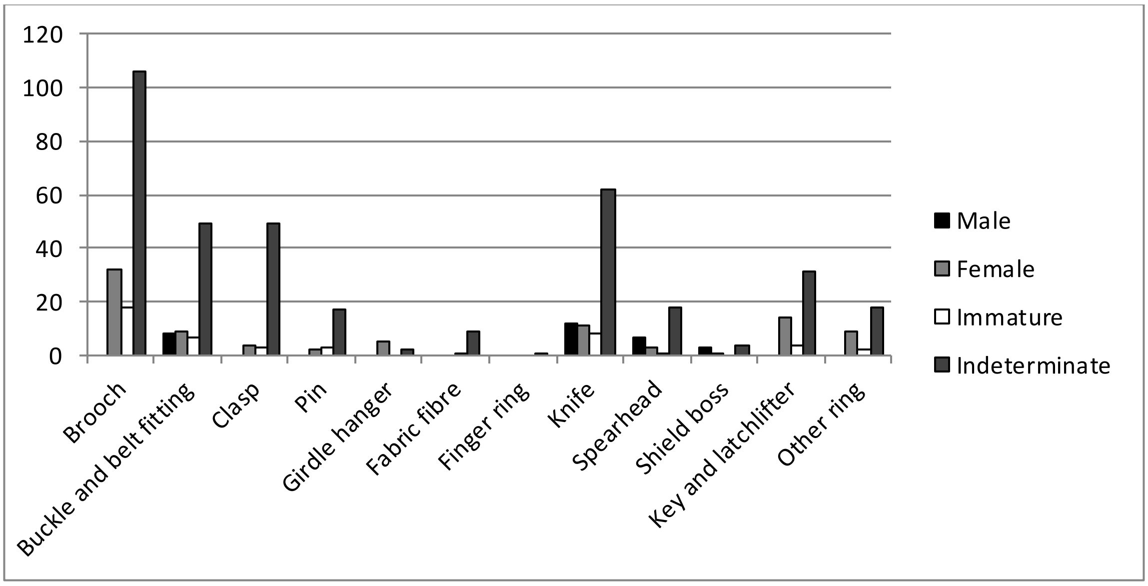


Figure 4.20: West Heslerton. Grave object distribution. Bar chart of the actual numbers of cultural traits.

Textile fibres and leather patches were found associated with 389 selected objects in total. Leather and animal skin occur in 97 cases, flax fibres 24 times, hemp fibre in one possible case, wool fibres in 61 cases, plant fibres in four, animal fibres occur once and 199 unidentified textile fibres (fig. 4.21).

This occurrence and distribution of selected objects facilitated the reconstruction of adult female costume, while male and immature burials had fewer objects. However, the disposal of the fasteners on the bones revealed that men and women were dressing in traditional local costumes (Haughton and Powlesland 1999, 154; Walton Rogers 2014). The female costume had an Anglian style and it included a tubular gown, clasped by brooches. Under the gown, an underdress covered the body and the arms, as witnessed by the wrist-clasps. Some hints, like linen tabby on a few brooches, suggested the likely presence of veils or other headdresses. Preserved textiles on the inner and outer sides of buckles indicate that women covered their tunic with another piece of cloth. An outer piece of garment was identified in at least 14 burials (Walton-Rogers in Haughton and Powlesland 1999, 156) and they were interpreted to be cloaks or shawls. All these interpretations rely on the finds of different types of textile fabrics preserved by the metal fasteners and comparisons with sculpted and painted representations.

Male costume had limited textile finds. Usually, fibres were found only in the internal part of buckles, and probably men dressed in a tunic to cover the upper part of the body and trousers to cover the legs. Finer textile fabrics occurred mostly on buckles, while fabric of lower quality was discovered on weapon blades and shield pieces, likely used as wrappings. Moreover, most of the leather and animal skins were found attached to shields, weapons and knives (Walton-Rogers in Haughton and Powlesland 1999, 157-8). Generally, textile finds suggested that the people of West Heslerton were used both animal and plant fibres to produce typical Anglo-Saxon costumes. The weaving techniques and the materials used were local, but this tradition did not reduce variation, allowing the production of different types of costume (Walton Rogers 2014).

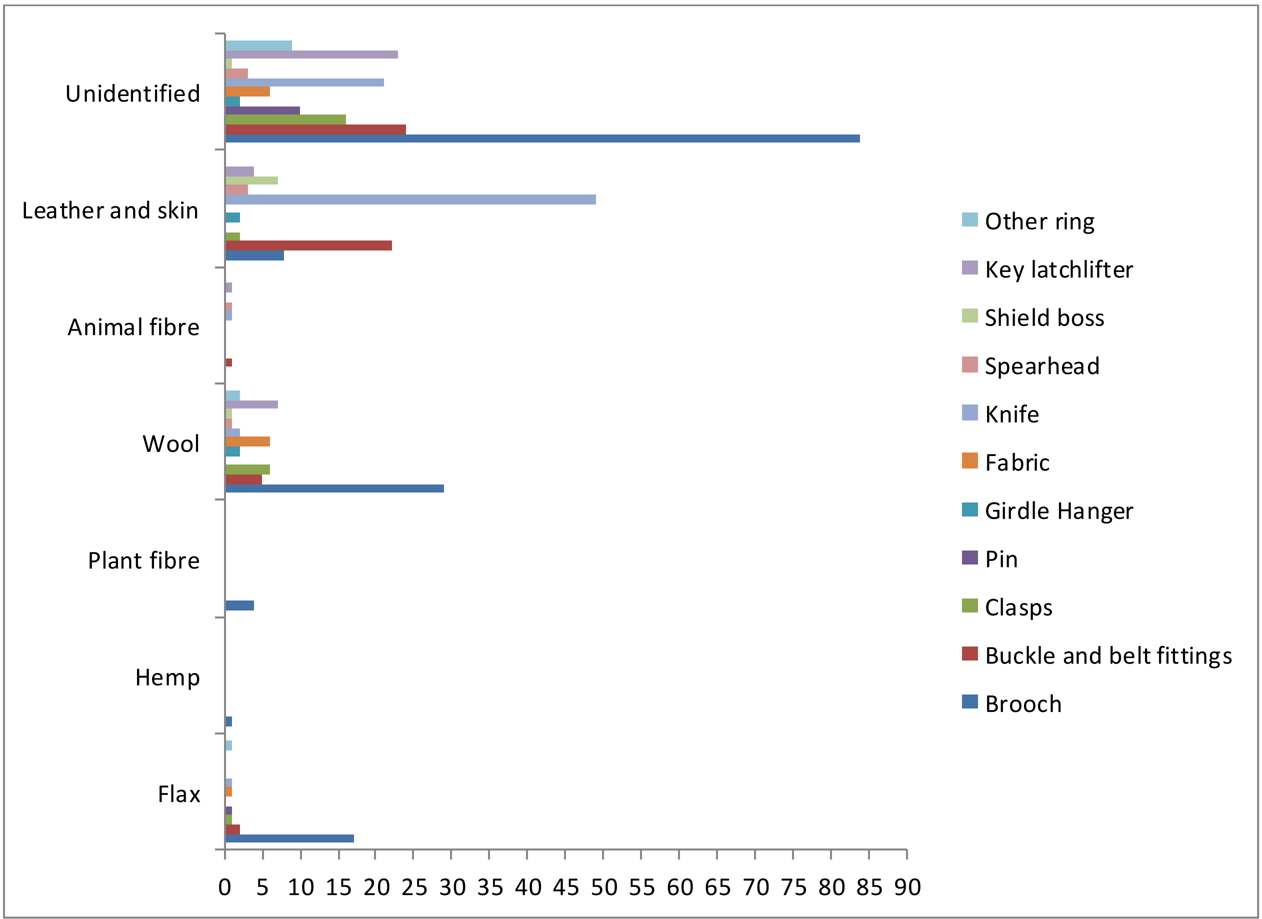


Figure 4.21: West Heslerton association of textile fibres and leather with selected objects in natural numbers.

As regards the identified materials, leather and skin remains represent the principal evidence. These materials were associated especially with knives and spearhead sheaths. On knives, the sheaths were covering both blade and handle. Shield bosses also provide evidence of leather, which was covering them, and in one case (**grave 19**) leather covered the grip of the boss shield. Moreover, other evidence of leather was found adhering on iron belt buckles. The preservation of leather is usually very poor or mineralised. Consequently, the identification of the original animal sources often failed. Few cases of leather sheaths preserved traces of awl working (**grave 130** and **grave**

161). The knife of **grave 157** is a unique case at West Heslerton, which reveals possible traces of decoration on the remains of a sheath.

Predictably, metal fasteners preserve the majority of textile evidence attached to the fasteners. The preservation of fibres is extremely fragmentary, and textile remains are highly degraded. Most of the textile finds were not identified even by SEM and light microscopic analyses, because of the extreme mineralization (Haughton and Powlesland 1999). Nevertheless, some cases have been classified as plant or animal in origin. The small quantity of identified material includes wool, flax and one possible case of hemp fibre (**grave 140**). The bulk of these textiles is associated with brooches (116 matches), clasp (24 matches) and buckles (49 matches). Minor occurrence is observed in girdle hangers (6 matches), other rings (7 matches) and pins (13 matches).

There are some cases of textile fibres associated with leather found on the blade of spears (7 matches) and knives (64 matches), which is proof of the original presence of a sheath. Rarely the same association of textile and leather appear on shield bosses.

4.6.4 Discussion

In conclusion, West Heslerton Anglian cemetery has left little evidence of organic materials, both human remains and clothing materials. Bones were completely decomposed in numerous burials. Nevertheless, metal grave objects are numerous and they have provided a considerable quantity of data of mineralised textiles.

In addition, the strategy of collecting soil blocks and the application of microscopic analyses has been effective and successful in giving further detail of fibres (Haughton and Powlesland 1999). From this starting point, specialists have been able to describe textile yarn and weave in numerous cases. Furthermore, the high quality of research has provided possible clothing reconstructions for several graves, especially for female clothing. The microscopic investigation had a fundamental role in the identification of fibres. A statistical comparison between West Heslerton and other cemeteries may help to clarify this field. The following sections will provide similar descriptions and analyses of other case studies, which will contribute to the final analytical discussion.

The high number of graves without sex or age indications has reduced the potential of cultural distance evaluation. However, theoretically and practically the CCL analysis is a reliable mean of calculation. Preserved textiles showed clearly that clothed burials might be the rule in this cemetery, even if the aggressive environment destroyed a significant portion of clothing. The finds of unmatched clasps in some burials suggested that, at least in those burials, dead were dressed with old clothing. It is unknown if this was the normal ritual. Further microscopic and chemical examinations on the collected soil blocks would be extremely helpful in reconstructing clothing, especially for male and immature burials.

4.7 Alton cemetery: description, analysis and discussion

4.7.1 Site introduction and soil description

Alton is a Saxon cemetery, which spans from half of the 5th to the beginning of the 7th century AD (Evison 1988). It was a cemetery with mixed burial ritual, inhumation and cremation. Around 50 graves were excavated but the real dimensions are unknown. The site shows strong signs of Germanic identity in the grave goods, which accompany some inhumations (Appendix 1.6), but also some Romano-British objects were found, indicating possible contacts with the Romano-British community (Evison 1988, 44).

At the time of the excavation, the topsoil was described as not the local one, but was replaced by recent building works. The original topsoil was probably mixed humus and chalk (Evison 1988, 1). The original report does not provide a more accurate soil description. The wider area around Alton is described as calcaric brown soil (Avery 1990, fig. 2.5). More specifically, the cemetery lies within soil described as freely draining slightly acid loamy soils (Cranfield University 2012). These environmental characteristics are usually associated with a massive degradation of organic tissues. Hence, expectations of preserved textiles are low.

4.7.2 Textile fibres and leather. Occurrence and preservation

Crowfoot (in Evison 1988, 67-69) examined textiles of Alton cemetery. The fibres are mostly preserved by the metal oxide replacement of copper alloy fasteners and iron artefacts. Fibrous finds are represented by small fragments and most of them are completely mineralised. The fibre identification was achieved in three graves (**graves 7, 16** and **37**) as flax fibre.

Over the 49 graves, there are 31 textile fragments (fig. 4.22). They are in very small amounts, identified as flax fibres, and they are always attached to metal objects and mostly mineralised. The majority of fragments were not identified, because of the extreme mineralisation.

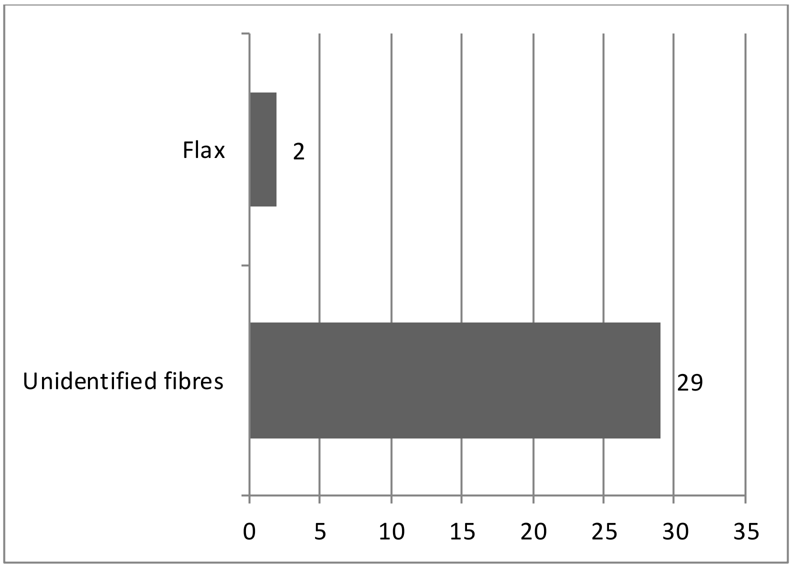


Figure 4.22: Alton cemetery, frequency of textile fibres.

Generally, iron objects preserved most of the textile finds. Identified fibres, which are only flax, were associated with iron and copper alloy objects in the same proportion (fig. 4.23). The preserved flax fibre fragments are only in two burials (**grave 7** and **37**). Theoretically, copper alloys are the best preservative agents of plant fibres (Janaway 1985, 30; 1989, 21), while iron preserves animal fibres better.

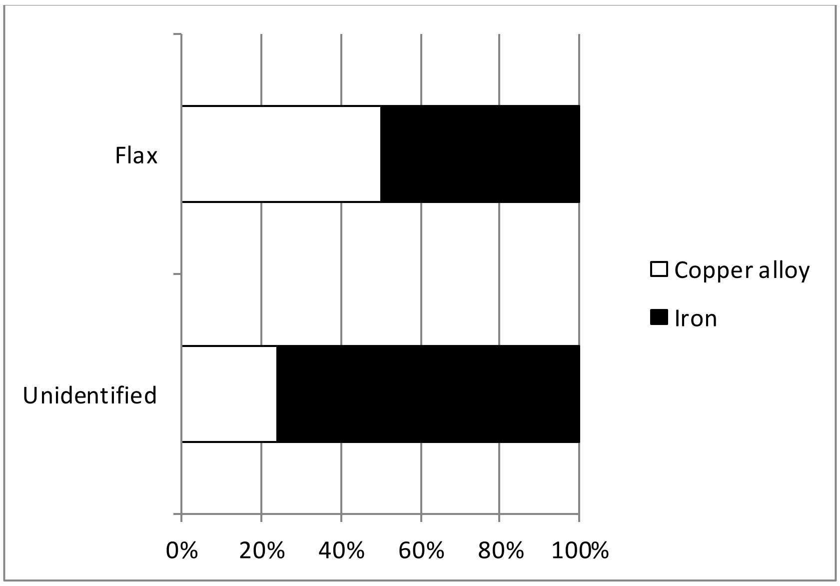


Figure 4.23: Alton correlation between preserved fibres and associated materials.

4.7.3 Grave objects and clothing reconstruction

Of the 15 selected grave good types, nine were present (fig. 4.24). The overall occurrence of grave objects is not high in absolute terms, but it is relatively high if the low number of graves is considered (Appendix 3.6, tab. 6). Fragmentary textiles were mostly found on metal fasteners, suggesting local clothing.

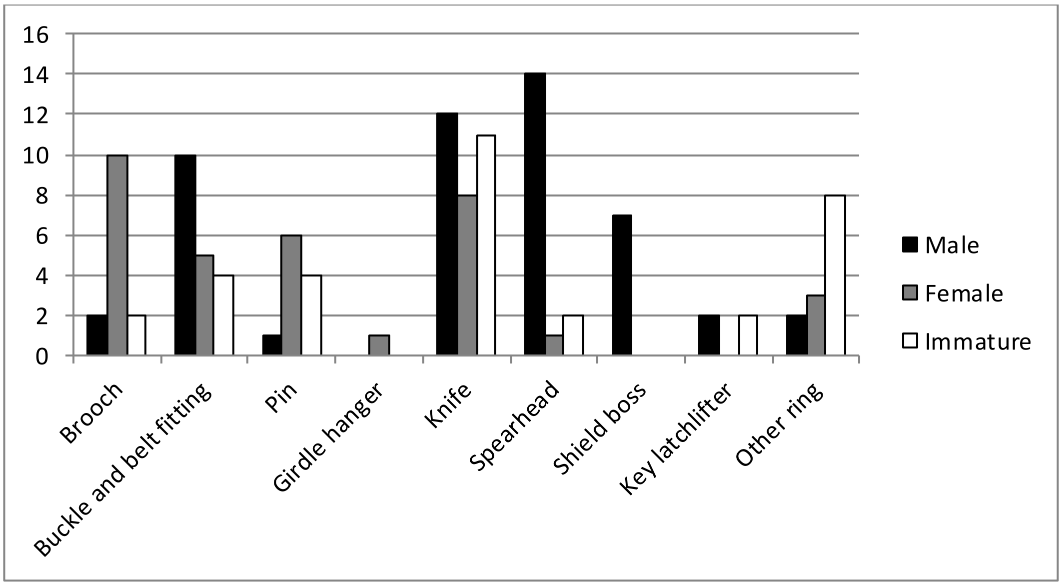


Figure 4.24: Alton cemetery grave goods distribution. Bar chart of the actual numbers of cultural traits.

Figure 4.25 shows the distribution of fibres on grave objects. 29 fibrous finds are unidentified. Identification was possible in two cases. A belt buckle from **grave 7** preserved evidence of flax. Flax was also recognised on a brooch in **grave 37**. Flax fibres are suggested even from a sword from **grave 16**. This male burial has an object assemblage for a warrior, because it contained two spearheads, two belt buckles, a shield boss and a knife. Some graves preserved fibres on more than one object, and probably offered better conditions for preservation. **Grave 12** reveals evidence from 5 grave goods, two brooches, two keys and a knife. **Grave 23** has three fibre finds, from two brooches and a girdle hanger (Walton-Rogers 2007, fig. 5.38). **Grave 27** provides three finds, on two rings and a buckle.

Grave 41, which contained remains of a juvenile female, was rich in textile fragments attached to several metal objects and fragments. This may indicate a fully clothed burial. Two small brooches found close to the shoulder area in **grave 43** imply the corpse was wearing a peplos, when it was buried (Walton-Rogers 2007, 147). Moreover, the fragments found over keys and a knife in **grave 12** suggests the presence of a cloak that was worn without metal fastener.

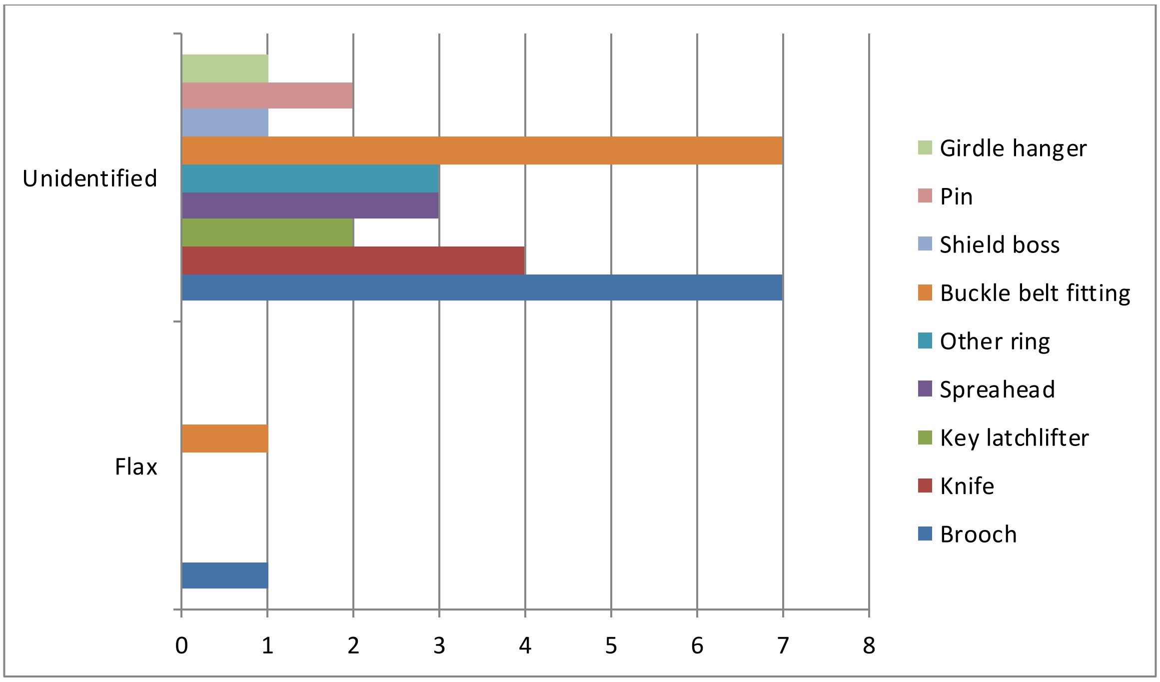


Figure 4.25: Alton cemetery association of clothing materials with selected objects, in natural numbers.

Attempts to reconstruct clothing cannot provide a complete picture of the local funeral costume. Male and immature burials did not produce textile evidence. Limited evidence came from female **graves 12** and **23**. In **grave 12**, fibrous traces on keys suggest a female gown, while the textile remains on a pair of brooches in **grave 23** are likely linked to an ornamental braid at the neck of a gown. In general, the technological analysis on threads and weave reveal similarities with the Saxon cemeteries of Hampshire and Kent.

4.7.4 Discussion

This Hampshire cemetery has been associated with the first Saxon settlers in the region and lasted continuously for more than two centuries. The chronology, type of grave goods and the presence of cremations support this historical reconstruction. Numerous graves contained weapons and evidence of men who were warriors. The presence of some Roman objects in the graves suggested a form of contact with Romano-British communities. However, the Saxon identity of these burials is not under question.

The textile material was found in small quantities and is mainly unidentified, except for a little evidence of flax fibres. Any traces of wool or leather have not survived. However, a few graves created a better environment for flax fibre preservation.

The size and shape calculations have shown that all groups are different from the Anglo-Saxon mean values. However, the figures are tentative, because the cemetery was not entirely excavated. In at least three cases gender and clothing indicate contrasting results.

4.8 Beckford cemeteries A and B: description, analysis and discussion

4.8.1 Site introduction and soil description

Two Saxon cemeteries were discovered close together at Beckford. The two sites have the same chronology between the end of the 5th and the first half of the 6th century AD (Evison and Hill 1996). It was not found evidence of settlement nearby the cemeteries and it was suggested that the two cemeteries served the same community (Evison and Hill 1996) (Appendix 1.7). These sites are ideal to evaluate the degree of variation between two close cemeteries, on the same soil, and likely belonging to the same settlement. Consequently, they can provide both a good comparison for textile preservation and cultural differences within the same community.

Soil characteristics and geological features were not discussed in the report, but gravel-digging works (Evison and Hill 1996, 1) revealed the sites. This information is indicative of the texture of local soil, but it is limited. For example, there are no reports on biota activity and basic data of soil composition. Data collected from specialist soil sources describe the regional soil features to be brown soil, mainly gravelly and sandy texture (Avery 1990, fig. 2.5). According to Soilscapes (Cranfield University 2012), local soil, where the cemeteries lie, is lime-rich loamy and clayey soils with impeded drainage. The local pH is recorded to be currently slightly acidic by NERC (2011).

4.8.2 Textile fibres and leather. Occurrence and preservation

Textile fibres and leather finds of the Beckford cemeteries have been studied on two different occasions by specialists, and provide a good level of analysis of these materials. Conservators provided the first description of these textiles in 1971-9 (Learmonth and Crowfoot with comments by Appleyard in Evison and Hill 1996, 62-66). The mineralisation process preserved the fibres and leather, due to the oxides produced by the iron artefacts. Thereafter a further examination allowed new fibre identifications.

Both textile studies agreed, describing the Beckford textile material as fragmentary and in poor condition. However, identification was possible in some cases. Four threads were recognised as flax or plant fibre (cemetery A **grave 18** and **20**; cemetery B **grave 6**). A comment in the report states "though the majority of these textiles would normally have been wool, the only fibres identifiable were of flax" (Evison and Hill 1996, 62).

4.8.3 Grave objects and clothing reconstruction. Cemetery A

In the majority of the burials, grave goods are related to the sex of the deceased. However, two cases show a discrepancy. Female bones of **grave 2** are buried with a spearhead, a shield boss and a belt buckle, which are considered to be male grave goods. **Grave 16** contains male remains associated with two brooches, a belt buckle, a pin, a knife and several rings (fig. 4.26; Appendix 3.7, tab. 7).

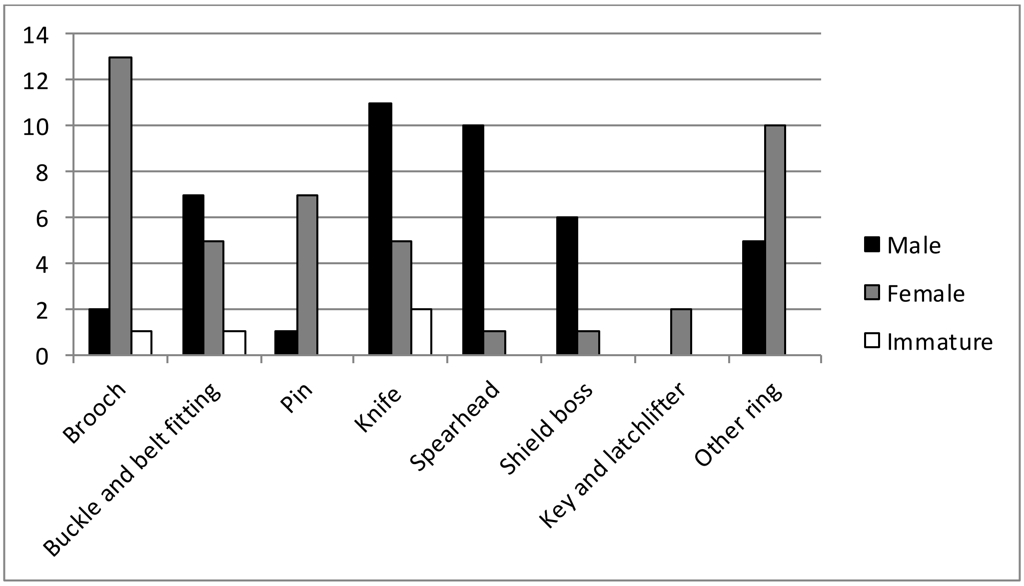


Figure 4.26: Beckford A selected grave objects distribution. Bar chart of the actual numbers of cultural traits.

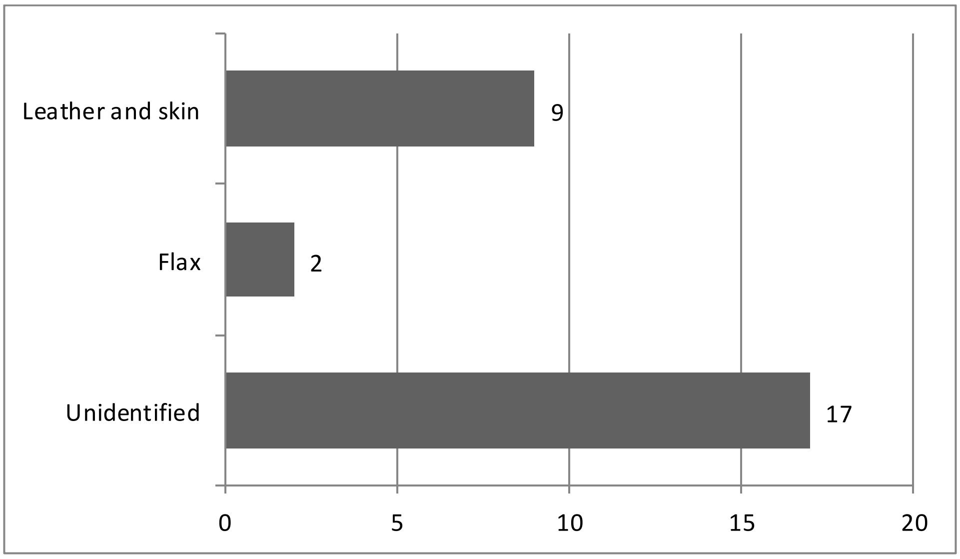


Figure 4.27: Beckford A, frequency of textile fibres and leather.

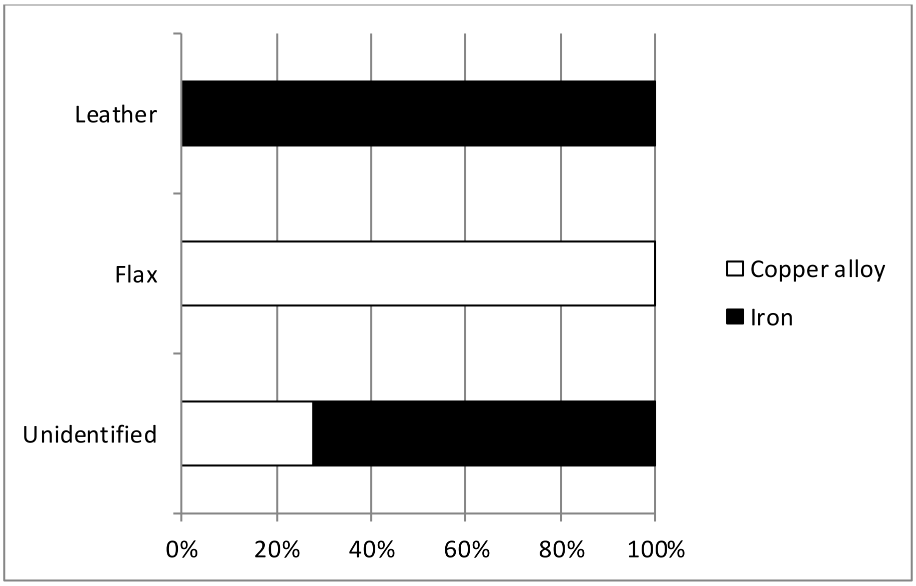


Figure 4.28: Beckford A correlation between preserved fibres and associated materials.

As a general comment on organic fibres, this cemetery does not have numerous textile finds (fig. 4.27). Textile fragments are 28 in total, 17 of which are unidentified because of their mineralisation, 9 patches are leather or animal skins and two fragments are flax. Figure 4.28 illustrates mechanisms of preservation. Flax fibres were found attached to two copper alloy objects (**graves 18** and **20**), while all leather fragments were associated with iron objects. Unidentified textile fibres were mostly connected to iron artefacts, while fewer unidentified finds were associated with copper alloy fragments.

Figure 4.29 shows the association of fibre finds with grave objects. Buckles and belt fittings show more evidence of association with leather patches and unidentified fibrous fragments. Out of six textile fragments, brooches preserved two cases of flax fibre (**graves 18** and **20**), which are the only ones to be identified in this cemetery.

Grave 18 had better environmental conditions for organic preservation. In fact, on the same brooch, flax and another unidentified fibre were found. Moreover, another superficial fragment of flax was recognised on the copper alloy tube. The same grave preserves a leather fragment attached to a buckle.

Other evidence is linked to shield bosses, which display leather in three items, which is a high occurrence. Other rings are linked to unidentified fibres three times and with leather twice. These associations may imply the presence of a purse in **graves 9** and **16**.

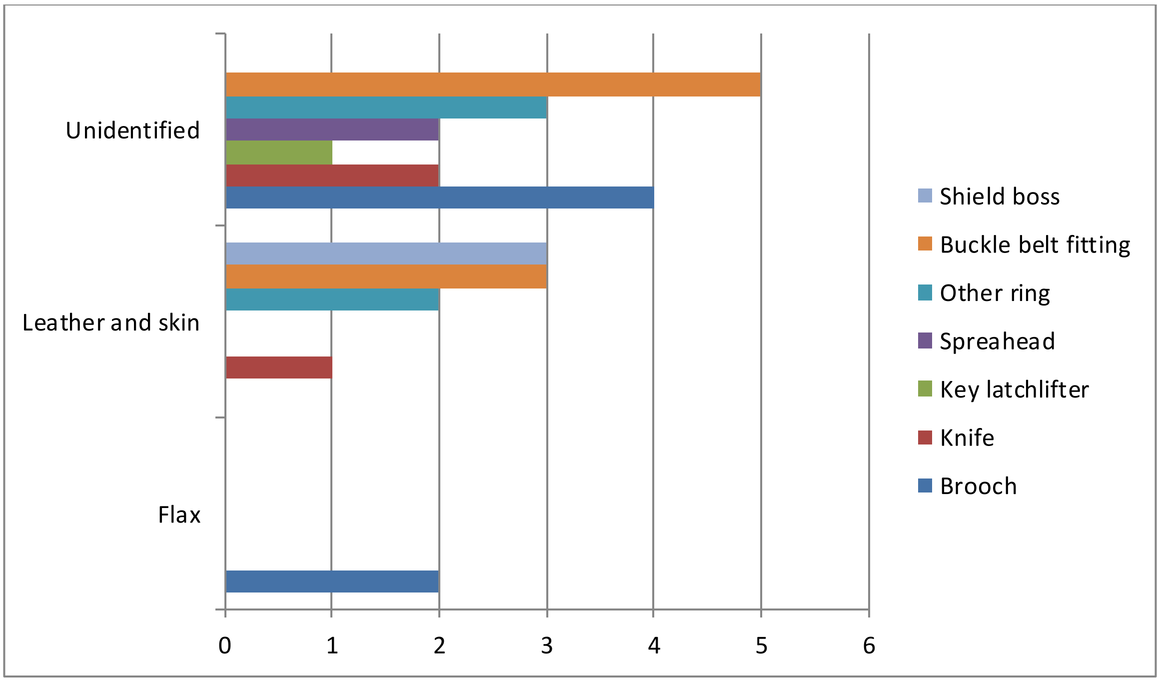


Figure 4.29: Beckford A association of clothing materials with selected objects.

4.8.4 Grave objects and clothing reconstruction. Cemetery B

Of 15 selected cultural traits (ch. 3.6), nine were found in this cemetery: brooch, buckle and belt fitting, pin, finger ring, knife, spearhead, shield boss, key and latchlifter, and other ring (fig. 4.30; Appendix 3.8, tab. 8).

Cemetery B has some burials with discrepancies between sex identity and grave goods. **Grave 5** is a female burial with a spearhead and a shield boss. Another adult female was buried with a spearhead in **grave 93**. **Graves 55**, **70**, **73** and **75** are male burials with feminine grave goods. **Graves 55** and **70** include a pair of brooches each, while **grave 73** had only one brooch and several beads. **Grave 75** included one amber bead and two perforated bronze coins.

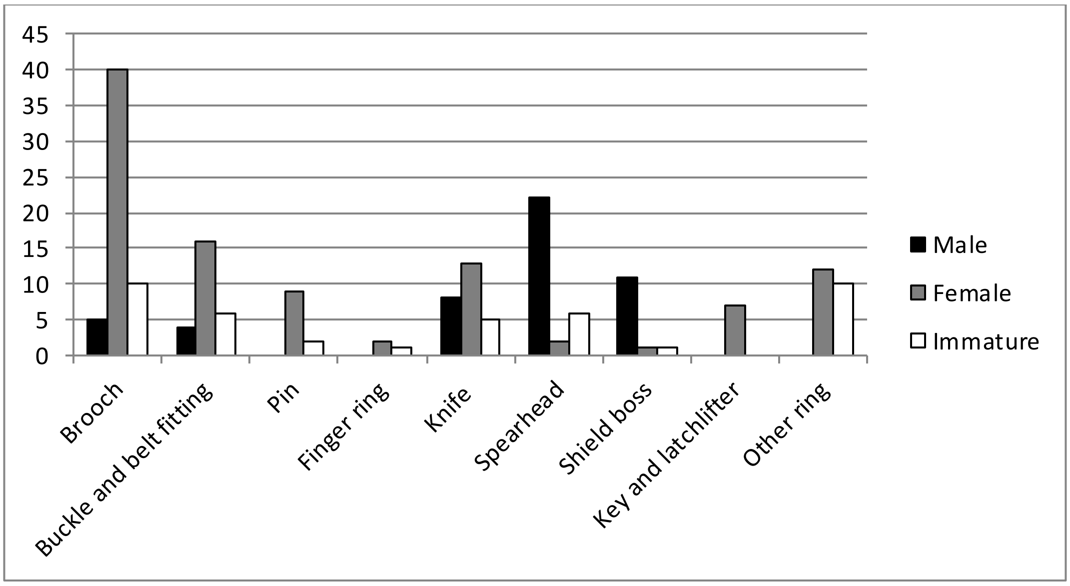


Figure 4.30: Beckford B. grave objects distribution. Bar chart of the actual numbers of cultural traits.

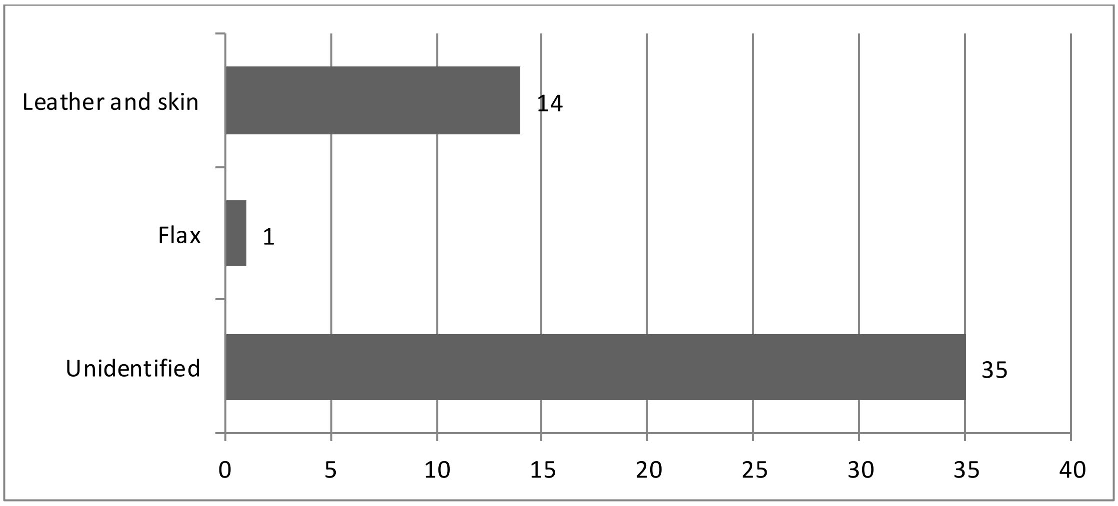


Figure 4.31: Beckford B, frequency of textile fibres and leather.

Cemetery B produced more organic fibre finds than cemetery A. This result may reflect the difference in quality of burials. Of the 50 fibrous finds (fig. 4.31) 70% are not identified. More than a quarter appeared to be leather. Belt buckles and other belt fittings have better preservation for leather (12) and other fibres (8) (fig. 4.33). Rings and brooches preserved, in order, eleven and ten textiles. The unique identified flax fibre was associated with a brooch from **grave 6**, which even preserved traces of unidentified fibre on another brooch and leather on a buckle. In **grave 68** a group of four rings and a buckle were attached to leather and other fibres. They also clustered with a Roman coin, two iron loop tabs and an iron strip. Considering this assemblage and its position at the right side of the pelvis area, it seems likely that they are the remains of a purse and its contents.

Preservation of textile and leather finds occurred because of metal presence (fig. 4.32). Leather fragments were always found with iron artefacts, while the only flax fragments were associated with a copper alloy brooch. Unidentified fibres were mostly preserved by iron rather than copper alloy objects. Interestingly, preservation of unidentified fibres of both cemeteries A and B show a similar proportion in the influence of iron and copper alloys.

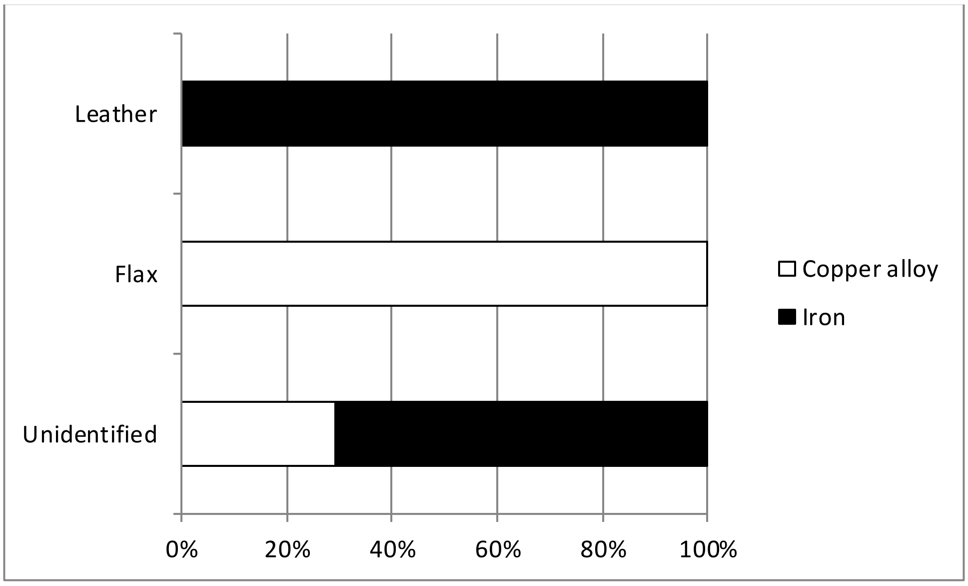


Figure 4.32: Beckford B correlation between preserved fibres and associated materials.

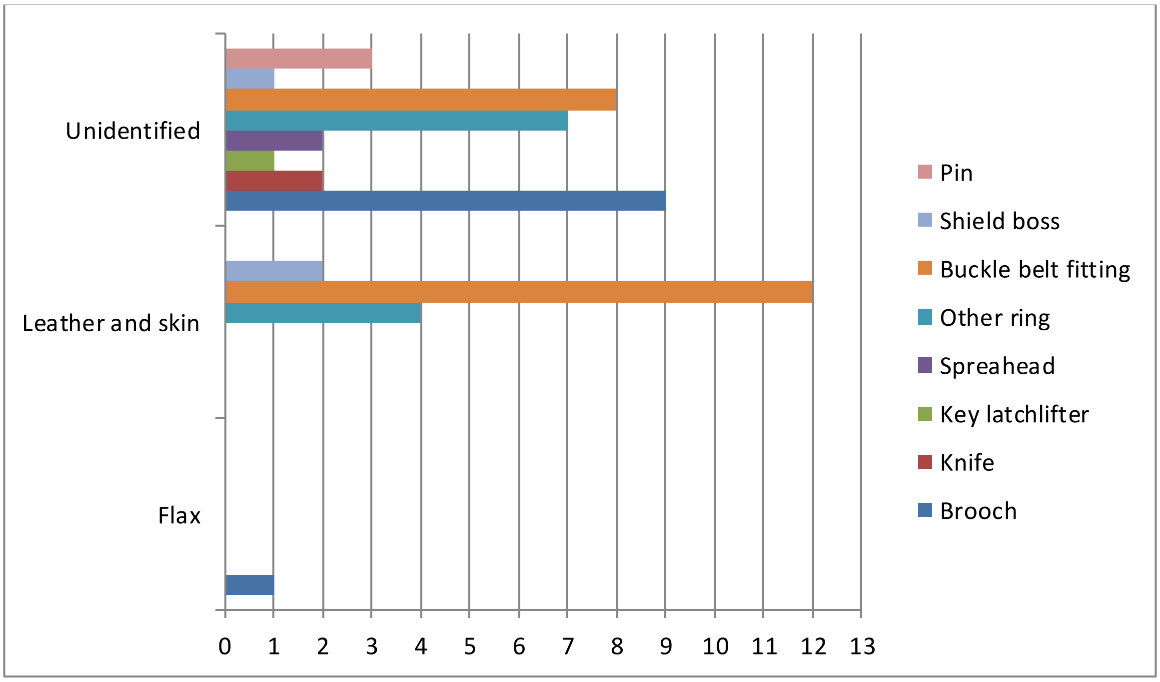


Figure 4.33: Beckford B association of clothing materials with selected objects.

Attempts to recreate Beckford female costumes are less successful than in other regions in the North and East of the country. The distribution of metal fasteners in graves has not helped effectively to identify costume features. However, the brooches appear to have practical use rather than ornamental. Crowfoot suggests that some coarse fabric fibre characteristics indicate a cloak or blanket (Crowfoot in Evison and Hill 1996, 66). Male costume is elusive because there was no collected evidence of that. Generally, Beckford textiles show links with the clothing fragments of Western and Midlands Saxon cemeteries rather than the Eastern and Northern regions.

Despite the limited evidence, female garments included in some cases a cloak or a blanket, as an outer waterproof layer. However, any attempt to reconstruct male and immature clothing was not done (Learmonth and Crowfoot in Evison and Hill 1996, 66). It may be implied that both cemeteries had clothed burials, which followed the Saxon custom. The peripheral position of these sites might also have influenced the reduced number of grave objects, implying poverty in the Beckford community.

The female local costume was partially reconstructed by the textile fragments and the clothing related objects. For instance, **grave 17** had a buckle placed on the upper chest, which indicates the presence of a cape. Moreover, **Graves 38** and **89** showed an unusual pattern of brooch positions. One was at the left side of the neck and the other on the left side of the thigh. In both cases, brooches did not preserve textile fragments, but a few examples of Celtic illustrations suggest a westerly influence on these burials (Walton-Rogers 2007, 198). Conversely, male and immature burials did not provide enough material for costume reconstructions.

4.8.5 Discussion

These case studies have presented several points of interest. They are peculiar because even if they are two distinct cemeteries, they were likely to be associated with the same Anglo-Saxon settlement simultaneously. It is assumed they lay on the same type of soil, but the human remains from cemetery A were better preserved than those from cemetery B. The fibrous and leather remains are poorly preserved in both cemeteries and there are limited finds. Hence, the soil conditions allowed an easy degradation of clothing and other organic material. Nevertheless, these cemeteries offer limited preservation of flax fibres, and none of wool, which is considered a rare event, due to the more perishable nature of plant fibres (Learmonth and Crowfoot in Evison and Hill 1996, 62).The type of grave goods is similar with no exception. Even the three cases of leprosy (**graves 8**, **11** and **22**) were buried without special treatment or items. All cultural traits from graves and chronology suggest that those cemeteries were actually for the same community. However, there is no convincing explanation for their physical separation. Unless, it may be some reasons linked with family relations or more special reasons. Cemetery A includes three lepers (**graves 8, 11** and **22**). Two of them (**graves 8** and **11**) were possibly brother and sister (Evison 1988, 23). Leprosy does not always affect bones. Therefore, osteoarchaeologists can recognise a leper only by osteological modifications produced by the disease (Lynnerup and Boldson 2012).

At this point, it might be suggested that cemetery A was dedicated to a particular group of people linked together in some special social way. However, this hypothesis cannot be proved. Considering that these cemeteries lay on the Western boundary of Anglo-Saxon territory, close to the limit with the Britonic regions, the differences between the two cemeteries may be founded on Saxon male migrants. A provisional comparison with the site of Stretton-on-Fosse may offer more suggestions. Stretton-on-Fosse shares some similarities with Beckford. It is a site close to the western Saxon limit. There are multiple cemeteries (I, II and III), which are very close to each other. Stretton-on-Fosse I and III are Late-Roman cemeteries, while Stretton-on-Fosse II is Saxon.

As Härke (2011, 14) suggested that at Stretton-on-Fosse II a "warband" of Saxon migrants were buried distinguished from the local male population, who were interred in the cemeteries of Stretton-on-Fosse I and III. Examination of weaving techniques of textiles found in Stretton-on-Fosse II suggested that there was continuity with the Roman techniques (Crowfoot in Clarke 1979, 329). Hence, the female population was likely local, while men might be Saxon migrants, who overcame the area, as the high number of weapons found in male burials may imply. The size and shape divergence of male burials in Beckford A and B may imply a situation where men had distinctive cultural characters.

The comparison between Beckford A and B may appear similar to the case of Stretton-on-Fosse I, II and III cemeteries. Here, the size and shape statistic shows a difference between men. Unfortunately, textile finds were not helpful as in the case of Stretton-on-Fosse, because here textiles did not reveal differences in weaving techniques. However, it may indicate that two separate groups were living close together, likely in the same household, and only female burials kept evident differences in burials. Likely strong familiar bondage was behind the cemetery A. It is suggested by anthropological and palaeopathological observations. The presence of leper cases and possible relatives sustain this opinion. Likely, women of cemetery A had clothing closer than those in cemetery B, as it can be showed by the difference in size values.

4.9 Butler's Field cemetery: description, analysis and discussion

4.9.1 Site introduction and soil description

Butler's Field, Lechlade is the biggest Anglo-Saxon cemetery included in this research with 229 inhumation graves, it spanned from the half of the 5th to the late 7th century AD (Boyle *et al.* 1998 and Boyle *et al.* 2011; Appendix 1.8). Likely, it was not entirely excavated and this may explain the proportion of adult male burials. Nevertheless, this site is extremely rich in grave furnishing and is one of the biggest Saxon cemeteries in the Upper Valley of the Thames.

The area is characterised by the presence of the river Thames and the cemetery is placed on the north bank in the higher gravelly terrace. This land varies morphologically and geologically, with the floodplain and then the higher well-drained gravel terrace. These features promoted different activities in this area, the lower terraces being used for pastoral activities and grass and hay pasture, while the second terrace was occupied since the Neolithic and currently is mainly used for agricultural purposes (Boyle *et al.* 1998, 1).

The report does not include more detailed soil descriptions. According to Avery (1990, 134) the southern area of the Cotswolds, where the cemetery lies, is covered by lithomorphic soil rendzina. Soilscapes (Cranfield University 2012) describes the area as a freely draining and lime rich loamy soil, which is the right habitat for herb-rich chalk and limestone pastures and lime-rich deciduous woodlands. The texture of this soil is loamy. The NERC (2011) provides a series of pH reports for the Lechlade area. The 2007 study revealed the local pH results as 6.31, which is considered slightly acidic.

4.9.2 Textile fibres and leather. Occurrence and preservation

Textile remains are described according to the specialists, recording the spinning direction and the thread count where possible (Boyle *et al.* 1998, 53). Overall, there were found 190 fibrous and leathery finds on grave objects. The majority of them were unidentified fragments (152 finds). Among organic clothing materials leather has the highest proportional identification with 30 fragments always found in contact with metal fasteners. Four cases were successfully identified woollen fibres and four other fibrous finds were recognised as plant fibres (fig. 4.34). The soil and burial conditions did not support a good preservation for clothing material.

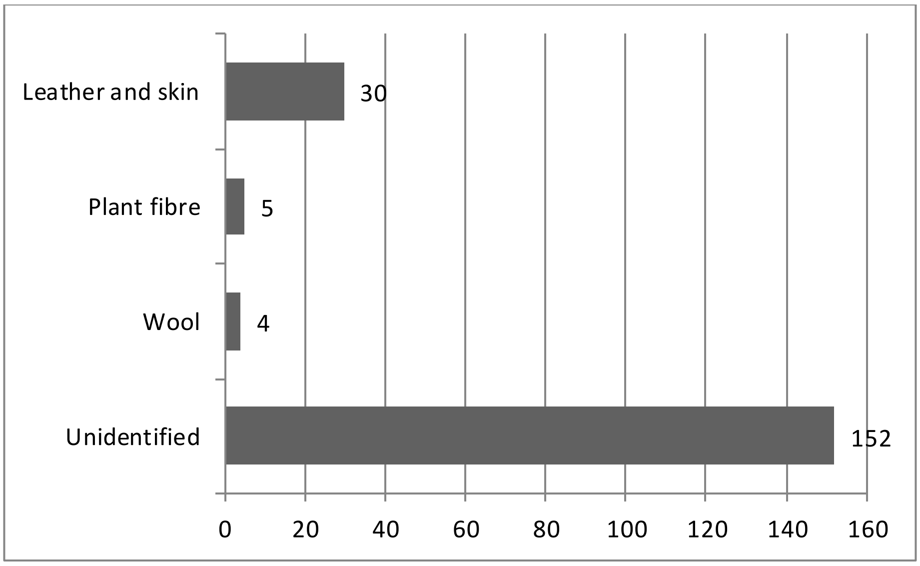


Figure 4.34: Butler's Field, Lechlade cemetery, frequency of textile fibres and leather.

The residues of textile are mostly associated with metal objects (fig. 4.35; fig 4.36), iron, copper and rarely silver (**graves 138**, **148** and **187**), so the main process of their preservation is mineralisation, even if other chemical reactions might also occur (Boyle *et al.* 2011, 93), but were not either fully investigated and reported. Analyses are also applied to describe threads of fabric fibres. The textiles have been separated into two groups, one 5th-6th century and the other 7th century AD, because the quantity of finds associated with fasteners was sufficient to create this chronology.

Figure 4.35: textile remains on saucer brooches. A and B from grave 130 and C from grave 10 (modified, © Oxford Archaeological Unit from Boyle *et al.* 2011, 93 pl. 8.1 and 8.2).

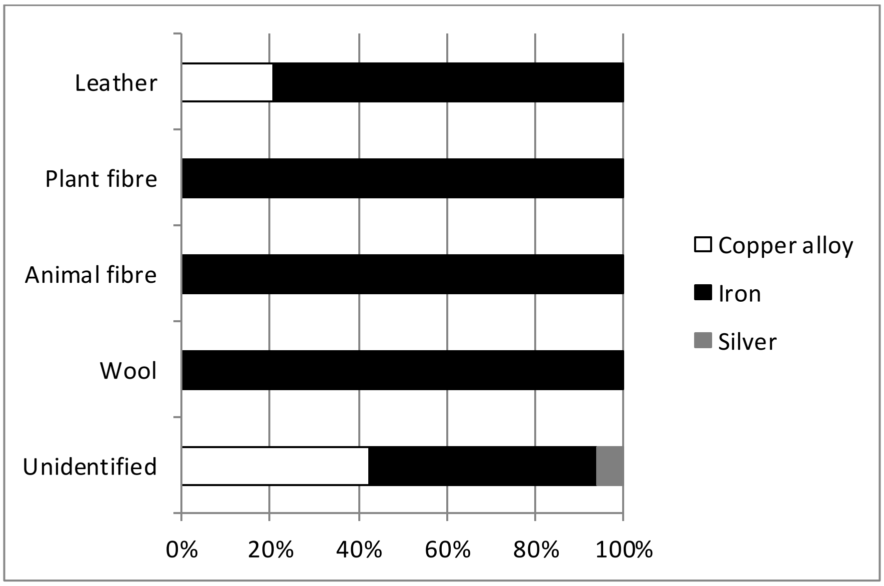


Figure 4.36: Butler's Field association between preserved fibres and associated materials.

4.9.3 Grave objects and clothing reconstruction

Except for bracelet, fabric fibre and footwear, all categories of grave objects were found at Butler's Field. Female burials have a clear predominance in the raw occurrence of grave goods (fig. 4.37; Appendix 3.9, tab. 9).

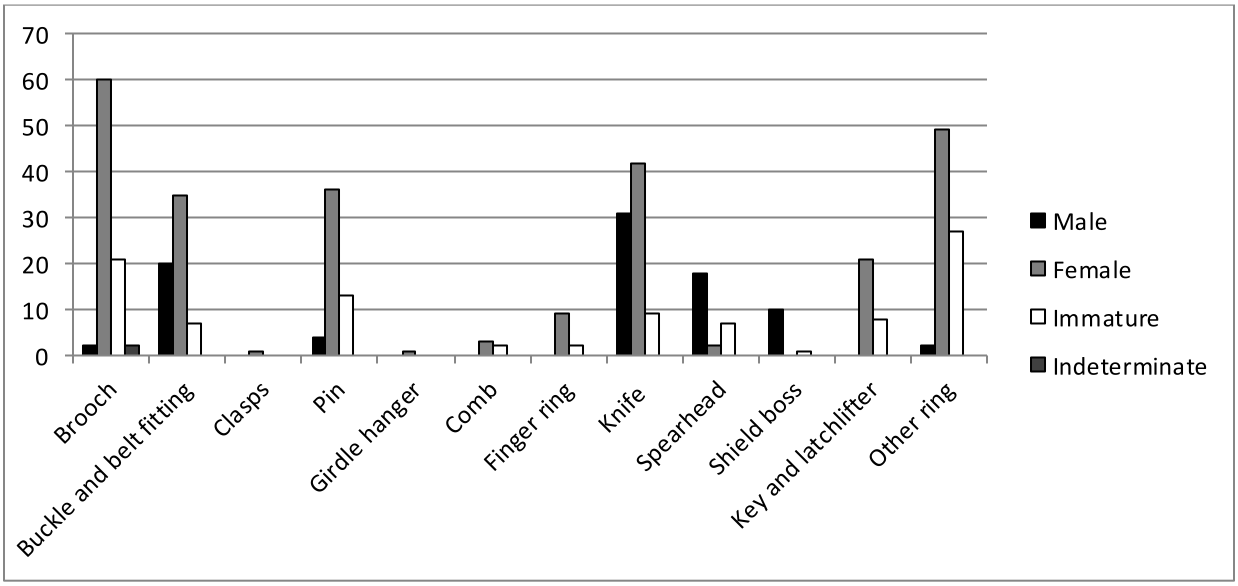


Figure 4.37: Butler's Field, Lechlade grave objects distribution. Bar chart of the actual numbers of cultural traits.

Figure 4.38 illustrates the occurrence of clothing materials by object types. The selected cultural objects which have remains of fibres are brooches, buckles and other belt fittings, pins, girdle hanger, knives, spearheads, shield bosses and fittings, keys and other rings. The identified clothing material is represented by 30 cases of leather (**inhumations 18, 42, 47, 57, 58 1, 64, 65, 69, 82, 88, 89 1, 92, 102, 106, 116, 160** and **163**), four cases of woollen fibres (**inhumations 2, 64, 65** and **115**) and four cases of plant fibres (**inhumations 14, 36 2** and **179**). Due to the high number of unknown fibres, the process of identification cannot be considered completely successful, possibly because of the poor condition of the fibres but also because there were no more sophisticated analyses, such as by SEM.

However, the data allows some interesting observations. Regarding the category of object, the brooch provides most of the evidence of fibre remains. In fact, 62 fibre finds were on brooches, but all those fibres were unidentified. Buckles with related belt fittings are associated with 25 unidentified fibres and 11 leather remains. The pins provide 14 cases of unidentified fibres.

Among the selected objects, which are not proper fasteners, knives provide two cases of wool (**inhumations 2** and **65**), one of plant fibre (**inhumation 36 2**), 11 of leather (**inhumations 41, 47, 57, 69, 82, 89 1, 92, 145 2, 160, 163** and **183**) and 4 of unidentified fibre (**inhumations 112, 136, 174** and **181**). Unidentified fibres are stuck to keys in 18 cases (**inhumations 10, 33 3, 56, 76, 78, 81 1, 97, 103, 130, 136 and 184**) and one key has remains of plant fibre (**inhumation 179**). Shield bosses have 14 occurrences of fibres: eight cases of leather (**inhumations 58 1, 64, 65, 92, 102, 106, 116** and **192**), 1 case of wool (**inhumation 115**) and four cases of unidentified fibre (**inhumations 40, 58 1, 92** and **116**).

Unidentified fibres have been found attached to brooches (fig. 5.29), buckles, pins, knives, spearheads, shield bosses, keys and other rings. The latter two associations – unidentified fibres on keys and rings – imply the probable presence of bags or purses in some cases. This hypothesis is substantiated by some finds, such as bag rings and bag frame (**inhumations 18, 71, 81 1** and **164**). Spearheads are associated with unidentified fibres in eight cases (**inhumations 35, 105, 115, 154, 155, 172 2 181** and **182**), which may suggest the blades of spears were wrapped.

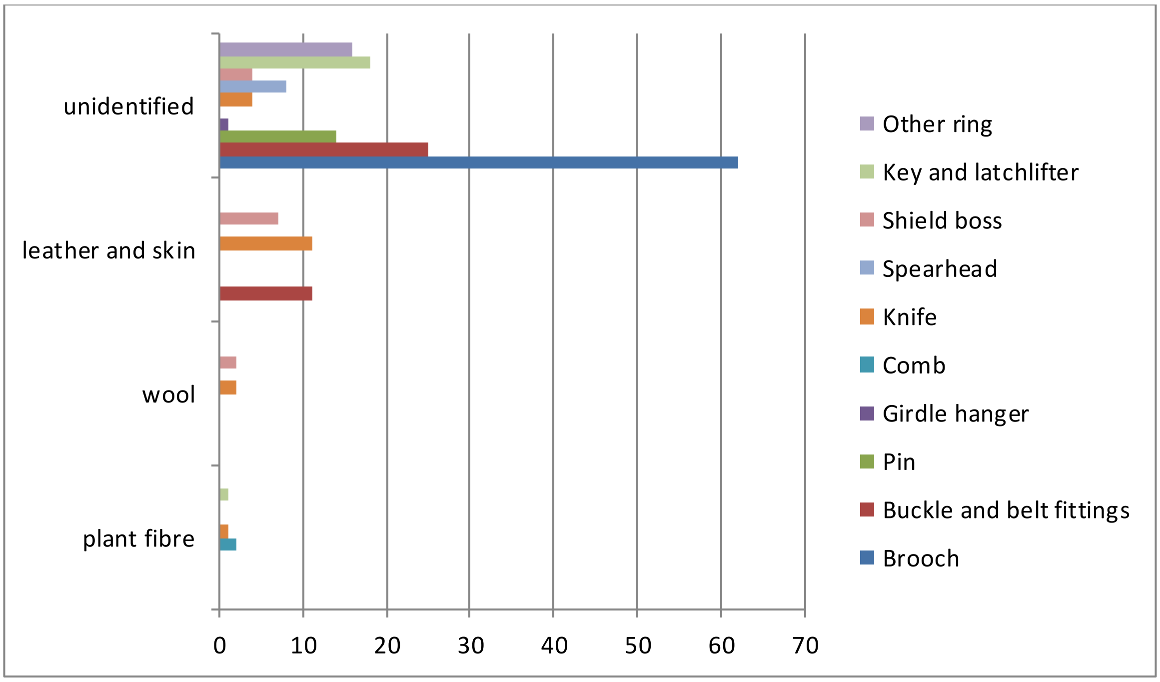


Figure 4.38: Butler's Field, association of clothing materials with selected objects.

4.9.4 Discussion

In conclusion, Butler's Field cemetery, which was historically settled in a Saxon area, offered good preservation conditions for human skeletons. Almost all of them were identified and a considerable percentage has bones in a fair or good state of preservation. Conversely, preservation of other organic materials is poor. Numerous fragments of fibre textiles were found, but the majority of them were unidentified. It seems that mineralisation is the principal factor for textile preservation, but no further details can be produced at this stage because of the absence of SEM studies and soil sampling analyses.

4.10 Empingham II: description, analysis and discussion

4.10.1 Site introduction and soil description

Empingham II is one of the several Saxon funeral sites discovered in the Rutland area (Timby 1996) (Appendix 1.10). It partially overlies some Iron Age features and it is very close to two other smaller Saxon cemeteries: Empingham I and III. During earthwork operation, severe damage was caused by machinery, which destroyed entirely some graves (Timby 1996). Additionally, earlier Roman features in the area can have had an impact on the local ritual in the Saxon period.

The site is placed on a geological feature of Lincolnshire limestone, on a slope, which descends to the River Gwash (Timby 1996, 1 and fig. 1). The soil is not described in the report, but is provided here based on web sources. Soilscapes (Cranfield University 2012) describes local soil as loamy and shallow lime-rich soils over chalk or limestone, freely draining. The pH is alkaline (NERC 2011). These characteristics may help preservation of plant fibres and impressions of textiles on chalky surfaces. However, the water movements are likely to have resulted in a highly destructive environment for fibres. Soft organic materials are easily affected by drainage. Consequently, expectations of preserved textiles are low.

4.10.2 Textile fibres and leather. Occurrence and preservation

The principal report includes a section dedicated to preserved organic material, which was studied at the Jewry Wall Museum (Timby 1996, 85-86). Analyses of fragmentary textile are missing because after the record, they were cleaned-off (Timby 1996, 85-86). Thus, textile finds result unidentified. The majority of fibrous fragments, but not all of them, were found attached to metal objects, both copper alloy and iron (fig. 4.39). These associations may indicate that the principal mechanism of fibre preservation was mineral replacement. In fact, the majority of mineralised textile fibres and leather fragments were associated with iron artefacts and copper alloy objects

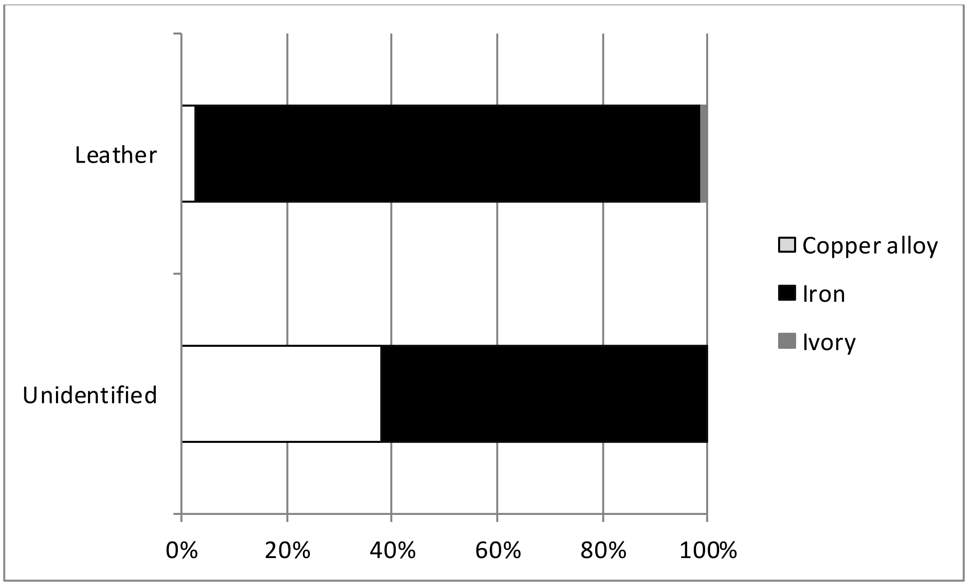


Figure 4.39: Empingham II proportional association between preserved fibres and associated materials.

Generally, their preservation was poor and it did not allow weave identification. Like the other organic material, textile fibres were examined by x 10 hand lens. However, no further analysis was produced for fibre identification, such as by SEM or chemical examinations. Hence, all textile fibres remained unidentified, while specialists were able to distinguish leather remains (fig 4.40). It was generally observed that organic preservation was poor in this cemetery, including human bones and wooden remains. Hence, the discussion on fibre preservation is limited. Additionally, it was observed that some organic leathery patches were found associated with an ivory ring (number 10, **grave 98 b;** Timby 1996, 122), but there are no further details on the state of preservation.

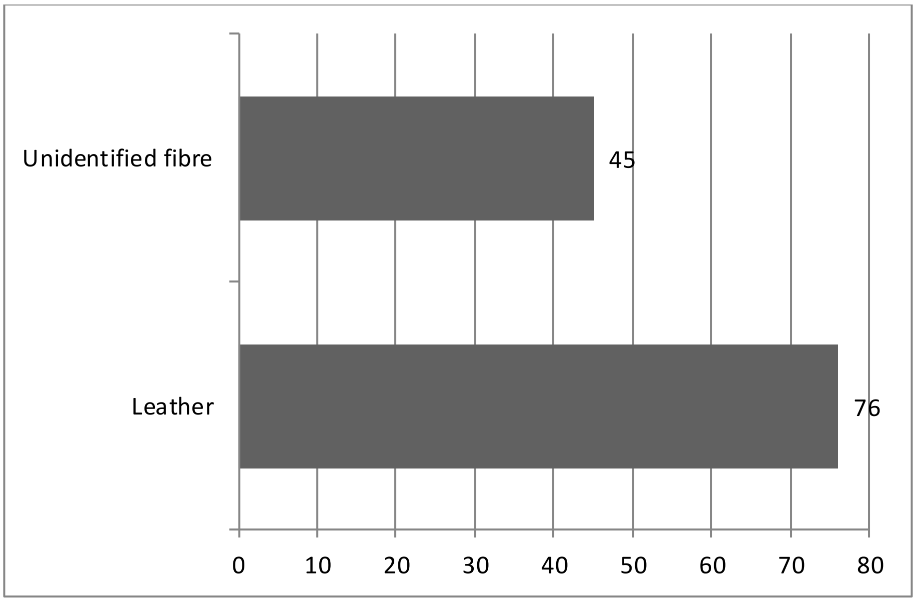


Figure 4.40: Empingham II cemetery, frequency of textile fibres and leather.

4.10.3 Grave objects and clothing reconstruction

Almost all grave object categories are represented in this site (fig. 4.41; Appendix 3.10, tab. 10) and generally female burials contain more objects, followed by male burials, while immature and indeterminate burials have limited grave goods.

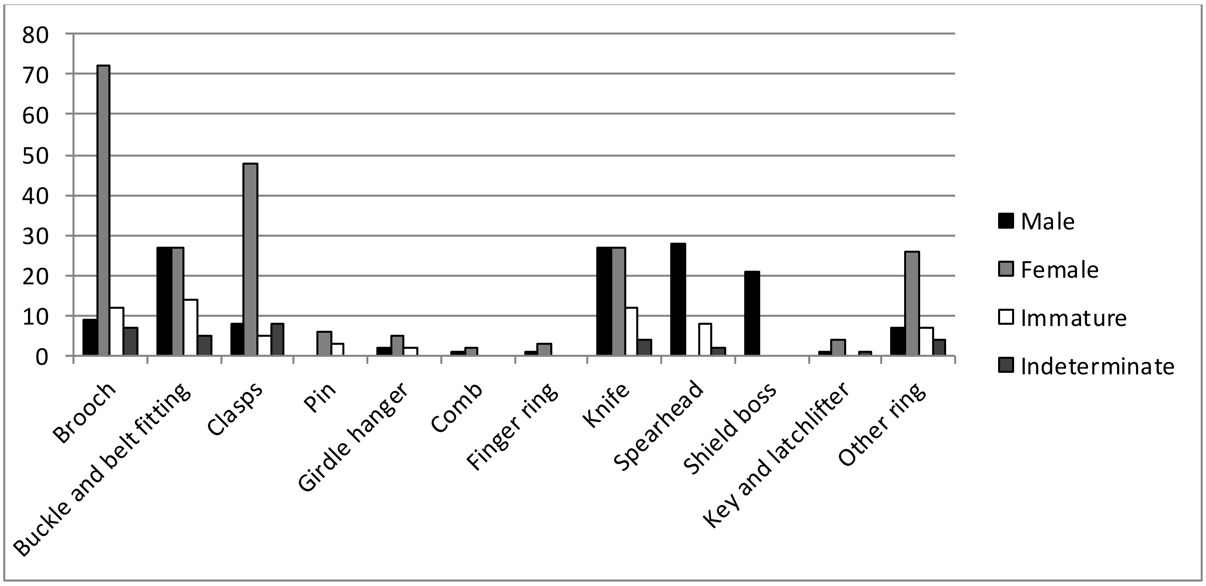


Figure 4.41: Empingham II grave objects distribution. Bar chart of the actual numbers of cultural traits.

No attempts were made to reconstruct original costumes, likely due to the limited amount of textile fragments and the biased environmental conditions of this excavation (Timby 1996). However, the assemblage of grave objects suggests that originally the bodies were clothed (fig. 4.42). As noted above, only one case of a leather fragment was found preserved on a non-metal ring. **Grave 98 b** is the burial, which contained this organic fragment. It is a double burial that includes both **grave 98 a** and **b** (Timby 1996, 122-123).

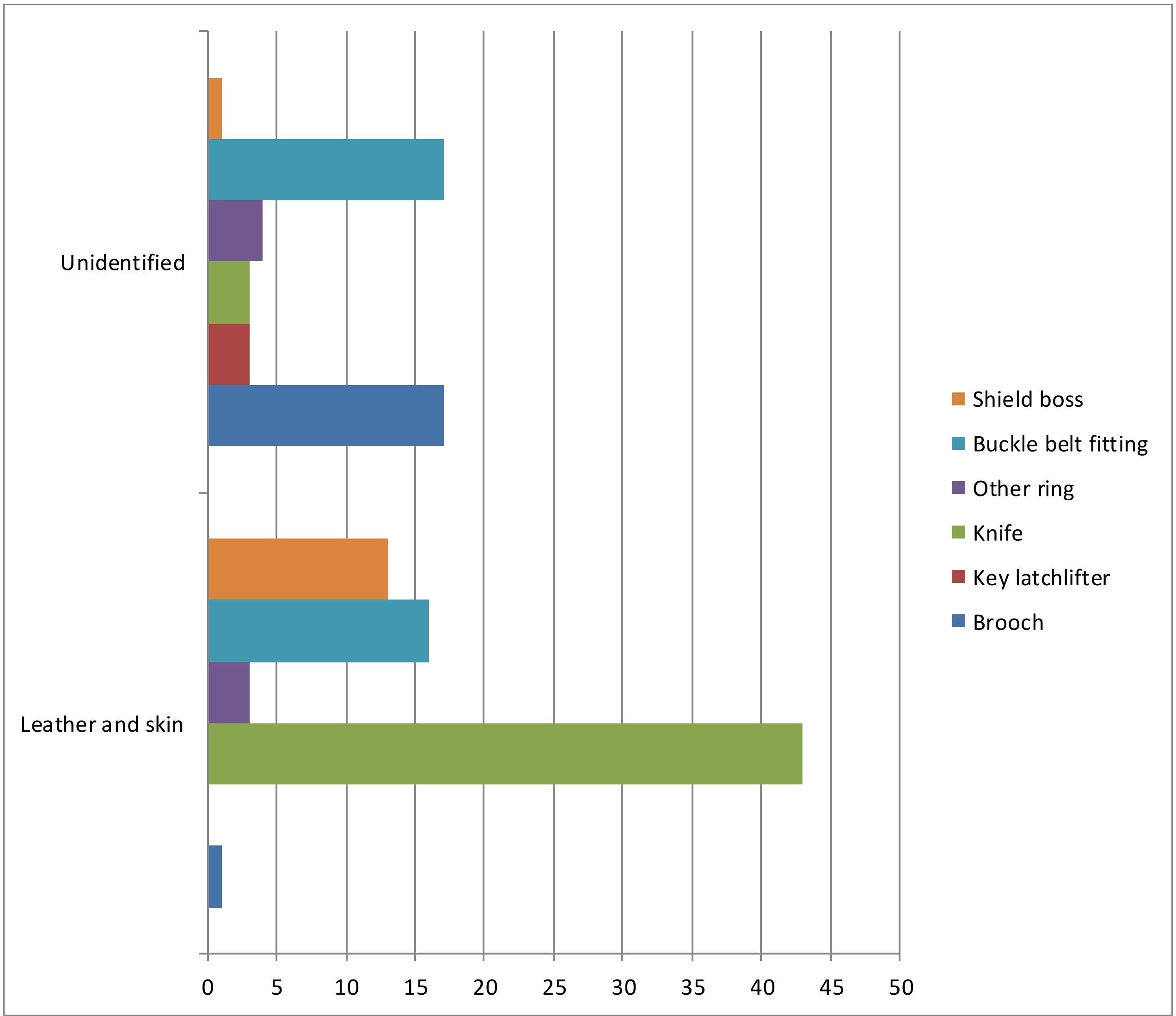


Figure 4.42: Empingham II association of clothing materials with selected objects.

4.10.4 Discussion

Cultural data from Empingham II are extremely interesting, but this site provides little information on textiles. This cemetery shows limits caused by the condition of the finds and the excavation. Likely, the rescue conditions of this excavation had impact on all finds (Timby 1996, 4). Textile finds suffered primarily from inappropriate cleaning before lab analyses and then because of the lack of microscopic observation (Timby 1996, 85-86). However, some interesting results can be given even in these conditions. Firstly, fibres were present and preserved mostly by mineralisation processes. Secondly, the same process of mineralisation has likely preserved a sample of human skin at least on brooch 2 from **grave 98 b** (Timby 1996, 122). The same grave probably had traces of leather on the surface of an ivory ring. This association may imply a process of perseveration different from mineralisation, which occurred in burial **98 b**, but there are not enough details to understand this process without further laboratory study.

4.11 Norton Cleveland cemetery: description, analysis and discussion

4.11.1 Site introduction and soil description

The cemetery of Norton on Tees, at Cleveland is the northernmost Anglo-Saxon site included in this research. It was excavated almost completely and it is representative of an Anglian community (Sherlock and Welch 1992). This cemetery is of the most interest because it provides more information on the male costume than other sites. Moreover, some of the male burials contain contrasting evidence of their gender. This site includes 126 inhumations distributed in 117 graves, and it dates between the 6th and the early 7th century AD (Appendix 1.10).

The report (Sherlock and Welch 1992) has not described the local soil. Therefore, present information of soil is based on external sources. The Avery general soil map (1990, fig. 2.5) defines this region as having gley soil around the site. Moreover, Soilscapes (Cranfield University 2012) describes the area as being impermeable soil, with seasonal moisture, slightly acidic, but base-rich loamy and of clayey texture. The water drainage is obstructed. Therefore, the assumption is that all graves lay on loamy soil. This type of soil has some characteristics, which preserve textiles better than other soils. Nevertheless, taphonomy is more complicated. On the one hand, the slow water movement is a damaging factor, but it is less affecting than fast drainage. On the other hand, biota activity was likely facilitated because of the friendly environment with permanent moisture. The current low acidity may be helpful for the preservation of animal fibres rather than plant fibres.

4.11.2 Textile fibres and leather. Occurrence and preservation

Textile fibres, leather and skin remains have been recovered from Norton cemetery and a short specialist report was published (Walton in Sherlock and Welch 1992, 57-61). The majority of fibres are extremely mineralised and so their full identification is largely impossible (fig. 4.44). However, a few examples of flax and woollen fibres are identified, beside one unique find of silk. Leather, like textile fibres, is preserved especially by mineralisation (fig. 4.43). Generally, textile fibre preservation is considered poor.

Among the identified fibres, two were flax fragments (**graves 1** and **22**) and one woollen fragment (**grave 63**). All the textile and leather fragments were attached to metal grave goods, except for one piece of fabric, completely mineralised and found in **grave 86** over the shoulder.

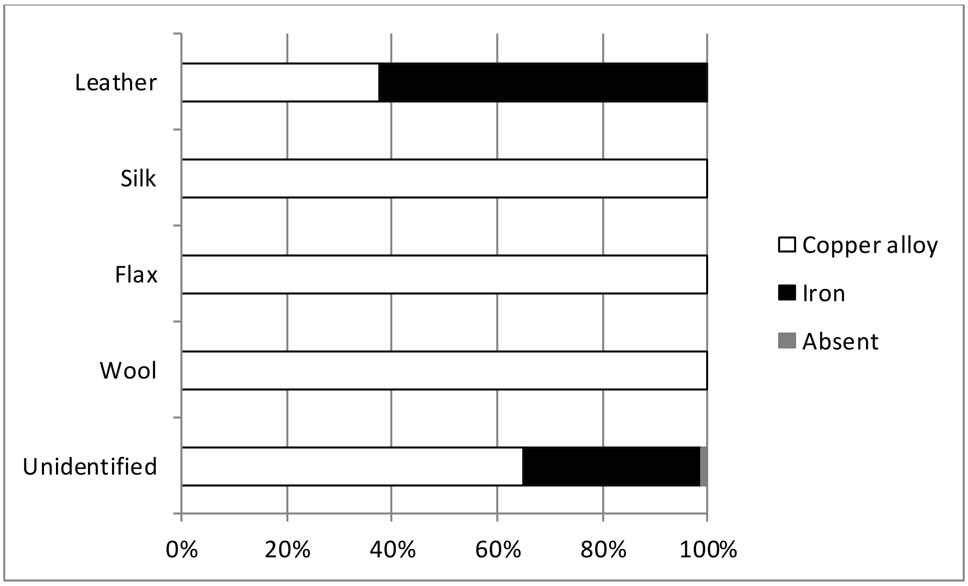


Figure 4.43: Norton, association between preserved fibres and associated materials.

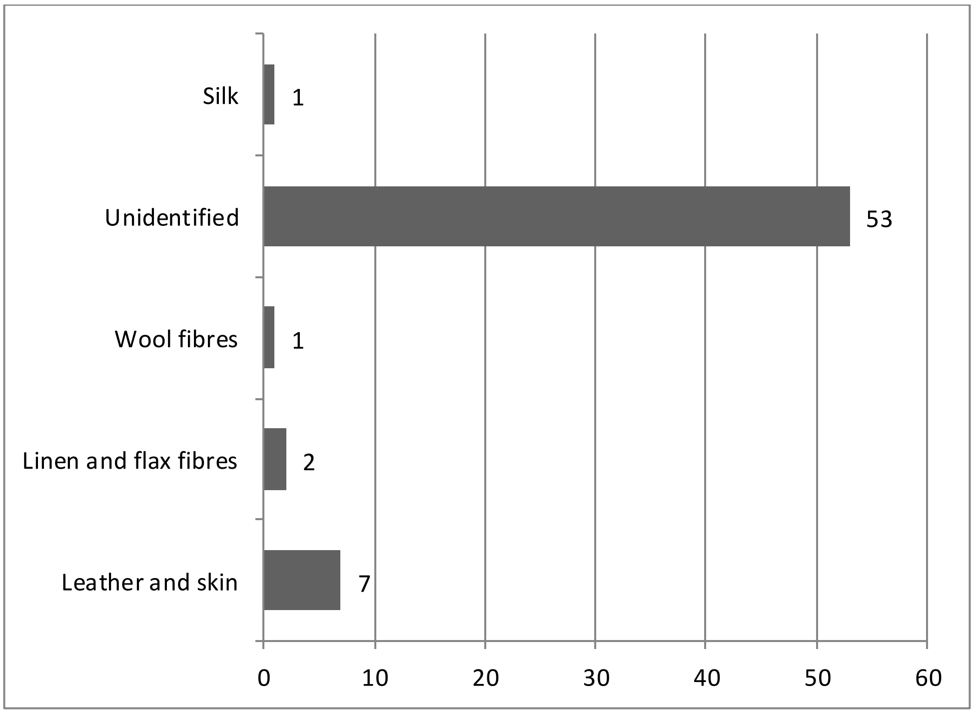


Figure 4.44: Norton cemetery, frequency of textile fibres and leather.

Copper alloy association had the main role in preserving wool, flax and a rare case of silk fragment (**grave 70**). Silk textile was found on an annular brooch and the length of the thread and the absence of spun fibre (Walton in Sherlock and Welch 1992, 61) identified it. The textile fragment was interpreted as remains of original brocade. The presence of silk fibre and other grave objects suggest that this was a rich burial.

Unidentified fibres and leather fragments occurred both associated with iron and copper alloy. Other minor preservative processes might have taken place in this cemetery. For example, it is reported that **grave 86** (Sherlock and Welch 1992, 61) contained male bones poorly preserved, whereas some textile finds were found beside the left shoulder without any metal artefact in direct contact. Unfortunately, there is no photographic record of this fragment or laboratory analyses. Nevertheless, it likely indicates the existence of preservative mechanisms other than mineralisation.

4.11.3 Grave objects clothing reconstruction

Thirteen out of fifteen grave object categories were found (fig. 4.45; Appendix 3.11, tab. 11). Female burials are slightly better represented than male burials, while immature and indeterminate burials have limited representation.

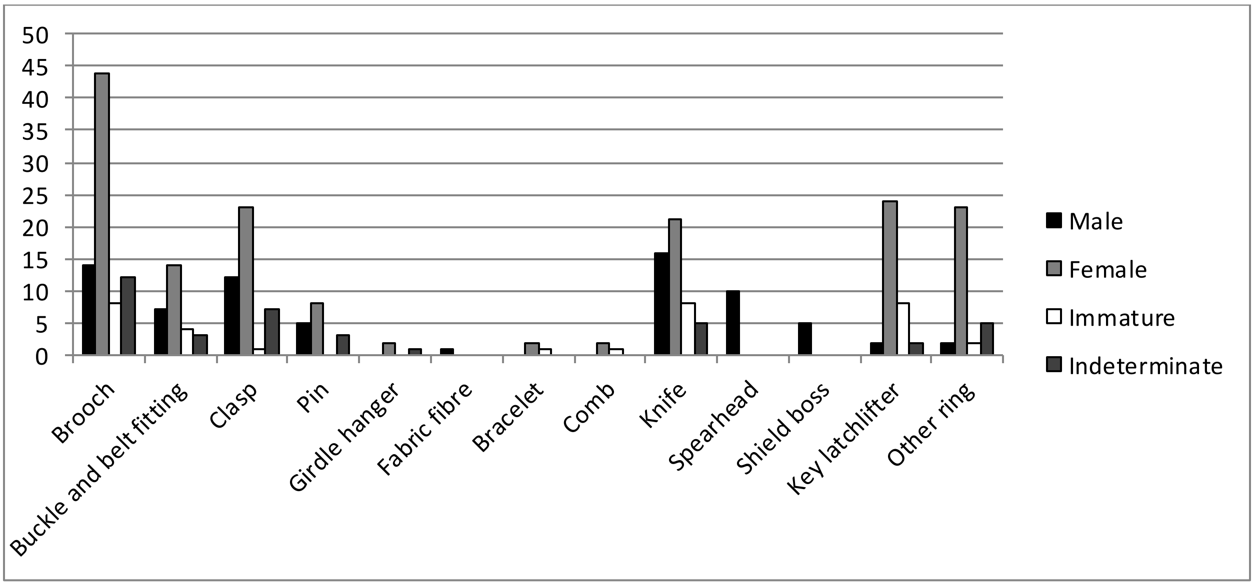


Figure 4.45: Norton, grave objects distribution. Bar chart of the actual numbers of cultural traits.

Overall, 56 cases of textile fragments have been recorded in association with grave objects, plus seven cases of mineralised leather fragments (fig. 4.46). Brooches have the highest preservation of textiles with 44 cases showing 63 textile finds. The other finds are spread between eight object categories: buckle and belt fittings, clasp, pin, fabric fibre, knife, spearhead, key and latchlifter and other ring.

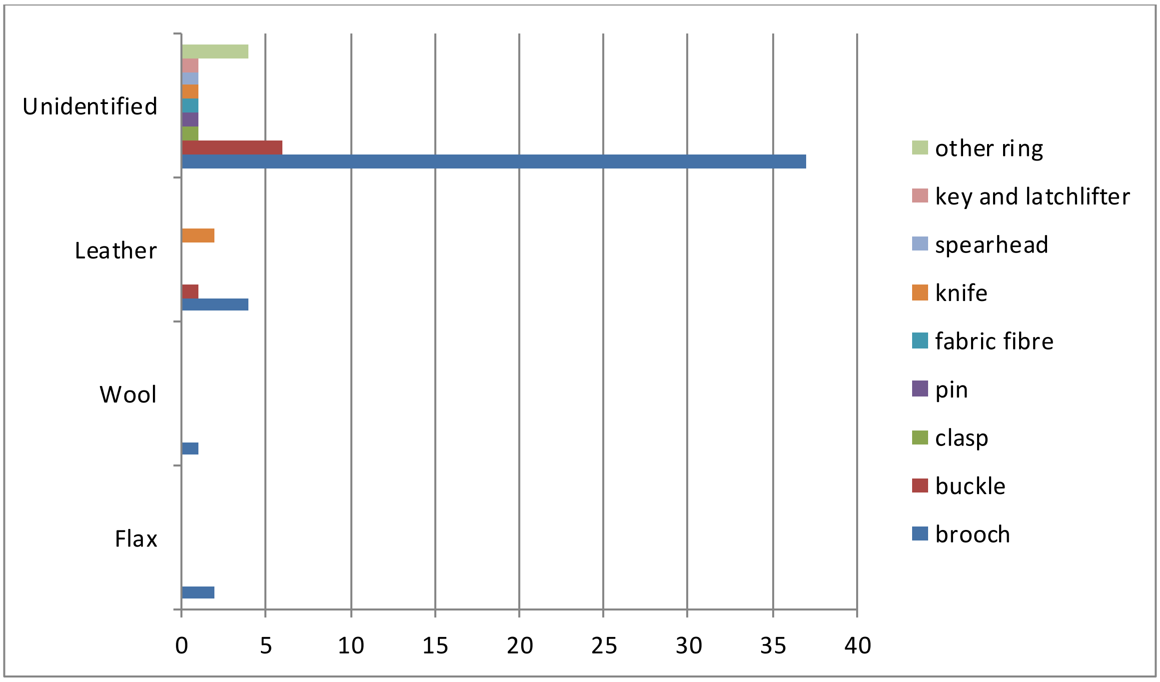


Figure 4.46: Norton, association of clothing materials and selected objects in natural numbers.

The fragmentary textile finds and the position of metal fasteners on bones suggest a possible funeral costume. The study of the textile remains indicates that the local costume was in line with contemporaneous northern cemeteries and only **grave 70** suggests a high ranking burial (Walton in Sherlock and Welch 1992, 61). At Norton, women and men might have worn gowns and garments with long sleeves. Wrist clasps suggest this dress (Walton in Sherlock and Welch 1992, 57-61). There are copper alloy buckles but most are iron buckles. Technological analyses on fibres were successful in identifying at least five different fibre types, with an interesting prevalence of ZZ tabby weave.

In some male burials, Walton-Rogers identified eight certain and two likely cases of individuals dressing in a loose-fitting tunic or peplos (Walton-Rogers 2007, 199). This is remarkable because peplos was a typical female garment found in Anglo-Saxon graves of the 5th and 6th century AD, while it became less popular by the end of the 6th and the 7th century, replaced by other dress (Walton Rogers 2014). However, more detailed reconstruction of clothing of these burials was not attempted. Another interesting clothing feature is the presence of small buckles placed up on the chest of the skeleton in **grave 100** (and likely in **grave 40)**, which is considered the richest female burial of this cemetery (Sherlock and Welch 1992, 22). Both buckles originally might have fastened an animal skin cape on the head and shoulders (Walton-Rogers 2007, 172). Despite the assumption that this cemetery included burials of ordinary people, **grave 70** is considered of a higher status because of the silk evidence.

4.11.4 Discussion

In conclusion, Norton cemetery is in Northeast England, which historically is a region under the control of Anglian people. Generally, textiles and leather preservation is poor. The major factor of preservation is mineralisation, which occurred for a few pieces of textiles close to metal fasteners. The analyses by conservators in the laboratory were by different types of microscope and by X-rays for all metal objects, but SEM analysis was not applied. Even if the site does not offer a high standard of preservation and the number of textile fibres is small, the description and record of fibres helps to understand the degree of fibre preservation on this site. The study of weave confirmed that textile finds were in line with Anglo-Saxon techniques of that time (Walton in Sherlock and Welch 1992, 61).

4.12 Sewerby: description, analysis and discussion

4.12.1 Site introduction and soil description

The cemetery of Sewerby (Hirst 1985; Appendix 1.12) is the third northern site included in this study, after West Heslerton and Norton on Tees. Despite the conditions of rescue excavation, the graves and grave goods were examined with different statistical means in order to compare Sewerby in a broader context and to understand better the local context. The **graves 41** and **49** are the peculiar in that one overlies the other. **Grave 49** contained the remains of a woman buried facing the ground with a bent arm behind the back in a forced position. It was defined as being buried alive a somewhat speculative interpretation (appendix 1.12). Beneath **grave 49**, there was **grave 41**, which contained the remains of a younger woman. **Grave 41** was contemporaneous with **grave 49**. In terms of organic preservation, some inhumations preserved organic evidence of different materials, including textiles.

The original report provides good descriptions of local geology and topography (Hirst 1985, 10-12). The cemetery is placed on an extended and level low crest, which measures 1 metre high, 60-90 centimetres long and 15 metres wide. The graves were dug in sandy and gravelly ground (Hirst 1985, 16 fig. 6). The surrounding region is characterised by the chalky south eastern Wolds slopes. At the top of the hills, the chalk is almost superficial. However, the lowlands are covered by clay, glacial sand and gravel and clayey alluvium, even if the clay layer was not found during the excavation of graves. The Gypsey Race is the main local stream. The region is covered by brown soil according to the soil map of the British Isles (Avery 1990, fig. 2.5). Moreover, Soilscapes (Cranfield University 2012) offers further details: the topsoil of the site is freely draining slightly acid loamy soils.

Even if the digging circumstances were not ideal, the report illustrates accurately soil stratigraphy in the cemetery (Hirst 1985, 16-17, fig. 6, 16). The upper layer is dark brown soil characterised by root disturbance and a thickness comprised of 8 to 15 centimetres. The second layer combines sandy gravelly soil, clay and sand. This layer is often homogeneous with the grave fill, its thickness is between eight to 30 centimetres. The following layer is sandy gravelly, it contains less sand than the superior level does and it seems cleaner. Its depth is between 23 and 35 centimetres. Finally, the subsoil is at a depth between 45 and 61 centimetres from the superficial layer. It is mostly composed of loose sand and gravel, but it even includes areas with clayey sand and more compact sand. Anglian structures appeared from the top of the third layer, while layer 2 was the medieval level. Layers 2 and 3 have been interpreted as possible buried soils starting their formation since to Middle Ages. After the cemetery was not in use, the site was employed in pasture.

It is interesting to report the case of unusual overlaying burials. The stratigraphy of **graves 41** and **49** differs from the other revealed graves. Under their topsoil there was a level covered by chalky pieces and blocks. This layer sealed **graves 41** and **49** and it included unintentionally **grave 42**. It seems likely that the chalk, which was transported from the near beach, was placed simultaneously to burials **41** and **49** to mark the area. Under the chalk, there was grave fill, which covered **grave 41**. Beneath this was found another grave fill and then **grave 49**. Information on Sewerby cemetery' soil textures imply that rapid water draining was facilitated. It is a condition that generally produces poor preservation of buried material. Therefore, textile remains were not expected.

4.12.2 Textile fibres and leather. Occurrence and preservation

Textiles from Sewerby were examined by specialists (Crowfoot and Appleyard in Hirst 1985, 48-55). Fibrous materials were regularly patchy and mineralised. Therefore, complete fibre identification was rarely accomplished. The local environment does not provide ideal conditions for organic preservation, so fibres were usually poorly preserved. However, the high quality of archaeological work was crucial for detailed information about these local textiles (Crowfoot in Hirst 1985, 48).

Mineralisation was the only mechanism ensuring textile fibre preservation that was observed (fig. 5.41). Hence, all textile and leather finds were associated with metal artefacts. Iron and copper alloy objects preserved organic textiles, and the figures are clearly different whether considered as sample numbers or percentages. In the latter case, as figure 4.47 shows, copper alloys are proportionally more effective than iron in preservation. This is translated into sample numbers as 40 textile finds attached to copper alloy artefacts and 6 associated with iron. The excavators did not provide an explanation for this difference in preservation. Here, it is suggested that the copper ions could effectively slow biodeterioration, while the rate of iron corrosion was not fast enough to produce cast over the textile fibres (Sibley and Jakes 1982; Janaway 1985; Gillard *et al.* 1994; Chen *et al.* 1998; ch. 2.12).

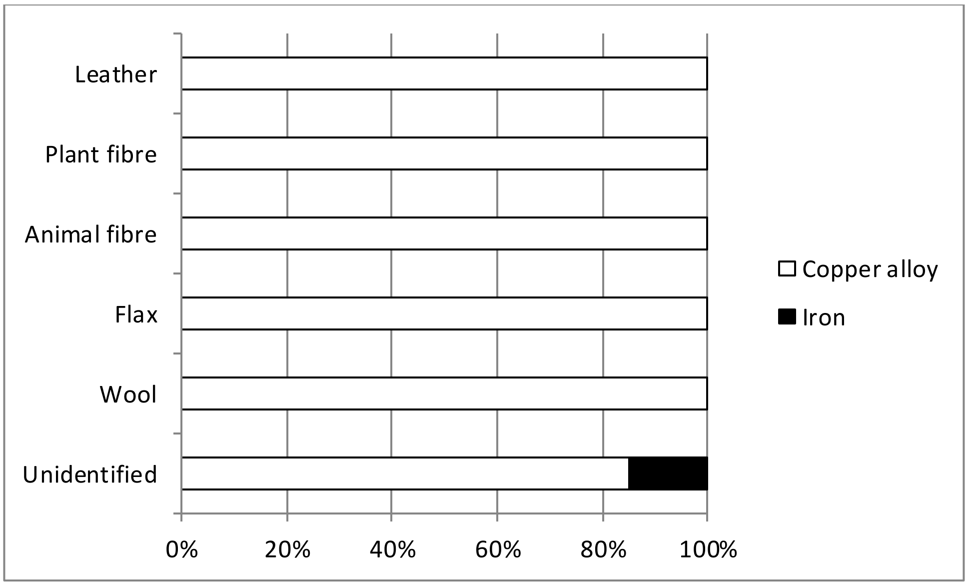


Figure 4.47: Sewerby association between preserved fibres and associated materials.

Figure 4.48 displays identified fibrous and leathery remains. There were 50 fibre finds on the selected grave objects, but the identification was fully successful only in 10 cases, with wool, flax and leather fibres identified. Two cases were identified only being animal or plant fibres respectively. The remaining finds were mineralised or in traces and so not identifiable. Identified fibres are proportionally low, but the fibre structure has still survived in a few fragments, providing a glimpse of the presence of both animal and plant fibres. Leather fragments have a very limited presence if compared to other sites. This limitation in leather finds is not usual among Anglo-Saxon cemeteries.

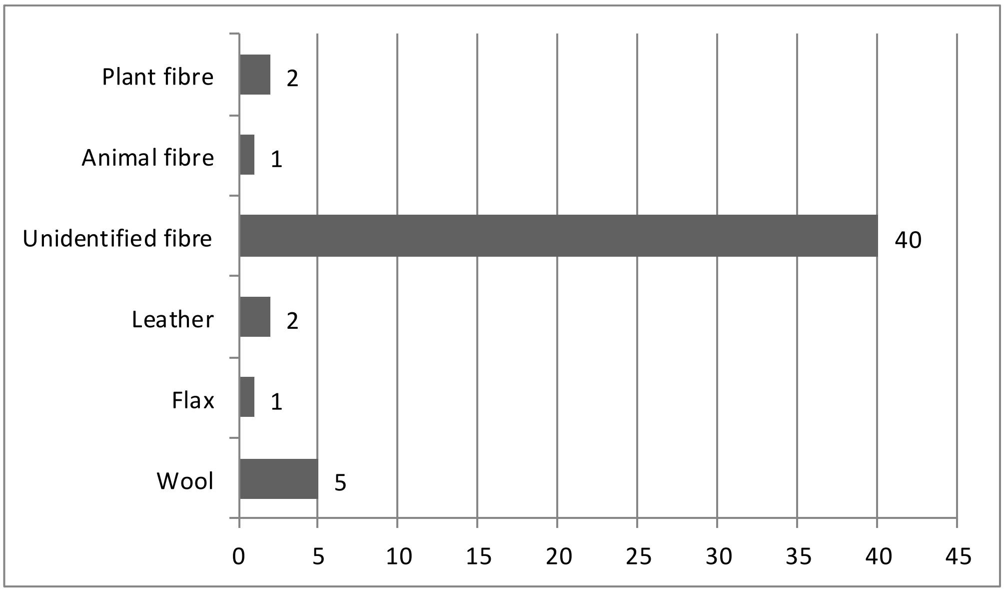


Figure 4.48: Sewerby cemetery, frequency of textile fibres and leather.

4.12.3 Grave objects and clothing reconstruction

Eleven grave object categories were present in this cemetery (fig. 4.49; Appendix 3.12, tab. 12). Overall, female burials have a slight predominance in comparison with male burials, but in some categories for males, like keys and shield bosses, are better represented. Indeterminate burials are also present.

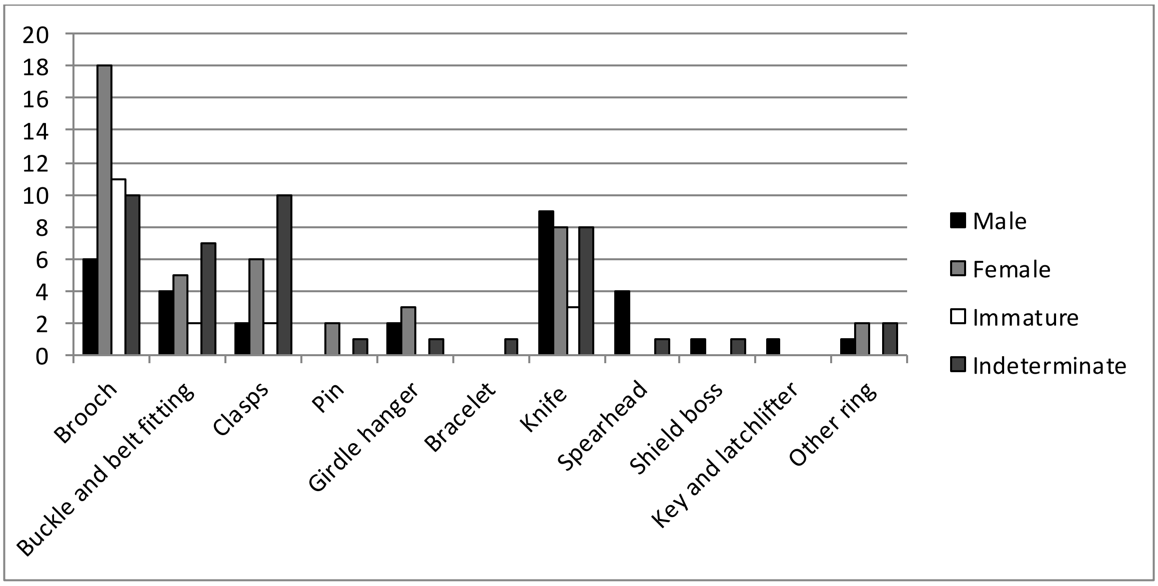


Figure 4.49: Sewerby, grave objects distribution. Bar chart of the actual numbers of cultural traits.

Overall, 46 selected objects were associated with textile and leather finds (fig. 4.50). Brooch is the category, which kept most of the textile finds and more types of fibres. Some graves offered better preservative conditions with more textile evidence. The majority of these fibrous fragments were metal replaced (Hirst 1985, 49-52 tab. III). Fifteen graves had preserved textiles or leathery fragments (**graves 8, 12, 15, 16 1, 19, 35, 38, 42, 49, 50, 51, 54, 55, 56** and **57**). It may appear obvious that coffined graves **15, 35, 49, 51** and **55** contained textile fragments attached to different objects. However, other un-coffined burials had a similar occurrence of textile preservation (**graves 19, 38, 54** and **57**).

The local garment style is partially reconstructed by the study of the position of the metal fasteners and fibre presence. **Grave 19** assemblage suggests a female costume which included an over gown fastened by three brooches. The woman was likely wearing a veil around the head. A belt and a cloak completed her clothing. Plant material was found on the chest, and this presence led to a double interpretation; either it was the remains of a floral tribute or there was no coffin to protect the burial. Moreover, fragmentary textile could not be associated with garments, but it was attached to the buckle, so it is likely to be the remains of a bag carried on the belt.

Disposal of arms and clasps found in **graves 35** and **38** imply the dress had long sleeves. Remarkably, **grave 12** had four brooches. Three of them were in the standard position, holding the gown and the cloak on the shoulders. The fourth was located on the body, possibly to keep a veil. **Grave 49**, had similar brooches' disposition, which indicates the remains of a cloak made of animal pelt (Walton-Rogers 2007, 171-172). Textile survival in **grave 57** is interesting, because the burial does not preserve any bones, but fibres survived in poor condition though. From this grave it was possible to reconstruct the presence of a cloak, a gown, an underdress and a possible hood that dressed the dead. All these burials were for women with no clear evidence of male costume.

Interestingly, at Sewerby, some of the weaving techniques prove the survival of Roman weaving techniques (Walton-Rogers 2007, 230). Weaving techniques are mostly comparable with those found in other Anglo-Saxon sites. Nevertheless, two textile textures show closer links with Late Roman and Romano-British textile techniques rather than Germanic (Hirst 1985, 48, 52-53). The first is a twill weave four-shed. It was found on a few objects in **grave 12** on a brooch (5), in **grave 49** on a girdle hanger (10) and in **grave 57** on a brooch (5). The second technique is twill weave three shed, which is documented in **grave 57** on a brooch (7).

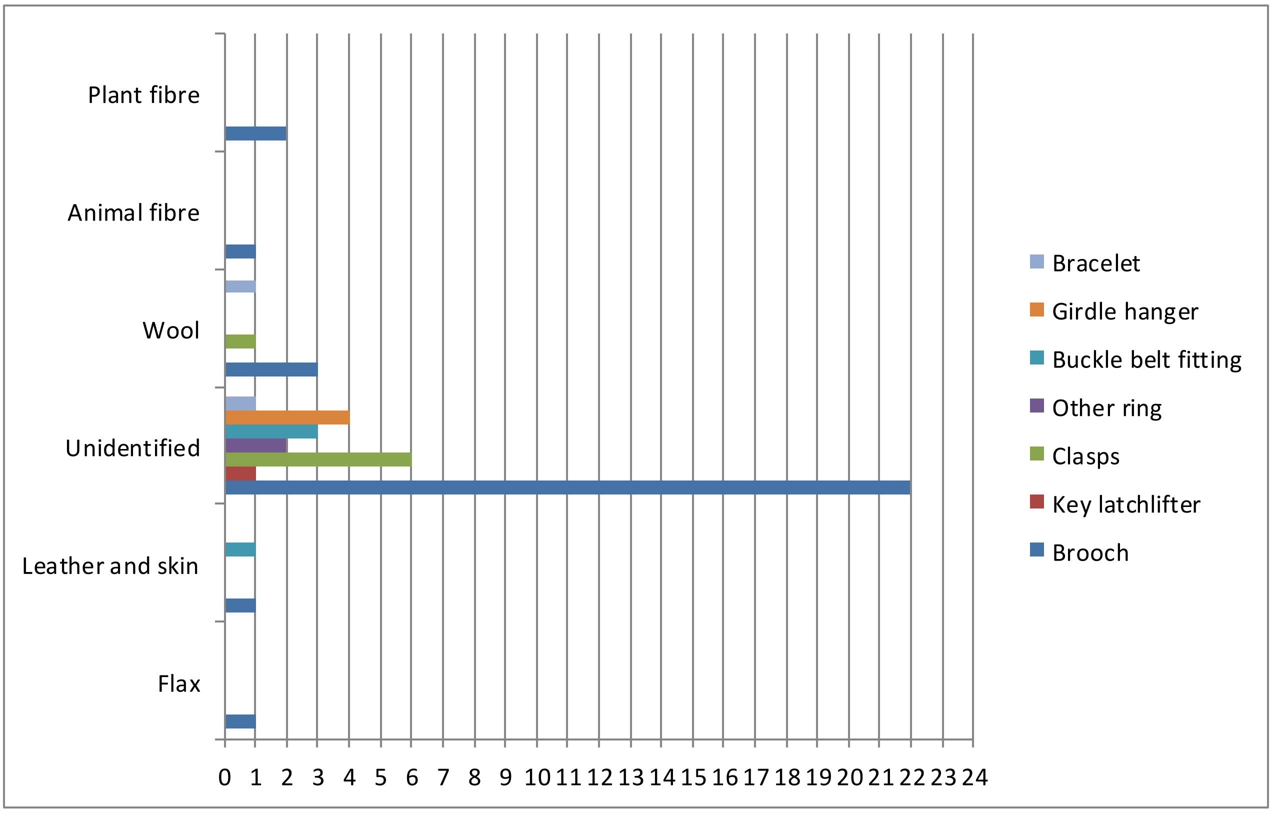


Figure 4.50: Sewerby association of clothing materials with selected objects in natural numbers.

4.12.4 Discussion

Sewerby cemetery is interesting for different reasons. It represents an ordinary Anglian cemetery of fifties inhumations dated by artefacts between the late 5th century and the 7th century AD. Soil conditions were not ideal for organic preservation, but some fibre textiles were preserved, mostly by mineralisation, and identification was possible for few fibres.

The burial ritual seems conventional, in the sense that grave goods are associated with biological traits without discrepancies. It is worth remembering the overlapping double burial with **graves 41** and **49**. The first burial was a prone female skeleton, interpreted as buried alive, done for punishment or other ritual reasons. The latter burial was a young adult female, buried in a wooden coffin. Interpretations on this double burial are still open, but their chronological relations seem to be contemporaneous. Double burials, like this at Sewerby, are not common. Both inhumations have metal fasteners and metal objects, which suggest they were fully dressed. However, the grave goods are not different from others of the same cemetery.

Preserved textiles of **grave 49** did not have a better preservation to the other textile finds. However, this burial preserved more textiles. **Grave 49** had an oak coffin, which was found mostly as a shadow on the ground. Likely, the coffin and the double soil layers on **grave 49** helped to protect better textile fragments. Although the overlying **grave 41** was likely to have been a fully dressed burial (Hirst 1985, 41), it did not preserve any fibres.

4.13 Spong Hill: description, analysis and discussion

4.13.1 Site introduction and soil description

Spong Hill shows some interesting characteristics of value to this research. It is placed in an area archaeologically well investigated and with numerous Anglo-Saxon cemeteries and funeral sites. The inhumations, which date from the end of the 5th to the end of the 6th century AD, are at the edge of one of the biggest Anglo-Saxon funerary sites that include more than two thousand cremations (Hills, Penn and Rickett 1984; Norfolk Historic Environment Service 2012) (Appendix 1.12). The big cremation cemetery is earlier than the inhumations. The proximity of two burial rituals leads to several questions about the cultural identity of the dead. Moreover, the local environment was extremely aggressive towards all organic materials. Hence, the preservation of textile fibres is expected to be low.

Penn and Brugmann (2007, 5-6) depicted a wide representation of regional geology and topography of East Anglian early cemeteries. Spong Hill is placed in a stream valley, like Morning Thorpe and Bergh Apton. The cemetery is on a gentle slope and the general soil features are described as gravelly and sandy and the pH is acid. The description provided by the report corresponds to that of

Soilscapes (Cranfield University 2012), which defines the soil of the area as slightly acid loamy and clayey soils with impeded drainage.

Since some graves were found with no bones, but dark stains and grave goods were contained in there, it was decided to produce detailed analyses on soil to verify the original presence of human remains in some of those graves. Detailed soil sampling analyses were carried out on three inhumations (**31, 40** and **42**) (Hills *et al.* 1984, 32-36, tab. 1, 2, fig. 8). Samples were examined for phosphate. Phosphate presence in soil can be used as an indicator of the original existence of bodies in empty graves. The first effective test was done at Mucking Anglo-Saxon cemetery grave 963 (Keely *et al.* 1977). The analyses of grave 963 demonstrated that manganese, phosphorus and copper accumulate in the skeletal area more than the surrounding soil (Keely *et al.* 1977).

The study of **grave 31** of Spong Hill did not establish clearly the presence of a human body, or whether the burial never contained a body, the body was moved soon after burial, or the soil samples were not taken at the same level where the body was laying (Hills *et al.* 1984, 33). Samples from **grave 31** do not contain high phosphate levels. Phosphate values from the burial are 60% higher than the values from control samples. This result is not considered equivalent to those obtained by the analyses of grave 963 at Mucking Anglo-Saxon cemetery. Trace element analyses of soil samples from **graves 40** and **42** examined phosphorus, manganese, copper, iron, cobalt, pH, and moisture content. High copper values were observed and were likely the result copper alloy grave goods. Phosphate content was compatible with the presence of human remains in both graves (Hills *et al.* 1984, 34-35).

4.13.2 Textile fibres and leather. Occurrence and preservation

Specialists (Hills *et al.* 1984, 17-28) examined textile fragments and produced fibre analyses. Fibre preservation was extremely poor. Metal replacement occurred predominantly as the preservative factor. This impeded fibre identification in the majority of finds. However, physical features of the weave remained identifiable.

Most of the metal replacement occurred with copper and copper alloy objects, and secondarily with iron objects (fig. 4.51). There is a contrast between textile fibres and leather finds. The latter were mostly preserved in association with iron artefacts, whereas the first were usually attached to copper alloy objects. No other preservative mechanisms other than metal replacement were seen. This suggests that local environmental conditions do not facilitate organic preservation.

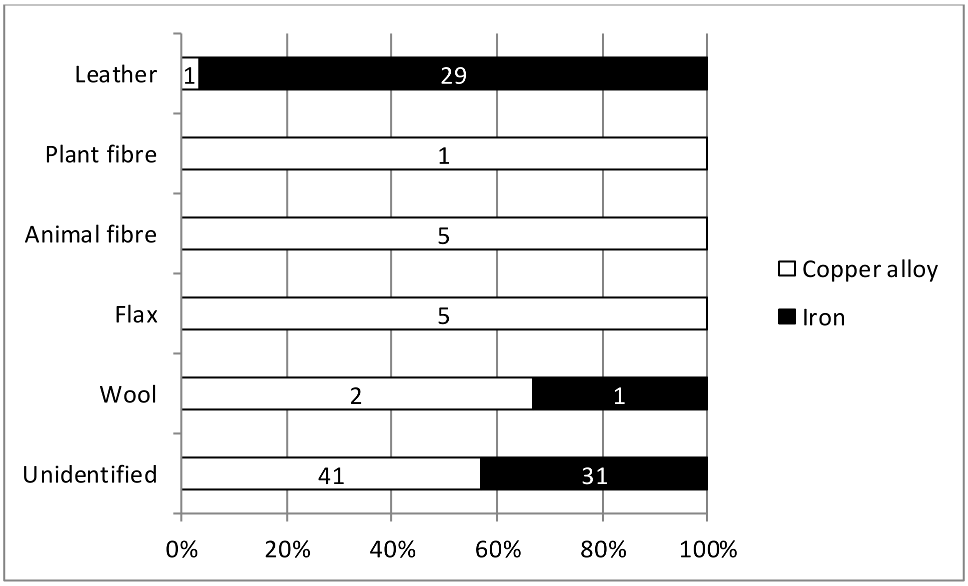


Figure 4.51: Spong Hill, association between preserved fibres and associated materials.

The majority of fibrous finds are unidentified (fig. 4.52), mostly because metal replacement changes deeply the physical features of the fibres. Only 30% of the textile finds were identified. The leather remains are the main identified materials and few finds of woollen and flax fibres occurred. Despite the low numbers of identified fibres, it is evident that flax and other plant fibres have a higher representation than woollen finds at Spong Hill.

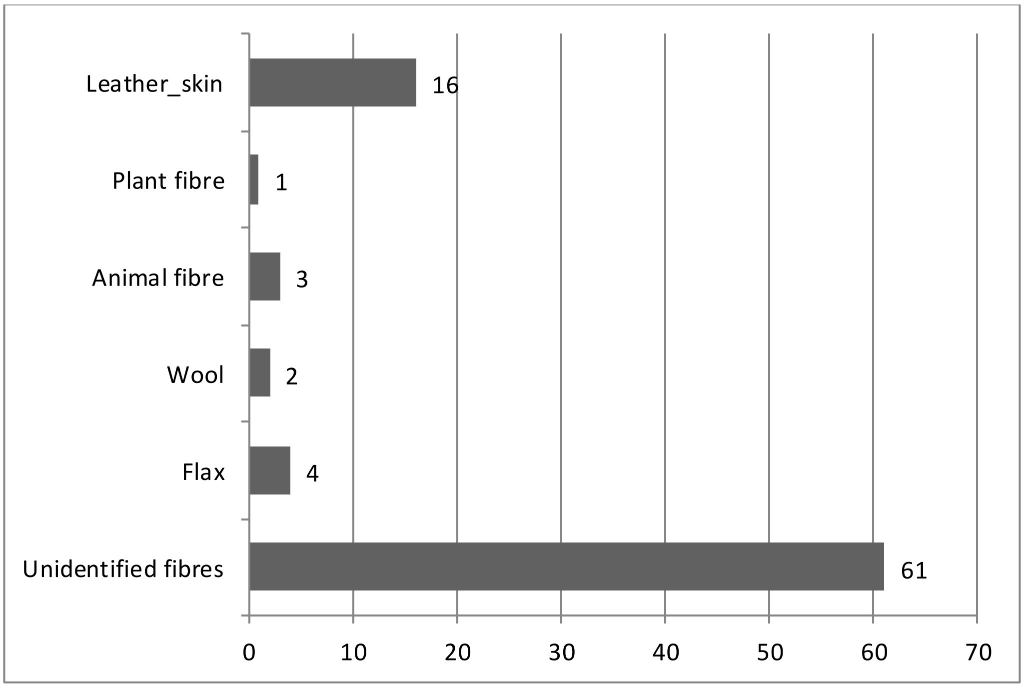


Figure 4.52: Spong Hill cemetery, frequency of textile fibres and leather.

4.13.3 Grave objects and clothing reconstruction

The inhumations of Spong Hill contained ten of the fifteen grave objects (fig. 4.53; Appendix 3.13, tab. 13). The objects were metal fasteners and weapons, while adornments, like rings and bracelets were absent. Indeterminate burials have an unusual high representation, because the acidity of the soil deteriorates bones in numerous graves not allowing anthropological identification.

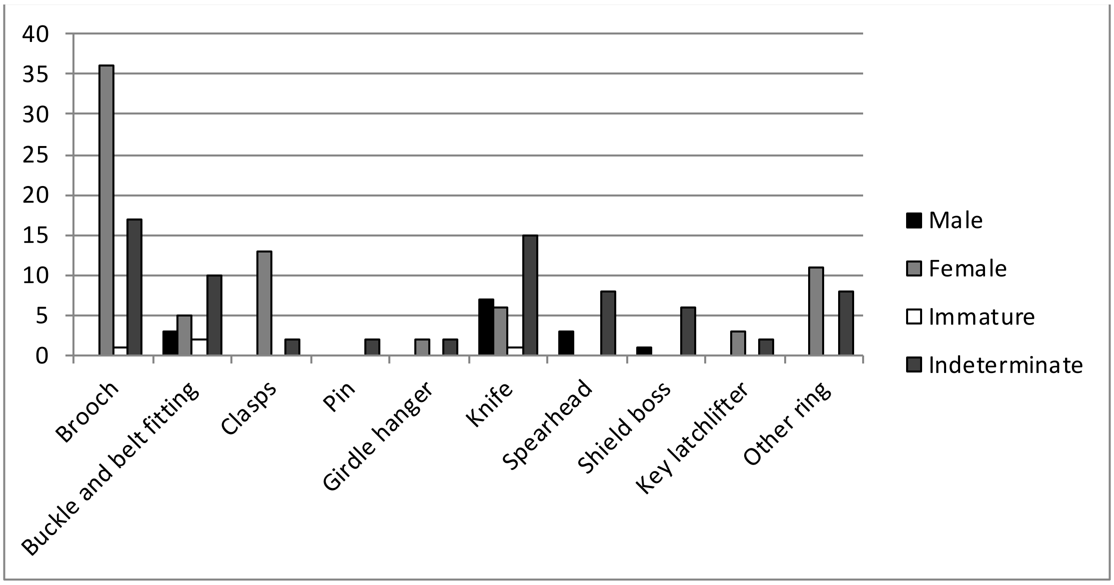


Figure 4.53: Spong Hill cemetery grave object distribution. Bar chart of the actual numbers of cultural traits.

Selected objects were associated with preserved textiles and leather fragments in 101 cases (fig. 4.54). Despite the poor preservation of textiles and the difficulties to discern anthropological identity of burials, some attempts to reconstruct the funeral clothes were done (Hills *et al.* 1984, 17-28).

Brooch is the artefact category, which is most associated with the majority of fibres, having 44 textile associations over 85 textile finds in total. Moreover, brooches are associated with all types of clothing material, but leathery finds are an exception. Leather remains were found mostly attached to knives, and it is likely that their blades were covered by sheaths. Textile and leather fragments were discovered in 36 **graves 2, 3, 5, 8, 11, 12, 13, 14, 16, 17, 18, 19, 22, 23 1, 24, 26, 27, 28, 29, 31 1, 32, 36, 38, 39, 40, 41, 42, 44, 45, 46, 48, 49, 51, 56, 57** and **58** (Hills *et al.* 1984 22-28, 47-113). The majority of the graves contained more than a single textile or leather find.

Textile remains and associated clasps provided evidence for the original presence of brocaded cuffs in **grave 5** (Hills *et al.* 1984), which suggests the body was buried wearing a long sleeved gown. The cruciform brooch found in **grave 26** was likely fastening a cloak. Some of Spong Hill inhumations kept traces of Roman weaving techniques, showing continuity of native Romano-British textile technology into the Saxon period (Walton-Rogers 2007, 230).

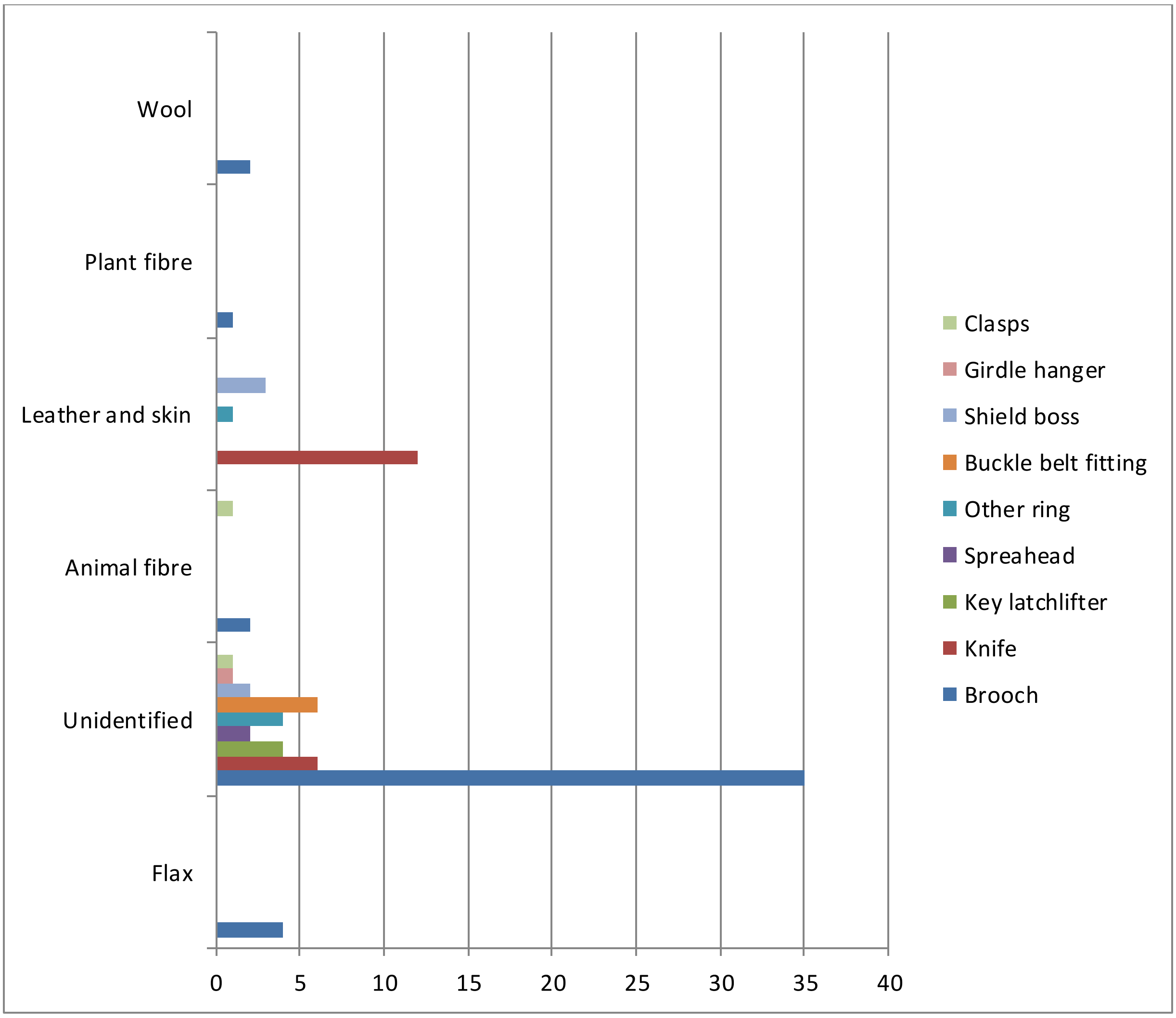


Figure 4.54: Spong Hill, association of clothing materials with selected objects in natural numbers.

4.13.4 Discussion

Ultimately, although preservation was bad, Spong Hill results provided excellent case studies because of its excavation conditions, analyses and published reports. It is a good example of early mixed East Anglian cemetery. The cremation ritual is the most represented, while inhumations are a minority. However, the low number of graves compared with urns seems not to be related with status differences.

The soil conditions were not ideal for organic preservation, because of the acidic pH and the sandy texture of the soil. Textiles were discovered in burials associated with metal fasteners or other metal artefacts. The number of fibrous finds is limited, mostly depending on mineralisation. Specialists analysed these fibrous remains, but their identification was rarely successful because of the extreme mineralisation. Among the identified fibres were wool, flax and leather. Some preservative aspects are in contrast with our theoretical knowledge of textile preservation. The acidic soil would be expected to preserve more wool than plant fibres, whereas the actual finds demonstrated an opposite trend. Moreover, mineralisation by copper alloy preserved more flax than woollen fibres. Leather finds occurred usually in association with iron objects. Specialists could reconstruct local female costumes from the metal fasteners and the fragmentary textile remains, while male and immature dress is more obscure. The women were wearing standard Saxon costumes, although the richness of their clothes was obscured by the aggressive soil.

4.14 Preservation of clothing material in Anglo-Saxon and Roman burials

The following sections debate the preservation of organic clothing evidence in the archaeological cases incorporated in this research. Moreover, it also includes consideration of the extent and influence that organic degradation can have in the archaeological record and consequently its effect on interpretations. Overall, 3874 inhumations from thirteen Anglo-Saxon and Roman cemeteries in Britain were reviewed, presented and investigated in this chapter.

In temperate regions, like England, preservation of organic fibres in archaeological contexts is not a common event, but it may occur under certain conditions that are influenced by intermingled factors. Here, some cultural and natural factors (ch. 2 and fig. 2.1, 2.24-2.25), which likely influenced fibre preservation, are discussed from a wide perspective to more detailed examples taken from the analysed cemeteries. Furthermore, some comparisons are provided with the archaeological and experimental contexts introduced in chapter 2.11, where it is relevant, especially those that were analysed by the author using SEM (ch. 2.11 tab. 2.3-2.7). Finally, there is a discussion of how the extent of preserved textile might influence archaeological interpretations.

Reviewing several sites demonstrated that the preservation of organics, namely textiles, has been underestimated, and as Janaway stated, "It is therefore of the utmost importance to assume that every metal artefact may have fibrous material adhering to it and to treat it accordingly" (1983, 48). In the same paper, Janaway defined the mechanisms of textile preservation in association with metal. His pioneering work based on SEM analyses commenced with his undergraduate thesis, and he immediately published some major points (Janaway 1983). He also illustrates the mechanisms of preservation of organic textiles with metal artefacts.

1. Metal ions preservation
2. Negative cast by metal corrosion products
3. Replacement by metal corrosion products
4. Combination of negative cast and replacement by metal corrosion products

Additionally, there are cases of pseudo-preservation, where textiles were not preserved at all, but traces, or impressions, of their original presence remained, leaving information in the archaeological record. Finally, rare cases of organic textile preservation are found. The bibliographical review included in this thesis highlights the occurrence of both alternatives: preserved textiles and indirect evidence of textiles in burials.

Roman and Anglo-Saxon fibrous finds were examined by a series of methods presented in archaeological reports and explained in detail in chapter 3. To sum up, these macro-features include selected soil characteristics such as soil type, texture, water movement and pH. Ritual factors, such as the presence of metal objects, coffins, depth of the burial, the position of the artefacts in relation to the bones, the type of fibres and so on, can also influence the preservation of organics. I am aware that these variables do not embrace all the possible factors that influence soil taphonomy and the preservation of organic clothing material, but the data referred to are more readily available in the literature and are more clearly defined and recognised among several sources of data that have been consulted for this research.

4.15 Impact of cultural factors on preservation of organic clothing materials

Concisely, burials are artificial environments created by human activity, where exogenous materials, such as a body or bodies, organic and inorganic grave goods, possible coffin, other possible fillings, are combined with endogenous soil. These new conditions, generated by a burial, dramatically change the previous soil environment, while they do not affect thermodynamic processes and degradation.

Among cultural factors, the presence of metal has the biggest impact in textile preservation. But other factors can also provide evidence for textiles but with minor influence. The preservation provided by mineralisation often provides good quality textile preservation, allowing fibre identification by microscopic examination. Beside metal replacement, other textile pseudo-preservations occur, but they are limited in their number of entries and in their quality of preserved evidence. These latter cases are usually related to the presence of a material easy to mark, such as plaster, or a hollow object, which could likely include organic fibre within it.

It has been stressed that preservation of fibres is the result of natural events and human actions, including rituals and other activities. They have a primary role in shaping and determining the burial environment. Below a list is given of the principal ritual factors that can influence clothing preservation, limited to evidence found in the case studies analysed in this work.

1. **Coverings and containers, such as coffin, slab, external structure.** They protect the burial from external decay factors in the first stages. Coffins create a system where biological,

chemical and physical circulation has more limited space than in burials without coffins. Coffins and coverings may give different preservative results depending on the materials and structures they were made from. Generally, coffins can protect their content from water drainage with a different degree of efficiency, depending on the type of coffin and its material. Similarly, they may also isolate their content from biological activities that run underneath. A coffined burial may have a different temperature and slightly more acidic pH, because of the body decomposition than the surrounding soil. Moreover, in the case of leaching, lead coffins may produce anaerobic environment through permanent waterlogging (Janaway 1993, 97).

Roman and Anglo-Saxon burials were often enclosed within wooden coffins, which were mostly degraded. In fact, cellulose and hemicellulose are affected by rapid biodegradation, while lignin decays more slowly (Crestini *et al.* 2009, 150). Another study about the cemetery North Brisbane Burial Ground, Brisbane, Australia, revealed that 6 per cent of 397 exhumed burials had their wooden coffin totally disappeared after 160 years from their first interment (Prangnell and McGowan 2009, 105).

Moreover, soil pressure is another factor of coffin breakage. For instance, larger coffins are more subject to soil pressure and wooden coffins are less resistant to the soil overburden than lead lined coffins (McGowan and Prangnell 2015).

Among the cemeteries included in the present study, little evidence of wooden coffin was discovered, because of the perishable nature of wood (Crestini *et al.* 2009). For example, at West Heslerton wooden coffins left organic stains in the soil (Haughton and Powlesland 1999; 1999a), while iron nails were revealing of original wooden coffins at Poundbury (Farwell and Molleson 1993) and Lankhills (Clarke 1979; Booth *et al.* 2010).

Stone and lead coffins are more resistant to decay. The first type is unlikely to be degraded by soil processes in a short time. The second type is resistant to biodegradation, but lead corrodes in presence of moisture and oxygen and when is attacked by acids (Umney 1992). When lead coffins are not affected by corrosion, they may offer some protection for organic remains. For example, Alington Avenue burial **grave 4378**, preserved fragments of textiles, with dye traces still identifiable, were attached to the bones (Davies *et al.* 2002, 158-159).

Other burial coverings or protections occur in the case studies here analysed. However, they are less frequent and mostly were slabs or mausolea. The majority of graves were found with coffin or other cover. The occurrence of textile finds preserved in coffined and un-coffined burials is reported in figure 4.55. These figures are tested with the chi-square test.

The result is p-value is < 0.005613. Thus, the null hypothesis is rejected. It is suggested that there is a negative correlation between coffined burials and preserved textiles.

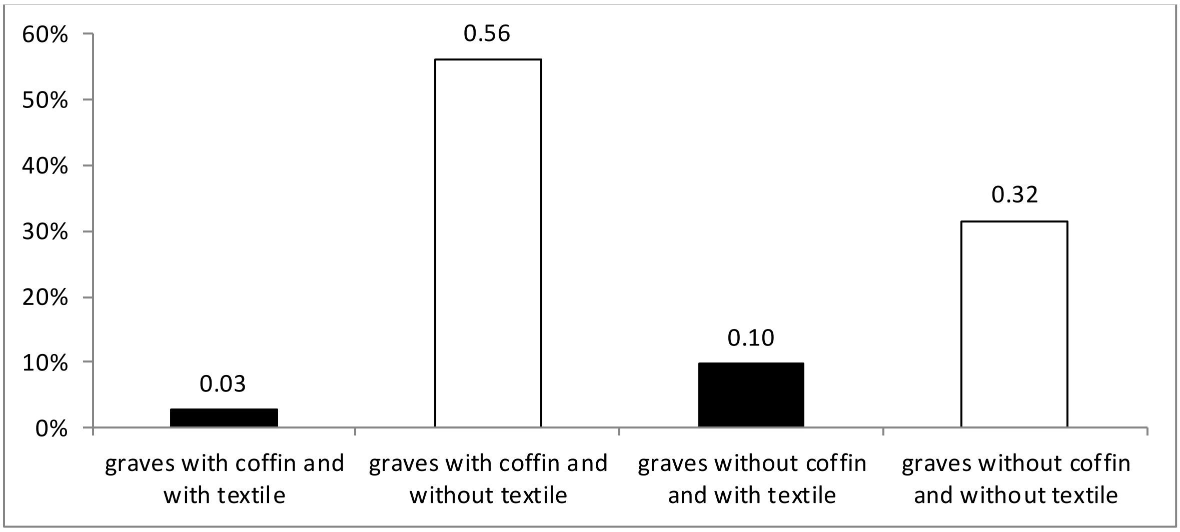


Figure 4.55: distribution of preserved textile finds in burials with coffins and other coverings and graves without coffin.

Experimental burials prepared by the InterArChive project at Heslington East, York (ch. 2.17), did not show particular differences in cotton fibre preservation between one coffined burial and the two that were without a coffin. In all three burials, cotton threads were observed still in good condition, whilst the weave structure was no more identifiable. Conversely, the two burials placed at Hovingham had a different result in cotton preservation. In fact, visible filamentous traces of cotton were detected in the coffined burial, whereas the burial without a coffin did not have any visible fibrous remains.

However, these results require further investigation. The type of coffin, whether is made in wood in lead or in another material, could produce different preservation of organics, as it was observed in the lead coffined burials at Alington Avenue (Davies *et al.* 2002) and at Spitalfields (Janaway 1993).

2. **Burial depth.** It is often stated that depth can influence burial taphonomy. Generally, it is assumed that shallow burials are more exposed to physical alteration, change in temperature and damaging from activities and events on the soil surface. Moreover, most of the soil biological activity is in upper soil layers (Lawson *et al.* 2000). Conversely, deep burials are more protected, especially if the burials are seasonally or permanently under the water table. In theory, this assumption seems likely. In reality, depth is biased mostly because often field archaeologists cannot know the original ground-level of burials. Hence, the burial depth is a factor that cannot be treated simplistically, but here it has attempted to evaluate whether a pattern is enclosed in the recorded data.

Figure 4.56 compares by frequency burials containing selected objects (ch. 3.6) with burials containing selected objects associated with preserved textiles according to different depth levels. Most of the preserved textile finds were found between 0 and 0.80 m depth.
The burials of all cemeteries are distributed across layers of 0.10 metres, where it was possible, starting from the surface until the deepest graves at 2.66 metres (Appendix 5 fig. 1-11).

Burial depth m	Graves with artefacts	Grave with artefacts and textile evidence
0.00 - 0.10	93	33
0.11-0.20	92	63
0.21-0.30	100	54
0.31-0.40	85	43
0.41-0.50	89	40
0.51-0.60	82	34
0.61-0.70	63	19
0.71-0.80	74	19
0.81-0.90	64	6
0.91-1.00	64	14
1.01-1.10	49	13
1.11-1.20	41	14
1.21-1.30	17	1
1.31-1.40	12	2
1.41-1.50	15	2
1.51-1.60	10	3
1.61-1.70	4	2
1.71-1.80	5	0
1.81-1.90	2	2
1.91-2.66	3	2

Figure 4.56: occurrence of textile finds in burials with and without grave objects at different depth ranges. Frequency of burial is reported within the columns.

Textile preservation seems to have a threshold at around 0.80 m depth (fig. 4.57). This result is tested statistically. The null hypothesis is that there is not association between burial depth and textile preservation, while the alternative hypothesis is that there an association between burial depth and textile preservation. The result of the calculation is X^2 22.585. The p-value is < 0.000001, which is statistically significant at $p < 0.05$. Therefore, the null hypothesis is rejected and the test shows that there is significant correlation between burial depth and fragmentary textile preservation.
As figure 4.57 reveals, that with significant difference nearly 30% textile finds occur in the shallower burials (0.00-0.80 m), while the deepest burials had textile finds in nearly 18% of burials.

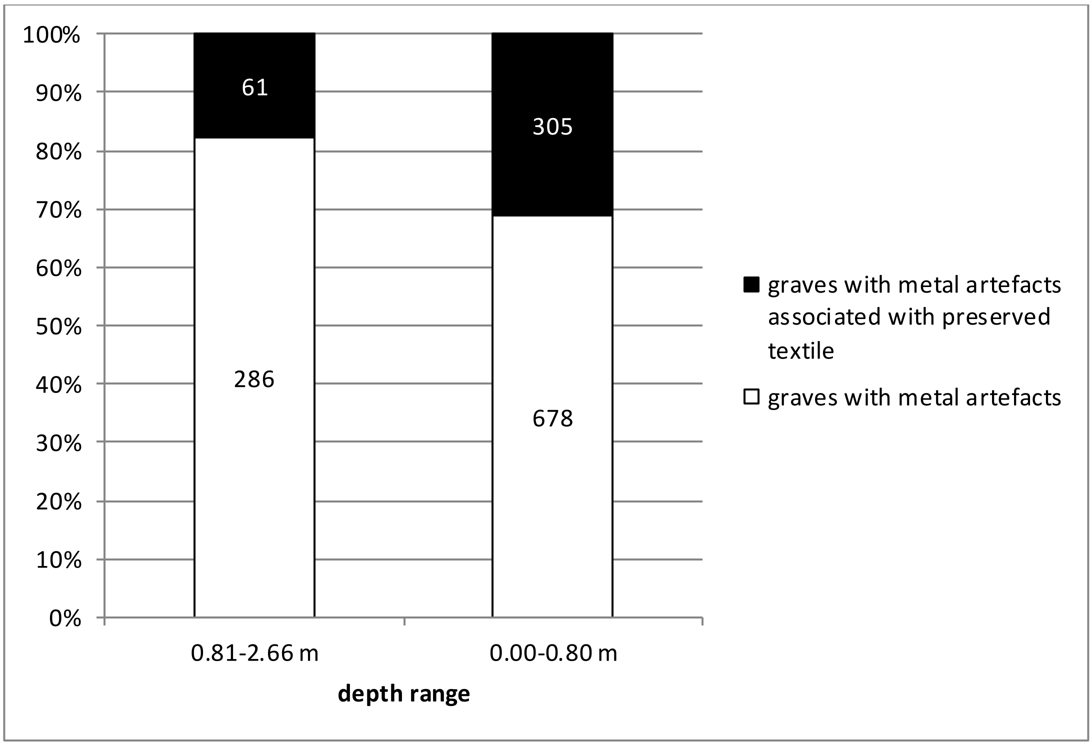


Figure 4.57: proportional distribution of textile finds in burials at two major depth ranges (metres); frequency of the finds is reported within the columns.

Spong Hill (Hills, Penn and Rickett 1984) and Eastern cemetery of London (Barber and Bowsher 2000) are not included in figures 4.56 and 4.57 because their depth measurements are not consistent with the other cemeteries.

These results may provide some likely explanations. Firstly, it is evident that most of the overall number of burials occurs mainly in the top layers rather than the deeper, increasing the chances of finding more textiles that are fragmentary, where the burials are more numerous. Secondly, it may occur that under a certain depth – e.g. 0.80 m – regardless of the soil type and the presence of metal, preservative factors are less effective. Whether the latter suggestion is correct or not, it should be investigated experimentally, to understand all physical, chemical and biological processes that occur under the limit of 0.80 m, comparing with the above layers.

3. **Grave goods material and position.** It has been questioned whether body decomposition has some effects on preservation of textiles in archaeological contexts. For instance, experimental forensic studies highlighted contrasting outcomes of degradation of clothing dressed by pig carcasses, but generally revealing good preservation of textiles (Lowe *et al.* 2013). The closer the textiles are to the body the more they can be affected by body decomposition, which slightly increases acidic pH and temperature and all around biological activity (ch. 2.17). Hence, the distance of clothing and other textiles from the body may

change the preservation of textiles. The illustrative data reported below (fig. 4.58) shows that usually there is difference in preserved textiles whether they were found on the body or not on the body. The observations collected in this research concur with the experiments of (Lowe *et al.* 2013).

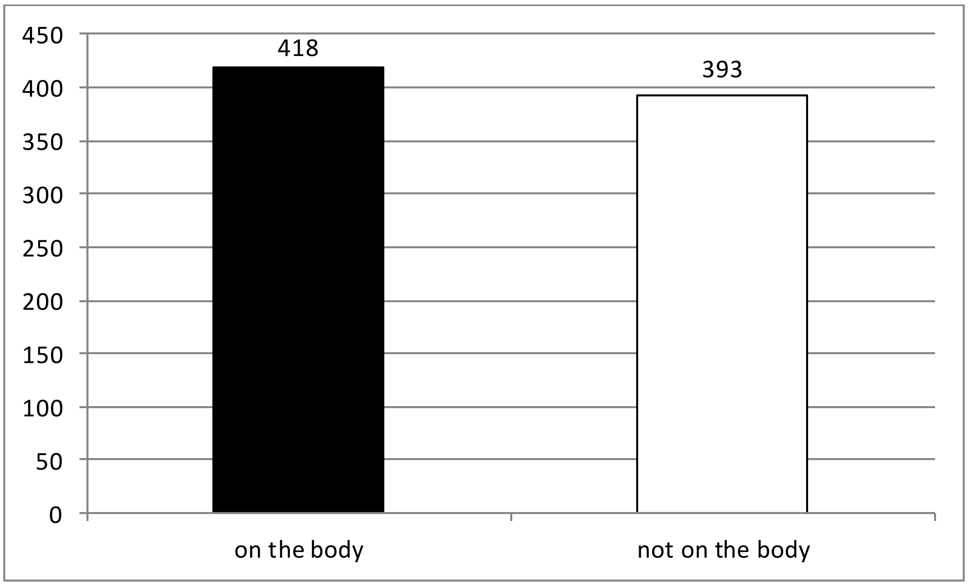


Figure 4.58: preservation of textile and leather finds on the body or not on the body, values are reported in raw numbers.

4. **Soil type.** It has been stated that the accent of the role of soils on body decomposition is exaggerated (Mant 1953). Nevertheless, clothing can be affected differently according to the soil type, recent experiments revealed different ranges of textile preservation in different soils (Wilson *et al.* 2007; Lowe *et al.* 2013). It is questioned if this observation is valid for archaeological textiles associated with metals.

   The distribution of fibrous finds associated with metal artefact types is shown in figure 4.59. Soils are defined by macro-features as defined by Avery (1990) and their meaning was discussed in chapter 3. Usually, the most effective textile preservation occurs with iron, followed by copper alloy, while preservation of organic textiles is less common with no metal preservation.

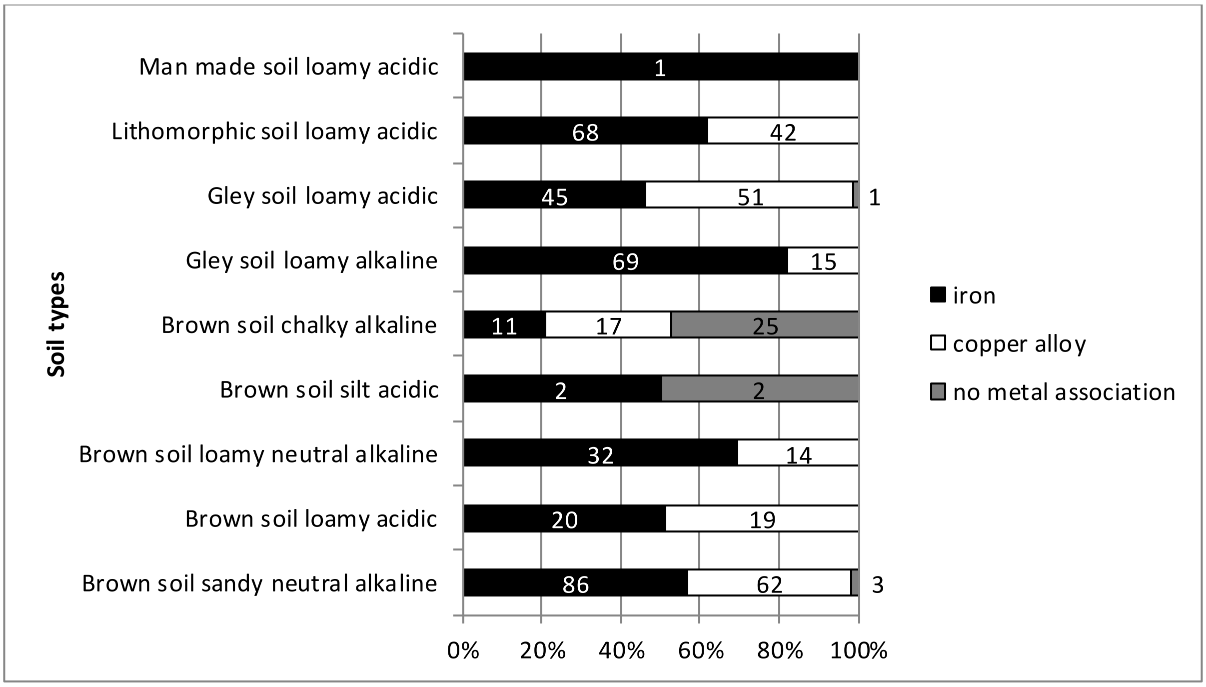


Figure 4.59: proportional distribution of fragmentary clothing finds associated with different soils and metals; frequency of the finds is reported within the bars.

In detail, preservation produced by iron objects is the most common mechanism of preservation in lithomorphic, loamy acidic soils (Butler's Field), man-made loamy acidic soil (Eastern Roman cemetery of London), gley loamy alkaline soils (Empingham II), brown loamy neutral-alkaline soils (Beckford A and B), brown sandy neutral-alkaline soils (West Heslerton). Preservation started by copper presence is more efficient in gley loamy acidic soils (Norton on Tees). Iron and copper have similar preservative effects in brown loamy acidic soils (Sewerby). Textile impressions without any direct association with metal artefacts are represented in brown chalky soils (Poundbury).

The cultural factors analysed above work in combination with natural factors. Hence, degradation can be physical, chemical and biological, and it always occurs. It may change its rate according to different factors. Below, a summary of principal natural factors abundantly described and discussed in chapter 2 are listed. These factors usually operate in combination, resulting in multivariate outcomes that cannot be reduced to simple patterns, but they are usually influenced by the textile fibre structure and composition and by the surrounding environment (ch. 2).

4.16 Textile mineralization

Fragmentary textiles and leather are usually numerically limited finds in the archaeological contexts examined in this research. However, to some extent they have been preserved. Preservation of textiles was influenced by different factors that in some cases operated in combination. Table 4.5

summarises data for each cemetery and it compares those graves that include grave objects and those that preserved textile finds with frequency and proportions.

Table 4.5: frequency and proportions (between parentheses) of graves containing grave objects listed in chapter 3.4.5, fragmentary textiles and leather.

Cemeteries	Inhumations	Inhumations containing selected grave objects	Inhumations containing textile fibres and leather evidence
1 West Heslerton	185	126 (68.1)	114 (61.6)
2 Spong Hill	59	41 (69.4)	36 (61)
3 Butler's Field	223	130 (58.2)	89 (39.9)
4 Empingham II	154	117 (75.9)	74 (48)
5 Beckford A	28	24 (85.7)	14 (50)
6 Alton	50	35 (70)	18 (36)
7 Norton on Tees	126	79 (62.6)	40 (31.7)
8 Sewerby	60	35 (58.3)	15 (25)
9 Beckford B	109	76 (69.7)	28 (25.6)
10 Poundbury	1410	94 (6.6)	23 (1.6)
11 Alington Avenue	98	44 (44.8)	4 (4)
12 Lankhills	761	321 (42.1)	26 (3.4)
13 Eastern Roman cemetery London	608	62 (10.1)	1 (0.1)

Figure 4.60 displays the frequency and the proportional differences between graves that contained metal objects and those that contained metal objects and textile and leather finds. Textile and leather finds are strongly connected with metal objects (fig. 6.15; tab. 6.4). The Anglo-Saxon cemeteries have high proportion of textile finds associated with metal objects. However, Anglo-Saxon cemeteries do not have homogenous results. West Heslerton and Spong Hill have the highest representations, while the other sites show moderate association between textile preservation and metal objects. The Roman cemeteries show little association between metal object and textile finds. Hence, Roman and Anglo-Saxon burials are distinct in term of mineralisation of textile. It is well-known that usually Roman inhumations contained few metal artefacts and most of the metal grave objects were hobnails, which were not in contact with textiles.

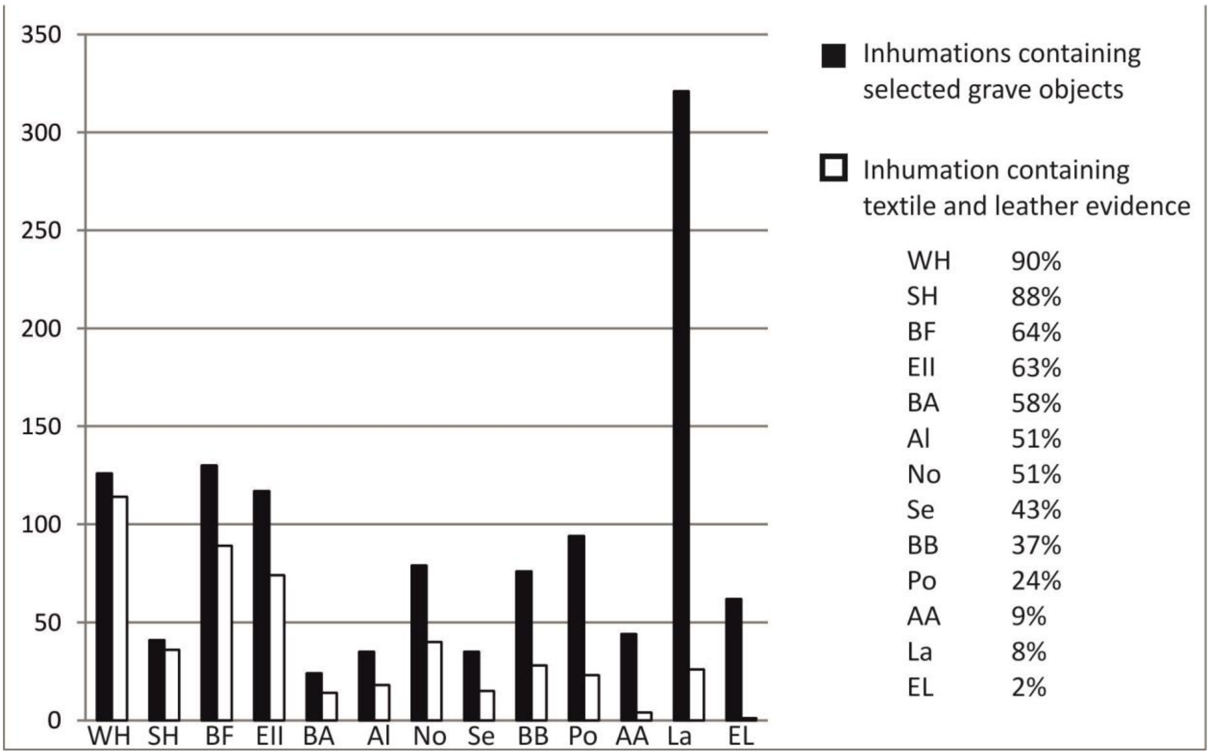


Figure 4.60: occurrence of fibres and leather fragments compared with grave objects listed in chapter 3.4.5 in the cemeteries. Sites abbreviations: WH (West Heslerton); SH (Spong Hill); BF (Butler's Field); EII (Empingham II); BA (Beckford A); Al (Alton); No (Norton on Tees); Se (Sewerby); BB (Beckford B); Po (Poundbury); AA (Alington Avenue); La (Lankhills); EL (Eastern Roman cemetery London).

The concept of mineralisation (ch. 2.12) includes different processes already discussed in the archaeological literature. In the examined sites, mineralisation usually means the process of metal replacement of textile fibres, or leather, by inorganic elements, usually iron or copper corrosion products. This is reported in the seminal article by Keepax (1975), who examined by SEM the stages of metal replacement of wood with iron corrosion products.

Replacement by iron corrosion products is the most common form of textile preservation among the case studies analysed in this work (fig. 4.61). It occurs both in Roman and Anglo-Saxon cemeteries in different soil conditions, usually because funeral rituals might include iron objects in the inhumations, close to the textiles. It is shown that total replacement of textile fibres by substances other than metals can happen (Gleba and Griffiths 2011-12), but it is extremely rare and it has not been found in the present case studies.

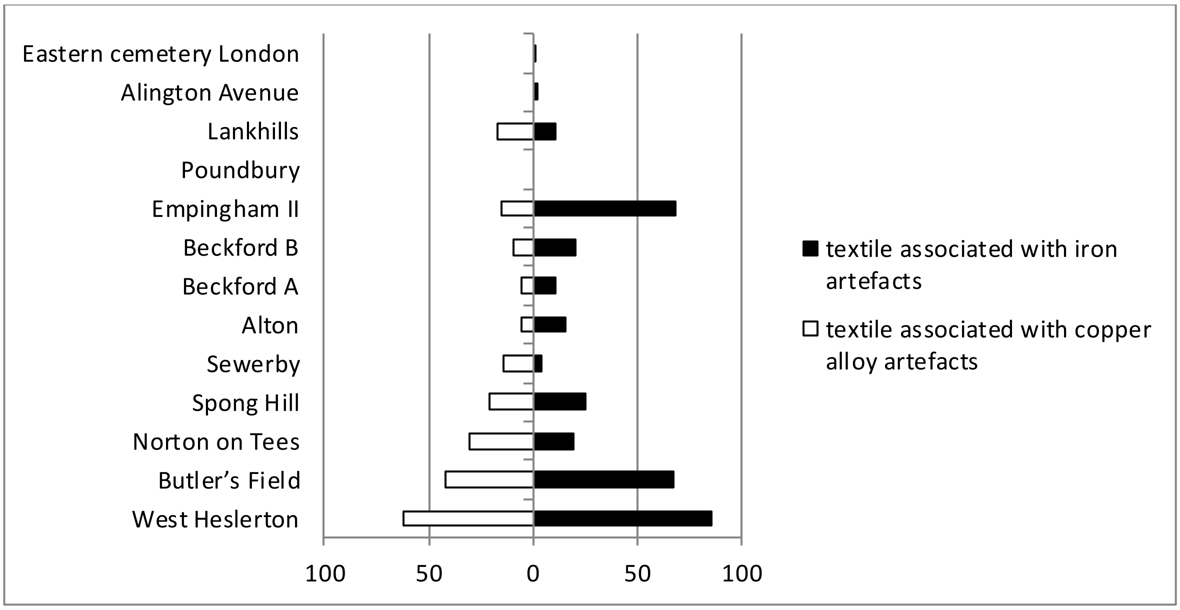


Figure 4.61: association between grave objects and preserved fibres in natural numbers.

When soil conditions facilitate fast metal corrosion, it is likely that organic materials, comprising textiles and leather can easily survive. Metal salts are restrictive to microorganism survival and while some metal can replace organic matter, like iron, other oxidising metals tend to produce a superficial protective layer. Usually, iron corrodes faster than other metals and it can completely replace organic structures (Janaway 1983). This phenomenon has two important outcomes from a preservative point of view. Firstly, it creates textile pseudomorphs, which are resistant to physical, chemical and biological degradation. Secondly, it can affect a complete identification when the organic structure is entirely replaced.

4.16.1 West Heslerton

Numerous burials from the Anglian cemetery of West Heslerton contained textile fragments attached to selected iron grave objects (Haughton and Powlesland 1999; 1999a). As it has been reported above (ch. 4.6.1), soil taphonomy of West Heslerton was particularly aggressive to human bones and many organic materials. Usually, the burials contained few and poorly preserved bones, while there were numerous burials containing organic stains, often mirroring accurately the shape of the bodies. Neither containers nor lids protected the majority of burials, while limited coffins were found totally degraded as organic stains. There was significant difference in textile preservation between graves protected by a wooden coffin, and those that were not (fig. 4.55). However, the InterArChive experimental burials made at West Heslerton had similar results. During the exhumation of the three piglet burials (ch. 2.17), direct examination confirmed that there was no visible difference in organic preservation between the one coffined and the other two un-coffined burials at a macroscopic level.

Conversely, this cemetery produced an interesting number of mineralised organic finds (fig. 4.65). This is partially due to the excavation strategy (Haughton and Powlesland 1999; 1999a) that produced large number of soil blocks carefully examined in the lab. Moreover, sandy soil, and probable acidic pH accelerated metal corrosion allowing fast preservation of organics close to areas impregnated with metal salts. The rate of metal corrosion was faster than biological degradation, as Janaway described (1983). The Anglo-Saxon cemetery at Christchurch, Dorset (Jarvis 1983) offers a good parallel with the organic finds of West Heslerton. Christchurch was partially excavated between 1977 and 1978. The soil had an acidic pH and the local burial ritual provided some of the 30 excavated graves with wooden coffins. The poor preservation of bones is another analogy between Christchurch burials and West Heslerton. In some cases, graves did not protect bones at all, and in other cases dark stains were found in place of the skeletons (Jarvis 1983, 113-130). These aggressive conditions produced an environment similar to West Heslerton. Quick corrosion of metal artefacts included in the graves was initiated and it inhibited microbial activity, preserving materials such as wood, leather, textile in the form of pseudomorphs (Jarvis 1983, 113). SEM analyses confirmed the preserved fibres to be based on proteins, so they were of animal origin. Hence, the retrieved fragmentary textiles at Christchurch were likely to have been wool or other animal hair.

4.16.2 Butler's Field, Lechlade

Textile pseudomorphs produced by iron corrosion products were discovered at Butler's Field, Lechlade. Soil macro-features are different from those recorded in West Heslerton, except for the acidic pH, which occurs in both sites, at least in modern surveys. Coffins were not a common ritual in this site. There were over 223 inhumations, but only two graves protected by coffins (**inhumations 18** and **92**), and another 17 were covered with stone slabs. At Butler's Field, preservation of textile by iron replacement has a similar occurrence to West Heslerton in almost all categories, except for identified woollen and plant fibres, which have higher numbers in West Heslerton (fig. 4.65).

The two coffined burials produced preserved textiles attached to iron objects. However, the low number of coffins does not make a significant difference in textile preservation between these burials and those, which were without a coffin. It is assumed that even in this site, the acidic pH and moisture had facilitated fast corrosion of metal grave objects, which accelerated the process of metal replacement of preserved textile and leather fragments. From a macroscopic perspective, this cemetery is illustrative of the limited influence of coffins in textile preservation.

4.16.3 Grave 70, Norton on Tees

Animal fibres other than wool, like silk, were occasional finds. Its low frequency is caused primarily by the archaeological contexts that are investigated. In fact, silk was a precious and rare fibre textile during Roman and Anglo-Saxon times. It was likely produced in the Mediterranean basin during Classical Antiquity, but most of the silk moved into Europe by a long series of trade routes (ch. 2.4). Secondly, silk may be less resistant than other animal fibres, like wool, to the environmental conditions that existed on the sites examined. Apart from the likely silk finds from Poundbury (see below), a possible silk find was in **grave 70** of the Anglo-Saxon cemetery at Norton on Tees, Cleveland (Sherlock and Welch 1992, 61). This specimen is illustrative of the preservation of silk thread in the environment produced by the **grave 70** of Norton-on-Tees.

A mineralised textile fragment was attached to a copper alloy brooch (Sherlock and Welch 1992, 169-171; **grave 70**, 10). The process of metal replacement was complete and the identification of the fibre was not possible by chemical or microscopic analyses. The weaving technique was fairly well preserved, and it showed clearly a pattern of brocading weft. The external appearance of the threads was described as uncurl and fine (Sherlock and Welch 1992, 61). These clues suggest that these threads were likely silk.

The micro-environment produced by these burials did not offer good organic preservation. For example, bones were not found at all. This cemetery has different soil characteristics from West Heslerton, but these do not seem to have influenced the process of metal replacement of fibre textiles. However, it is suggested that the numerous metal artefacts accompanying this burial initiated fast corrosion and metal movement that mineralised different fragments of textile attached to metal objects.

4.17 High toxic content, metal ions movement

Direct contact with metal objects is the event that results in most of the preserved textile, but there are other mechanisms of preservation, which do not require this connection (tab. 4.6). In chapter 2, some factors were described in detail that can inhibit biological activity because they generate a poisonous environment. Janaway (1983) demonstrated that copper and copper alloy artefacts under the right conditions could release toxic salts, which protect organic matter, like natural textiles, from bacteria and fungi. Copper and other metals, like lead, are more resistant to corrosion than iron. Moreover, they keep textile features, which are easier to identify by microscopic examination.

Table 4.6: preserved textile fibres not directly in contact with metal objects.

Cemeteries	Textile evidence not directly associated with metal	Type of textile	Preservation	Association
West Heslerton	graves 55, 132, 152	unidentified; wool	metal replacement	None
Norton on Tees	grave 86	unidentified	metal replacement	None
Poundbury	graves 6, 8, 9, 49, 99, 114, 376, 478, 514, 517, 525, 529, 530, 817, 858, 862, 864, 867, 868, 869, 1012, 1060, 1127, 1215	unidentified, likely silk; unidentified	consumed; impressions	gold (thread shape); calcium sulphate
Lankhills	grave 155	leather	metal replacement	None
Alington Avenue	graves 2613, 4378	unidentified; wool and leather	metal replacement	None

Several metals can contaminate soil and water (Evangelou 1998, 484-489) and affect biological activity (Brookes and McGrath, 1984; Aka and Darici 2004). The natural occurrence of these metals in soil is usually not sufficient to affect biota, while the human addition of these elements can seriously influence the chemistry underground (Nwachukwu and Pulford 2011).

Another example of likely textile preservation by metal poisoning is the silk found in Lady Dai's tomb (Buck 1975; Appendix 2). It was filled with a liquid mixture containing mercury. This suggests toxic metals can efficiently preserve textiles. Few case studies analysed by this work indicate that textiles were preserved by this mechanism initiated by the presence of copper and lead in burials. Archaeologically, copper toxicity can be ascribed to the presence of grave goods made in copper alloy. These objects were common in historical contexts and were buried in inhumations by both Anglo-Saxons and Romans to a lesser extent. The toxic effects of copper have been studied widely. Copper can radically reduce respiration and metabolism in several microorganisms (Flemming and Trevors 1989).

Lead can inhibit soil respiration in different soil textures, like sandy soils and clay soils, while it does not affect peat (Brookes and McGrath, 1984; Konoka *et al.* 1999; Aka and Darici 2004; Nwachukwu and Pulford 2011). Therefore, some types of bacteria and microflora are seriously affected by lead concentrations. Moreover, it has been observed that lead also has a certain retardant effect on the decomposition of organic compounds in sandy soils (Doelman and Haanstra 1979; 1979a; 1979b).

Textile preservation by lead occurs in burials with lead coffins, but the process is not fully assessed (Janaway 1993, 97).

4.17.1 Copper toxicity likely evidence

Grave 152 of West Heslerton (Haughton and Powlesland 1999a, 264-269) may represent one of the most impressive cases of textile and leather preservation by copper toxicity. Large organic stains were identified on the soil during the excavation, around the area of the shoulders and the back of her body. An adult female individual was buried and her bones had mainly decomposed, with only a few poorly preserved ones surviving. The grave did not have any sign of coffin or covering, and the burial seemed to lay in direct contact with the ground, which has a sandy texture, and facilitated water drainage (ch. 4.6). Soil characteristics and cultural features do apparently encourage good extensive metal corrosion. The proportion of metal buried in West Heslerton soil was easily corroded, starting quick reactions and impregnating the soil with metal salts (Haughton and Powlesland 1999). Preservation of textiles, and other organics, occurred from both iron and copper alloy corrosions.

The excavation strategy of collecting soil blocks from the site and scanning with X-rays and excavating in the laboratory was crucial to obtain all impressive finds, it was clearly stated "it is mostly unlikely that some of the more exceptional detail on the organic material from the graves could have been retrieved without this removal technique" (Haughton and Powlesland 1999, 21). The soil block 909 contained different objects, which were assumed to be part of a purse or a bag. There were two copper alloy girdle hangers, three iron latchlifters, an iron knife, some fragmentary copper alloy lace tags and a fragmentary ivory purse ring. Textile preservation was not limited to direct contact with the metal objects included in the block (Haughton and Powlesland 1999a, 268 fig 2BA909AH-AQ; BC). Figures included in the original report and re-published here (ch. 4.6) show the degree of preservation of these fragments. Further analyses, in the laboratory, identified some of the fibres as wool, while others were not identified because of the deep mineralisation.

Here, it is suggested that this grave produced the right conditions for different mechanisms of organic preservation. The high concentration of copper alloy artefacts and the aggressive acidic soil conditions produced one of those environments. The rate of copper corrosion was fast and spread sufficiently to inhibit microbial attack and preserve textiles to an unusual extent, as demonstrated by Janaway (1985).

Grave 19 of Sewerby (Hirst 1985, 49-50, 59) shows another interesting feature of organic preservation. Overall, metal fasteners were interpreted as part of an adult female costume, even if the bones belonged to a male individual (Hirst 1985, 33). Moreover, metal fasteners in this grave, three brooches, a buckle and a belt fitting, were associated with preserved textiles. It seems likely that copper objects, especially the brooch number 4, a square headed brooch in gilded bronze, started the mechanism of preservation (Hirst 1985, 59). This textile was identified and analysed by low power binocular microscopy (Appleyard in Hirst 1985, 54-55). The examination distinguished three different types of animal fibre on the front side of the brooch. One type of fibre was lacking cuticular scales and another one had the resemblance of fur. It was not possible to establish for sure whether fur was included in the garment.

On the back of the square-headed brooch and the two minor brooches placed at the shoulders, flax textiles were preserved. Therefore, it was assumed that the individual was wearing multiple layers of costume, likely a vest covered by a cloak (Crowfoot in Hirst 1985, 54). On brooch number 4, a grass stem was adhered. The presence of plant material adhering to the metal fastener is indicative of the absence of a coffin. This grass might be the remnant part of a floral tribute, left on the chest of the dead or the remains of grass cover over the burial. The latter assumption finds some links with the practise of grass burials in Western Europe. On the Continent, similar burials dated from the 4th century AD to the Merovingian period, appear to have grass shrouds to cover the body and avoid direct contact with the earth (Salin 1952, 128-131).

If the last suggestion is correct, a shroud of grass covered the burial, where copper salt ions likely had the right conditions to contaminate the area close to the brooch and preserve organic matter. The absence of coffin and the high concentration of plant material might activate high degradation, because it attracts biota. At the same time, a cover of grass could facilitate water drainage and accelerate metal corrosion and ion movements, which obstructed biological activities.

Grave 35 of Sewerby produced contrasting evidence of textile associated with a copper object (Hirst 1985). This burial included some copper fasteners as a part of the costume, and few of them had fragments of textiles. However, unlike the cases of West Heslerton discussed above, here metal replacement occurred instead of preservation of the fibre through metal toxicity. The replaced material was analysed without positive identification. “In the sample 35/11 it was clear that the substance which had replaced the fibres was almost in fine crystalline form. It is certainly interesting to see how the yarns still retained their fibrous appearance” (Appleyard in Hirst 1985, 55). The comment reveals how the structure was preserved perfectly, but the actual fibre was completely substituted by an unidentified material.

4.18. Anaerobic preservation

Lead lined coffin burials, irregularly packed with gypsum or plaster (Toller 1977, 14), were a feature of late Roman cemeteries (Toller 1977). This type of coffin seems to be limited to urban sites and those with a privileged status in rural contexts (Toller 1977, 2-4; Philpott 1991, 53). Archaeological textiles are found in these coffins that can produce anaerobic and preserving conditions (Janaway 1993; ch. 2.14).

Grave 4378 of Alington Avenue (Davies *et al.* 2002, 135) is one of the best examples of preserved fragmentary textiles found within a lead-lined wooden coffin. The grave belonged to a juvenile individual of high status. The social interpretation is widely based on the preserved textile fragments (ch. 4.4.4). This is a rare case of textile preserved without direct contact with metal objects, while the lead could actually contaminate the internal environment of the burial, reducing biological activity in parts of the coffin. This cemetery did not preserve large amounts of textile; and this is the only one in which the lead coffin may have preserved organic textile (fig. 4.5-6). Even if the textiles were in a fragmentary condition, their quality was still good and allowed identification of material and also a dye (Crowfoot in Davies *et al.* 2002, 158; Walton-Rogers in Davies *et al.* 2002, 159).

Other burials in the same cemetery produced preserved textiles and leather fragments as a result of contact with metal artefacts (**graves 785** and **3664b**) (fig. 4.7). Here, the lead might have raised the soil toxicity, limiting soil respiration and then biological activity.

Grave 3664b of Alington Avenue was protected by a sandstone lid and a wooden coffin and it was packed with gypsum (Davies *et al.* 2002, 133). Leather fragments were associated with iron nails of footwear (fig. 4.7). The report does not describe properly the mechanism of preservation, but it is likely that the leather was preserved by mineralisation rather than other events.

4.19 Textile impressions

Textiles and other organic materials can be recorded in archaeological contexts by indirect evidence. It is the case with textile impressions on plaster or other materials, where textiles had adhered to plaster by the time of decomposition, had left marks of their original presence on the surface of those materials. Some cases of textile impressions have been referred to such sites as the Agora, Athens (Unruh 2007; Appendix 2) and in the bronze vessels in Kazakhstan ((Doumani and Frachetti 2012: Appendix 2).

Potentially, all materials and soils high in calcium content are readily susceptible to this process. This mechanism can cast features at a high level of resolution, and is helpful in different fields from sculpture to dentistry. This phenomenon has also an impact on the archaeological record, not only for textiles but also in a wider context. For example, an archaeological study on calcified soils revealed the formation of arthropod fossils by calcium carbonate replacement (Girling 1979).

In the archaeological contexts considered in this work, calcareous replacement and imprinting occurred in the so-called plaster or lime burials. This category of burials spread across the Roman Empire by the 3rd and 4th century AD (Philpott 1991, 91) and it consists in inhumation burials where coffins have been filled with plaster. However, archaeological literature shows a certain degree of inaccuracy in referring to "plaster" burials (Philpott 1991, 90). The term "plaster" gathers together all these graves (Green 1977, 51) that cannot be defined better without further analyses (Philpott 1991, 90).

The use of lime in burials is extremely ancient. For example, it is well known that the Egyptians made plaster masks of the dead and this practice was continued until Roman times (Rune 2010). The principal component of plaster is lime, which contains calcium and other inorganic constituents. Lime derives from calcium carbonate, such as limestone and it can occur in different forms, like quicklime and hydrated lime (Schotsmans *et al.* 2012, 51, fig. 1). The cycle of the lime is well explained by Schotsmans *et al.* (2012, 51, fig. 1; 2014, 141.e2, fig. 1). If limestone or calcium carbonate is heated at 800 ^{0}C, there is a loss of carbon dioxide. This process is called calcination. Consequently, quicklime is the result of calcination. Quicklime can absorb water promptly. If water is added to quicklime, an exothermic reaction changes quicklime into calcium hydroxide. Calcium hydroxide reacts with carbon dioxide and becomes harder in the process, which is called carbonation. Calcium hydroxide absorbs carbon dioxide and depletes water turning into limestone again (Schotsmans *et al.* 2012, 51, fig. 1) (fig. 4.62).

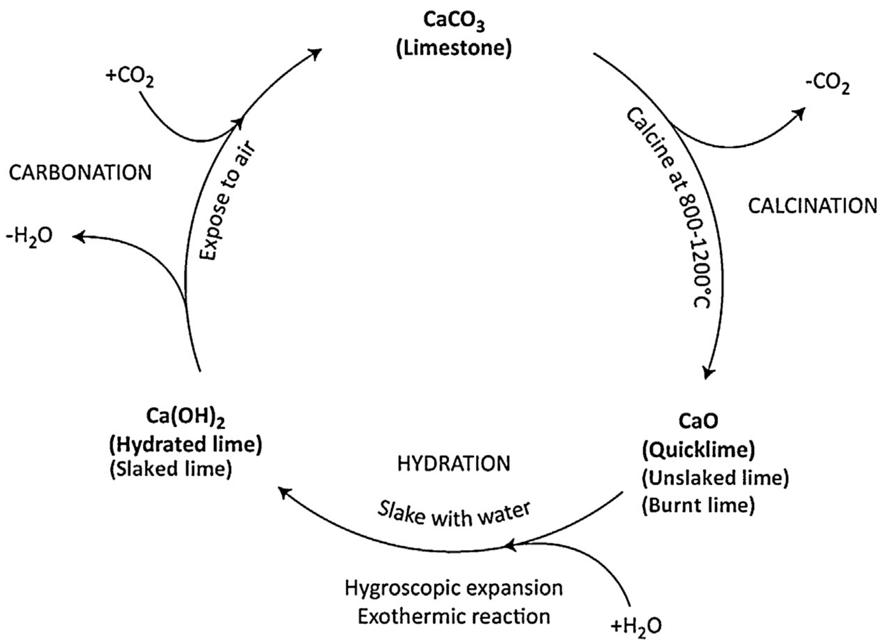


Figure 4.62: the lime cycle (Schotsmans *et al.* 2014 fig. 1, Copyright © 2014 Published by Elsevier Ireland Ltd).

The absence of standard chemical analyses on plaster burials results in terminological imprecisions. Moreover, there is the possibility that gypsum plaster influenced by significant moisture can be turned into gypsum, misleading archaeological interpretations. Consequently, the low representation of plaster figures in wooden coffins might be the result of the inability of these containers to keep the plaster intact (Philpott 1991, 90), while lead or stone coffins could obstruct plaster dissolution.

There were some possible options to packing coffins with plaster. Below, the list summarises the possible techniques for filling coffins. Ramm (1958, 405) provided the first three points and Ward-Perkins (1938) and Philpott (1991, 90) suggested the fourth (fig. 4.63).

a) Making a full cast by pouring liquid gypsum into the burial, covering the body.

b) Pouring sufficient gypsum to cover the shrouded body with a thin layer.

c) Incomplete cast of gypsum placed with gravel.

d) Textile impressions are cast in the hemihydrate powder, which is highly soluble and can be converted into plaster by accidental leaching.

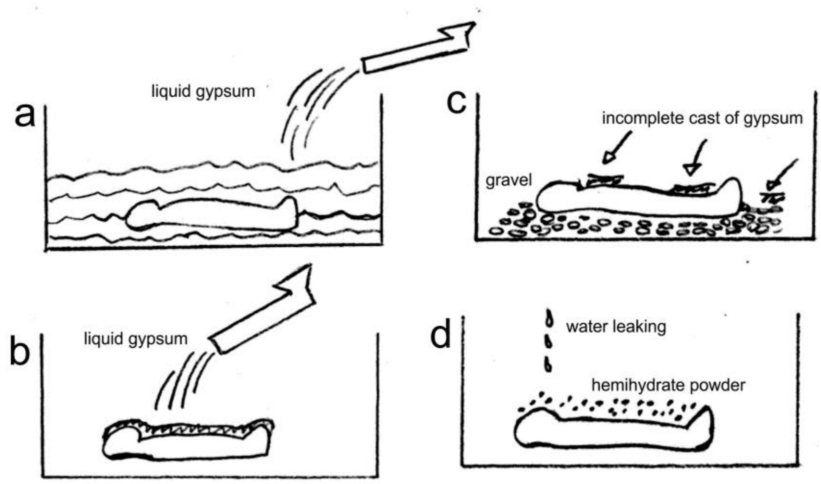


Figure 4.63: hypothetical explanations of Roman "gypsum burials" according to Ward-Perkins (1938) and Philpott (1991); figures of the author.

Among the case studies included in this research, the Roman cemetery of Poundbury included some coffins packed with plaster, which produced impressions of textiles (tab. 4.6). Only a few graves, considered in this work, were filled with plaster, but they did not preserve impressions. It is generally assumed that this type of burial has good organic preservation. However, not all 27 lead coffins packed with gypsum at Poundbury offered ideal conditions for bone preservation, and in some cases bones were severely damaged (Farwell and Molleson 1993, 151).

Nevertheless, plaster was marked by superficial contact with the textiles that were covering the bodies. Hence, plaster did not actually preserve the fibres, but their impressions were kept on the surface of gypsum/plaster. However, it is difficult to understand whether the impressions left on the fragmentary plaster of Poundbury graves were shrouds or clothing. Moreover, it is also difficult to understand what type of fibre was impressed on the plaster. Usually, it is identified as flax (Crowfoot 1993, 111-112), by comparison with other archaeological contexts. This identification is likely but not entirely convincing, in the absence of samples that can be examined by microscopy and chemical analyses.

Plaster burials with textile impressions occurred in the other Roman cemeteries, such as Lankhills (Crowfoot 1979, 329-331), London (Green 1979, 51-52) and York (Wild 1970, 95-96). The function of plaster burials has been considered as having at least two possible purposes. Plaster can absorb liquids produced during putrefaction and it reduces the initial phases of decomposition (Schotsmans *et al.* 2012; 2014; 2014a). Plaster burials, which were proportionally a minority in Roman cemeteries, have been linked with Christianity and the idea of physical preservation (Green 1977, 48; Philpott 1991, 93). This ritual seems to have begun in Northern Africa and then spread into other provinces of the Empire. The early Christians wanted to preserve their bodies for the Last Judgment and the resurrection (Green 1977, 48; Thomas 1981, 228-229; Philpott 1991, 93). However, by the time plaster filled coffins were considered a sign of Christian ritual; it was criticized, with other features previously considered as indicative of Christian burial (Philpott 1991, 94; Garcia 2010, 170-206; Watts 1991).

Whether or not these practises were actually good preservation techniques (Philpott 1991, 92), plaster filled graves did preserve textile impressions. A good example is the fragmentary impressions found at Poundbury. It is not possible to tell for sure whether the textile was wool, or flax based. During late Roman period, covering bodies with shrouds was a documented practice (Martorelli 2000) and those shrouds were made of linen (Crowfoot 1979). However, we cannot assume shrouds were the only ritual covering for bodies. At Poundbury, there are limited clues that suggest some burials might have been clothed. For instance, **grave 530** preserved a woollen hairband (Crowfoot 1993, 111). Moreover, **grave 99** contained golden thread found close to the left foot (Crowfoot 1993, 112), and although it is not possible to tell whether this was a fully clothed burial, it certainly included a vest. Although we cannot assume that all shrouds were exclusively made of linen, this was the most popular choice for a shroud (Crowfoot 1979). The impression of textile on gypsum cannot provide a reliable identification of fibres.

4.19.1 Further comments on lead-lined coffin packed with plaster

Lead coffins packed with plaster or gypsum are a special environmental niche, where fragmentary evidence of textile are preserved or as impressions or, more rarely, as actual fibrous materials. Some of the burials of Poundbury and Alington Avenue, reported above, are illustrative of these possibilities. It is highly likely that the two factors 1) lead coffin 2) plaster packing, work in combination in order to occasionally preserve textile evidence.

During building foundation work at Crown Buildings site, Dorchester, a group of graves was discovered, and one of them was a lead coffined burial, which was carefully examined (Sparey-Green *et al.* 1982). This burial was protected by a lead coffin, likely encased in a wooden coffin, which did not leave traces, and finally it was packed with plaster gypsum. This burial is useful as it reveals several preservative processes enclosed in the same restricted environment. In fact, this burial contained bones of a young adult man, which was well-preserved but brittle. On the surface of the plaster, textile impressions were preserved and the burial also contained well-preserved human hair (Sparey-Green *et al.* 1982, 81-89).

If we consider human hair as similar in structure to animal hair, with the surface covered by cuticular scales and innermost layer comprised of medulla, we can compare different degrees of preservation in animal and plant fibres. The Crown Buildings site burial was well-examined in different aspects. The lead coffin was analysed by spectroscopy, X-ray diffraction and infrared analysis (Sparey-Green *et al.* 1982, 70-72. A stain of organic origin was found on the bottom of the coffin, but it was not successfully identified (Sparey-Green *et al.* 1982, 70-72). The study of this burial produced analyses on the packing material included in the lead coffin (Sparey-Green *et al.* 1982, 75-76). The packing material was mostly rehydrated microcrystalline gypsum (Sparey-Green *et al.* 1982, 74-75). Some plaster samples were collected from the abdomen area in order to test for possible organic traces. Two incisor teeth and two erupted seed or egg cases, together with fragments of grass were included in the samples (Sparey-Green *et al.* 1982). Moreover, the examinations found worm casts in the samples, which is symptomatic of soil contaminated by a burial (Sparey-Green *et al.* 1982). Microscopic identifications were not entirely clear.

The fibrous impressions found on one of the gypsum samples were examined by Crowfoot (1993) and Cox (in Sparey-Green *et al.* 1982, 76-77). These impressions were compared with similar cases from England, which were rare at that time, and from the Continent. It was suggested they were impressions of flax fibres making part of a shroud as the marks embraced the body. Hence, the fibres of likely plant origin were preserved just as impressions, while the human hair was well-preserved as seen by the naked eye. Forensic analyses were undertaken on the human “head” hair and plait (Sparey-Green *et al.* 1982, 81-89). Gypsum was covering the hair, but after cleaning it, microscopic observations revealed that some hair samples had eroded cuticles, while other samples were well-preserved. Additionally, signs of possible fungal and bacterial activity were discovered in the medulla (Sparey-Green *et al.* 1982, 91). Chemical analyses showed that these samples had a high calcium content, which was likely absorbed from the gypsum, and an interesting concentration of nickel, even if in lower quantities than the calcium (Sparey-Green *et al.* 1982). There was not another explanation for the presence of nickel; and it was suggested that nickel was present in the hair before the burial. Conversely, no lead traces were found in the hair, while lead traces were found on the skull. The plait hair of Crown Buildings site has been recently examined for presence of resinous substances (Brettell *et al.* 2015). This analysis reveals traces of animal fats and plant oils that could be applied on the hair of the dead (Brettell *et al.* 2015, 643), which suggests possible ritual unguent.

The study of Cox (Sparey-Green *et al.* 1982, 95-96) was very critical about definitions of gypsum plaster that are in the archaeological literature, because of the difficulties of tracking down the process of production of that material.

They suggested three possibilities for the use of gypsum:

1. Crushed natural gypsum spread over the body.
2. Calcined gypsum, as powder, spread over the body.
3. Calcined gypsum and water, cast over the body.

Here, this case study seems to suggest that toxic metals, like lead, copper, nickel, mercury and antimony, which have an inhibitory effect on biota, were present in the hair. It is unclear whether at least one of these metals was used on the hair as a cosmetic or in the burial (Sparey-Green *et al.* 1982, 99).

A recent experimental study (Schotsmans *et al.* 2012; 2014; 2014a) clarifies several aspects of lime packed burials and their effect on cadaver decomposition. The experiments used juvenile pigs as human body analogues and examined the process of decomposition in the time range of 6, 17 and 42 months (Schotsmans *et al.* 2014a, 142.e2), comparing the results of burials packed with quicklime, burials packed with hydrated lime and burials without packing (Schotmans *et al.* 2012, 51-52). After 6 months, both quicklime and hydrated lime packed burials slow down decomposition, acting as a barrier against necrophagus insects and limiting the emission of decomposition chemicals in the surrounding soil (Schotsmans *et al.* 2012, 57). The formation of lime casts happened within this time, when the carcasses were bloating (Schotsmans *et al.* 2012, 55). The tissues in contact with the lime were better preserved than the others (Schotsmans *et al.* 2012, 57).

Conversely, after 17 months, all the burials, those packed with lime and those without lime, showed similar liquefaction of soft tissues (Schotsmans *et al.* 2014, 141.e6). After 42 months, all the pigs were skeletonized (Schotsmans *et al.* 2014, 141.e6). Hence, lime packed burials help to slow down decomposition, but cannot prevent it (Schotsmans *et al.* 2014, 141.e11). The void left in the lime casts, after liquefaction and skeletonization, The microbial activity was found higher after 42 months than 17 months, while changes of aerobic microbial communities were recorded during decomposition (Schotsmans *et al.* 2014, 141.e10-141.e11).

4.20 Other indirect evidence of textiles

The presence of textiles is also indicated by indirect evidence. **Grave 99** (fig. 4.64) of Poundbury (Crowfoot 1993, 112) provides an illustrative example. A tangled mass of golden thread was found in a sample collected close to the left foot of the burial of an adult male individual. According to a golden thread classification made by Wild (1970, tab. H, 1-11), this artefact belongs to class 3, spirally-spun ribbon. The spiral shape had included an organic filament in the core, which degraded in time, leaving a hollow space in its place.

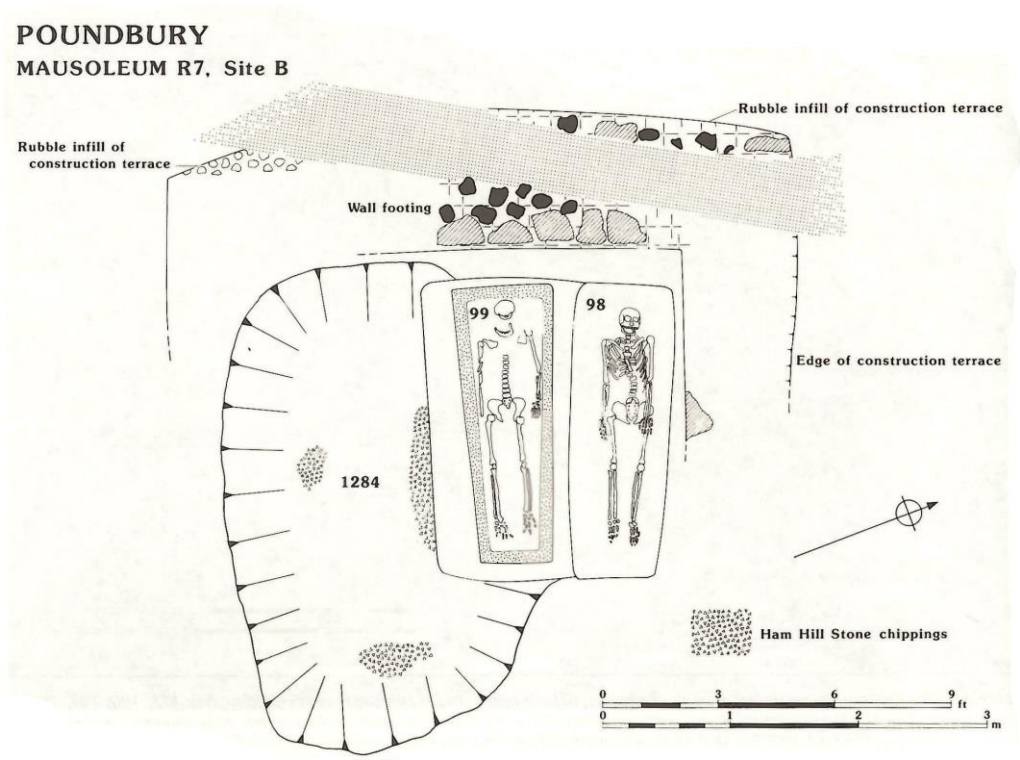


Figure 4.64: Poundbury grave 99 (© Dorset Natural History and Archaeological Society 1993, Farwell and Molleson 1993, fig. 40).

Similar threads have been found across Europe, Russia and the Near East (Wild 1970, tab. H, 1-11; Gleba 2008), and some cases associated golden thread with preserved silk filament within the spiral of the golden thread. In England, only a few golden threads were found. The finds from Lexden, Essex and Verulamium, St Albans did not preserve any actual traces of organic matter (Wild 1970; Gleba 2008). The investigation of the golden thread of a young female Roman burial in Spitalfields, London (Thomas 1999; Gleba 2008, 64; ch. 2) suggested the likely presence of a silk filament. Continental and British archaeological comparisons have been made, and some of them indicate the possible presence of silk associated with golden thread. The identification of the organic filament, which was within the golden thread of **grave 99**, Poundbury was done by comparing the diameter of the hollow with the diameter of other fibres. It was found that the measure of the diameter was consistent with silk fibre. The burials of Spitalfields and **grave 99** of Poundbury share some similarities and some differences. Both burials were contained in an external stone coffin. Then, the burial at Spitalfields was also lined in a lead coffin and filled with soil, while **grave 99** was packed with gypsum or plaster. Both burials retained evidence of an original textile. Textile traces were found under the remains of leaves in the skull area of the Spitalfields grave. “She was laid in the coffin with her right arm by her side and her left arm drawn up across her chest. Her head, at the west end of the coffin, was laid on a pillow' of bay leaves. Textile found beneath these leaves may have formed a kind of pillowcase” (Thomas 1999). Marks of textile were found on the gypsum of **grave 99**. Moreover, **grave 99** was included in the mausoleum R7 (Farwell and Molleson 1993, 51). All these clues suggest that both burials were of elite people, so it is likely that they might have been buried with rich garments decorated with gold and having an exotic and expensive textile like silk.

Preservation of the textile fibre inserted into the golden thread is similar in both cases. In fact, silk was not preserved entirely. Gold is not a reactive metal, and cannot corrode and does not influence textiles and other organics, like iron or copper. Hence, it is logical that the golden thread did not induce any chemical reaction that helped preserve the filament contained in the thread. Silk fibroin has a chemical structure different from wool keratin, which makes silk more resistant than wool (Cook 1984, 160; ch. 2.4). It can be assumed that both graves experienced water movement, which affected the content of the burials. However, recent experimental studies proved that silk is not resistant to bacterial attack (Kaur *et al.* 2014).

Grave 35 at Sewerby (Hirst 1985) offers another interesting case of replacement that is not directly linked with metal. A pair of bronze clasps 35/11 (Hirst 1985, 54-55, 61) preserved what to the naked eye appeared to be a fragment of textile attached to the surface. The microscopic analyses revealed that there were plant fibres, with the structure perfectly preserved but entirely replaced. Appleyard described this sample in this way "… the substance which had replaced the fibres was almost in fine crystalline form. It is certainly interesting to see how the 'yarns' still retained their fibrous appearance" (Hirst 1985, 55). **Grave 35** was one of the few encased in a wooden coffin, which left dark organic stains in the soil. It is possible that this specific environmental context produced a quick degradation of organic matter, including both wooden coffin and textiles. The copper contained in the clasps might firstly mineralise textiles close to it. Then other mechanisms of mineral replacement might occur. It is not possible to go further because no chemical analyses were produced on the "earth replaced" fibres. However, it is remarkable how this pseudo-preservation kept all the microscopic features of the fibres.

Another case of organic preservation was found in **grave 2613** of Alington Avenue (Davies *et al.* 2002). Limited details were provided by the report but referred to the presence of a possible fragment of leather on the left mandible coded as SF 364 (Davies *et al.* 2002, 208). The body was in a wooden coffin. The limitation of published data on this find creates uncertainty about the preservation of this fragmentary material. Here, it is suggested that the coin left at the mouth, which was an *as*, was made in copper alloy and might have influenced the local environment preserving that piece of leather adhering to the mandible. Microscopic and chemical analyses in the laboratory might have provided a more reliable answer.

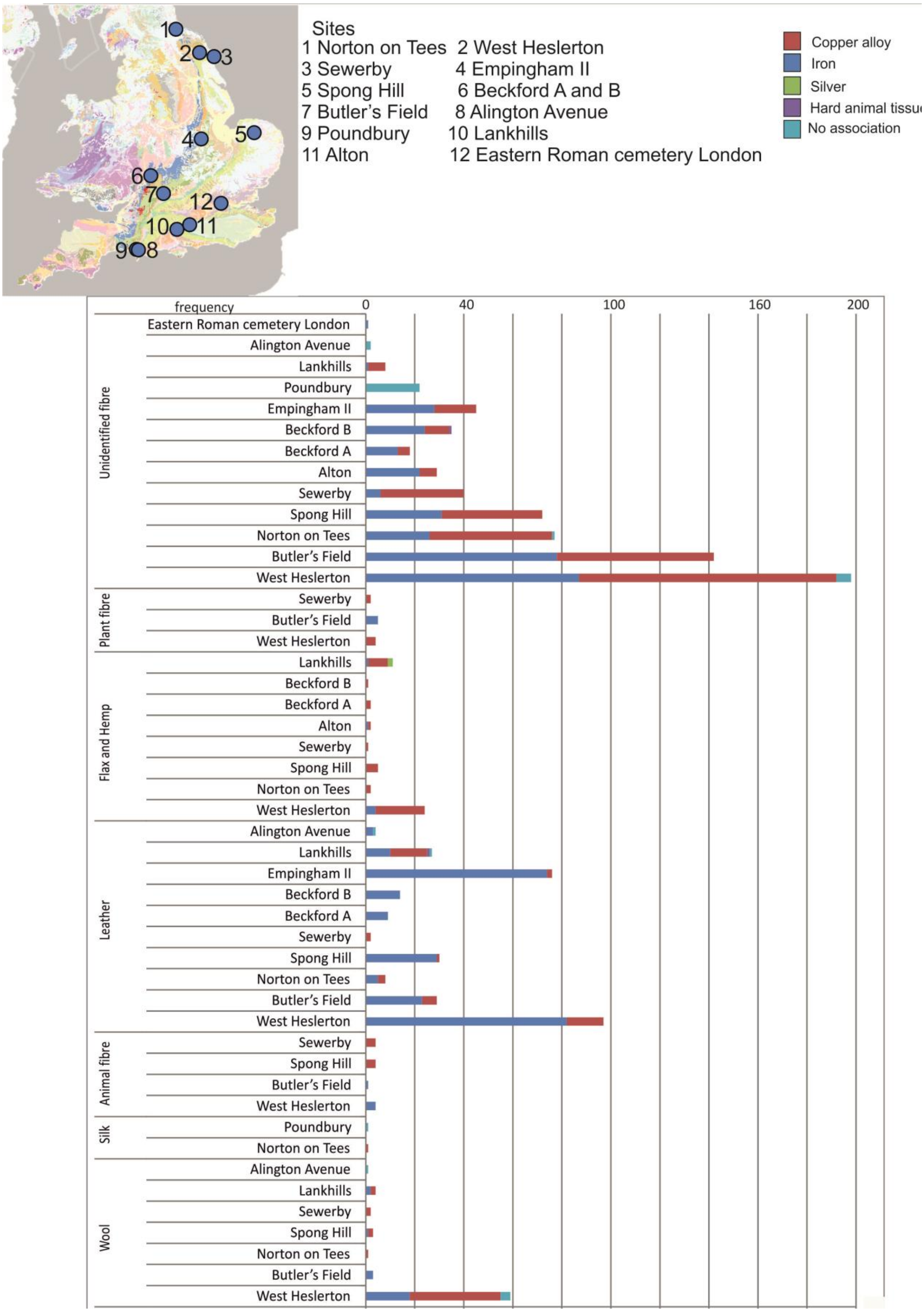


Figure 4.65: distribution of preserved fibres and associated materials. Map displays sites locations.

Table 4.7: distribution of fibres associated with other materials. Figures represent percentage values. Other metals include gold, silver and lead/tin alloy. Hard animal tissues include bone and ivory.

Site	Fibre	Copper alloy	Iron	Other metals	Hard animal tissues	Calcium Sulphate	Absent
Alington Avenue	wool	0	0	0	0	0	14.3
	leather	0	42.9		0	0	14.3
	unidentified	0	0	0	0	0	28.6
Poundbury	silk	0	0	4.1	0	0	
	unidentified	0	0	0	0	79.2	16.6
Lankhills	wool	4	4	0	0	0	0
	flax and hemp	16	2	4	0	0	0
	leather	30	20	0	2	0	2
	unidentified	14	2	0	0	0	0
Alton	flax and hemp	3.2	3.2	0	0	0	0
	unidentified	22.6	70.9	0	0	0	0
Eastern Roman cemetery London	unidentified	0	100	0	0	0	0

4.21 From the particular to the general. Connections between preserved textile remains and cultural-historical interpretations

The variation in preserved textiles depends on multiple factors, and here they have been examined, some from a macroscopic perspective. Anglo-Saxon and Roman inhumations are dissimilar to some extent, the burials were treated differently according to the age, sex and status of the dead (ch. 1 and 3). Moreover, preserved textile is a bias in the archaeological record, because it is not possible to quantify accurately the extent of lost information. In fact, this was not the aim of this research. This is a contribution in understanding the nature and occurrence of organic preservation, namely of textiles, and evaluating clothing evidence by CCL.

Some factors were examined that may have a major impact on preservation. Most of the preserved textile fragments were produced by the close distance to associated metal objects (fig. 4.65; tab. 4.7). Other ritual factors have a role in preservation but to a lesser extent, like coffin presence, object position, burial depth and type of soil. These four latter points are seriously biased also because often they lack in consistency of recording, sometimes due to the impossibility of field conditions, at other times due to the lack of common standards of recording. However, it seems valuable to produce further studies using other scales of observation and other methods combined with the archaeological methodology.

Definitions of cultural and natural factors (Schiffer 1987) that affect the archaeological record, crucial to have a clear representation of clothing in archaeology. Clearly cultural evaluation of the clothing evidence is vital. The comparison of variations in Roman and Anglo-Saxon burial groups reveals interesting patterns. It is observed that Roman burials, male, female and immature have limited variation in the overall presence of grave objects (size; 3.7), while they fluctuate more in the internal contrasts of the categories of artefacts (shape; ch. 3.7). Anglo-Saxon cemeteries respond to the analysis with different patterns. Female burials have a considerable variation along both axes (size and shape), while male burials show variation especially in the internal contrasts of categories (shape).

The examination of clothing suggests the existence of gender differences. For example, it was highlighted in this chapter that there are burials that contained bones of men associated with supposedly female personal equipment, and vice versa (Gilchrist 1997; Stoodley 1999). It happens mostly in Anglo-Saxon inhumations, which are richer in personal objects than Roman ones. Possible interpretations of these contrasting finds are numerous. Below, there is listed a likely but not exhaustive list of options.

1. Mistake in sexing bones (Mays 2010, 46-47).
2. Dead were buried with objects belonging to someone close to them, a relative or a partner, of the opposite sex (Lucy 1997, 157-161).
3. Cases of third gender (Stoodley 1999, 76).
4. Deceiving appearance of fragmentary clothing, as it is found in the field, originated by degradation of textiles (ch. 2).

Hence, these possibilities suggest that identification of sex and age of burials only by the use of clothing is not reliable. However, these ambiguous cases are only occasional if compared to the general record of data where the association of clothing and bones is usually compatible. In fact, patterns produced by the Penrose calculation appear mostly regular across sex and age groups, in spite of the occasional presence of these conflicting sex features in the burials.

Identified fibres do not reveal any significant association between a type of fibre and sex and age of the dead. Wool and leather are the most frequent identified materials, followed by plant fibres – namely flax – and then uncommon silk finds. It is more likely that, if specific associations existed in the use of textile fibres to produce clothing, they were not linked to the basic anthropological characteristics of sex and age, but to more cultural concepts of gender or status. For example, clothing made with expensive fibres, such as silk, might be worn by high-ranking people or clergy rather the ordinary folks.

Clothing was used also as indicators of contrasts or similarities between two archaeological contexts, which are in chronological continuity and in the same geographical area. Therefore, late Roman burials shows limited variations in comparison with Anglo-Saxon averages calculated for the Penrose statistic (ch. 3), whereas the Anglo-Saxon cemetery groups provide more variation in the scatter plots. Archaeologically, Roman clothing is less evident than Anglo-Saxon, because of the limited numbers of metal fasteners and generally less grave objects. However, this does not mean that the Romans buried all their dead naked. The absence of metal fasteners in burials obviously biased the archaeological record, but ritual plaster burials in Poundbury give us details about the presence of textiles even in Roman burials. Whether these textiles were only part of a shroud or of clothing, are hard to tell, but it seems another valuable field of investigation for future research.

Even the latter points encourage us to proceed further in the study of clothing in burials by the examination of microscopic and chemical traces left in the soil associated with detailed collected data in the field during the excavation and strategic collection of samples, unless it is not possible to extract the entire burial and excavate it in a laboratory.

Clothing assemblages and textile evidence found at West Heslerton (ch. 4.6) show that generally local funeral costume was lacking uniformity, and included several variations. In spite of the high organic degradation, this result is clear. However, male and juvenile burials appear more uniform than female burials, likely because of limited metal objects. The excavated areas of these sites included between eight and fifteen groups of burials (Haughton and Powlesland 1999, 95-96). Overall, burial ritual does not leave any evident marker of ethnic origin (Haughton and Powlesland 1999, 93). Consequently, the community of West Heslerton might have been composed of a mixed group of well-integrated natives and newcomers.

Similarly, the cemetery of Sewerby, which is only 35 km away from West Heslerton and was in use from the 5th to the early 7th century AD, shows variation in the funeral clothing. The female burials contain more grave objects than the male and immature burials, but their distribution is slightly different from the West Heslerton cemetery. This difference between two sites that were close in geographic distance and had similar chronology may be connected to different local traditions. However, the community of Sewerby might also be mixed of natives who embraced some Germanic rituals and Anglian immigrants. In fact, the distribution of graves and grave objects at Sewerby suggested that family groups were in clustered burials and the cemetery included burials of different ranks (Hirst 1985, 96-102). Unfortunately, **graves 41** and **49**, the so-called "living burial" (Hirst 1985, 40-43), is not helpful in this discussion, because they remain controversial.

At Spong Hill (Hills *et al.* 1984; ch. 4.13), the inhumations had a different archaeological context. Textiles were found, even though the taphonomic conditions were severely hostile. This group of burials was inserted into a bigger and slightly earlier cremation cemetery and it may represent a group who preferred a distinct funeral ritual from the main community. It was indicated that these inhumations represented an elite group (Hills *et al.* 1984, 41). The soil was extremely aggressive but some textile remains were preserved thus helping the local costume reconstruction. Considering the region and chronology of the site, it is suggested that the costume had importance in indicating different ethnic group, like Germanic newcomers and British natives.

The case of the cemeteries of Beckford A and B (Evison and Hill 1996; ch. 4.8) are a good example of two close cemeteries. These likely served the same community, but were distinct in some regards. The presence of related leprosy burials indicate that cemetery A might be dedicated to a family group separated from the bigger group buried in cemetery B. The CCL analysis confirms that clothing varies across the burial groups of the two cemeteries. It is likely that the two groups were showing their difference in funeral traditions not only by burying their dead in separate sites but also dressing their dead in different clothing styles.

Roman inhumations show different funeral traditions from the Anglo-Saxon. Clothing finds are rare, but this does not always indicate absence of clothing or textile in Roman inhumations (ch. 4). The apparent uniformity of Roman burials does not exclude the presence of other traditions in Romano-British cemeteries. Even if less marked than Anglo-Saxon burials, appreciable variation is demonstrated by PCA and CCL calculations (ch. 3.6; 3.8) and by the examination of specific burials. For instance, **grave 1846/2** of Lankhills (Booth *et al.* 2010, 218-219; ch. 4.5) contained spurs, which is an unusual object in Romano-British burials. This find does not suggest simplistically the Germanic origin of the dead, who came from the Continent, but he was a professional soldier buried with the *insignia*.

Textile fragments found in **grave 4378** of Alington Avenue (Davies *et al.* 2002, 158-159; ch. 4.4) show another aspect of Roman inhumation. This cemetery was serving a rural community, but this burial preserved precious textile fragments with purple dye, which was an indicator of high status. Whether the juvenile dead was an aristocrat or someone gave for his burial a rich vest is unknown. This site is important because it shows continuity in funeral ritual from the Iron Age to the Roman period (Davies *et al.* 2002, 146).

At Poundbury (Farwell and Molleson 1993; ch. 4.3), numerous burials preserved textile impressions on fragmentary plaster. The dimensions of those fragments do not help to understand whether the imprints were of shrouds or clothing, but it is a clear proof of textile cover for the dead in those burials. Roman cemeteries indicate the presence of perhaps variable funeral traditions rather than only one, despite the limited archaeological evidence of textiles.

It was suggested that some inhumations of at Lankhills could represent the turning point in funeral costume from the more official Roman tradition to a more mixed costume (Clarke 1979, 327-328; ch. 4.5.4). Likely, the later phases of this site showed a transformation that was already in progress before the official end of the Roman administration of Britain.

The variations revealed by the PCA and CCL (ch. 3.6; 3.8) indicate an archaeological situation which was extremely mobile and not really frozen in long-term traditions. Among different social factors, I propose that at least four may have had a major role in the variation shown by the changes in burial clothing: namely ethnicity, politics, economy and religion, but many others also influenced these variations, like fashion and technology that are not commented on here.

According to the ethnogenetic hypothesis of Härke (2011), who based his study on a combination of archaeological, historical and biological data, multiple migratory events with different strategies happened at the passage from Romano-British times. Anglo-Saxon waves reached Britain in different periods and with different purposes, and newcomers dealt with local communities differently (Härke 2011). Moreover, the concept of ethnos was not linked with blood but with other values, like the sense of belonging to a lord. So British natives might adopt Germanic traditions, including clothing, in order to deal with the new Germanic lords (ch. 1.5). The cemeteries examined in this research show that groups of adult male, female and immature burials respond to distinctive needs rather than a unique Anglo-Saxon tradition (ch. 3.4). The ethnogenetic interpretation may be applied with some revisions to the Roman period. The urban cemeteries likely contained not only burials of locals, but also citizens from other provinces of the Empire. It is reasonable to think that the variation in Roman burials, which is limited if compared to the Anglo-Saxon, was influenced also by the different traditions of the mourners that buried their dead.

Economy was another significant factor in the change of clothing. During the Roman Empire, British textile manufacture was a combined system that included professional weavers and spinners, even if it is difficult to identify in detail the extent of this production. Moreover, the strong presence of the army implied constant production of clothing for the soldiers. Exotic textiles were imported by the same soldiers when they were moved from Eastern provinces to Britain, or for the civilians who needed clothing not produced by the local industries (Wild 2002). The fall of Roman administration meant gradual dismissal of all organised production because the troops withdrew to the continent and the urban system collapsed. Hence, the changed context reduced the needs for textiles. Communities started to produce only for local use (Walton-Rogers 2007, 41-47) and textile manufacture was broadly under women's responsibility. It is likely that some influences came from the Germanic newcomers who brought with them their clothing style and technique of production, but evolution from Roman clothing styles also occurred.

Here, it is argued that religious beliefs also had a major impact on changes in funeral clothing. Some scholars still see religion as influential in clothing (Walton-Rogers 2007, 245). Some stimulus was possibly provided by religions, whether paganism or Christianity, but unless there were clear signs of votive offerings found in the grave, we cannot assume a supreme influence of religion on clothing. Often archaeological evidence from inhumations is not sufficiently accurate to imply significant information. The major distinction between paganism and Christianity and all sects can be obscured in graves. Generally, Christianity is more evident from the first half of the 4th century AD, while there is a regression in its expansion around the second half of the same century and by the end of it was the official religion of the Roman state, but archaeologically no significant traces are archaeologically recorded (Watts 1998; Sparey-Green 2003, 106). The early Anglo-Saxon period similarly show uncertainties. Generally, it is stated that paganism of Germanic origin replaced Christianity. However, it is hard to clearly distinguish whether burials are indicative of specific religious beliefs or not (Crawford 2004). It is suggested therefore that such context was originated by the absence of a proper religious canon and the presence multiple pagan beliefs. Consequently, burials represented a multicultural reality that likely included different religions mixed in an original way.

Carver proposed (2010, 8-17) that early Anglo-Saxon burials showed intricate ideologies, where religions have a role, but not the main one. Politics and economy were more significant and to lead other changes in other fields. It seems likely that funeral clothing also responded more to the political development of Britain and the Northern Sea regions. When Britain was within the Empire, it was connected and participated in the life of Roman order, even if it was at the periphery of the Empire. The presence of Roman soldiers, citizens, traders provided a connection with the Mediterranean area, until the Roman retreat. Afterwards, a new world developed in the Northern Sea area, and Roman style was no more the principal model. New models, Germanic influences, spread in Britain and the burials show this new tendency. This trend is shown also in some princely monuments, which were not part of this research, like Sutton Hoo (Carver 2005) or Snape (Filmer-Sankey and Pestell 2001). These clearly reveal links between Northern Europe and England, and ordinary graves, examined in this research, display evident contrasts between Roman and Anglo-Saxon clothing.

In spite of the limits of preservation, it seems likely that the major variation, which occurred in the Anglo-Saxon burials, correspond to a fragmented reality in fast transformation, while the greater similarity across Roman inhumations show possible acceptance of the Roman tradition, with limited exceptions that became more frequent in the latest phases. The differences between male and female graves are noticeable (ch. 3.6; 3.8) and are possibly linked to the changes in society and the roles of men and women within the closer community, where the women gained a more active role during early Anglo-Saxon times (Walton-Rogers 2007, 229-247).

4.22 Conclusions

The combination of cultural and natural events may produce niches for textile preservation even in mild temperate regions, like England. These integrated cultural and natural factors work at an extreme specific level. Despite the complexity, in some cases it is possible to reconstruct preservative mechanisms from a macroscopic investigation and this work discussed some of those niches that can occur in archaeological contexts. It also discussed possible causes and effect of preservation from visible evidence.

The archaeological record deals regularly with fragments of the past. By these remains, as archaeologists, we try to rebuild the entire picture or at least to make an effort and produce a likely image of the original picture. Both Roman and Anglo-Saxon cemeteries show statistical variation in different degrees, which suggests that some social factors had an influence in burial clothing changes (ch. 3.6; 3.8). Additionally, Roman and Anglo-Saxon inhumations display distinct patterns. Roman burial groups are close in size and spread in shape (ch. 3.8). Conversely, Anglo-Saxon burials are well-distributed in both size and shape, revealing marked differences between male, female and immature groups (ch. 3.8). This outcome suggests a link with the broader archaeological context. After the collapse of Roman authority, Britain passed from central control to fragmentary forms of government (Cleary 1989). The clothing variations reflect this change and help to explain it.

Chapter 5: Conclusions

5.1 Introduction

This study investigated clothing remains in archaeological burial contexts. Focus was directed to some materials –textile fibres and leather – and selected artefacts related to clothing and personal equipment, which likely were associated with textile fibres and leather. Data were collected from published archaeological reports. This investigation involved clothing in three aspects. Firstly, it evaluates cultural variation in clothing across fundamental dimensions, such as differences in sex, age and two distinct but contiguous cultures, Roman and Anglo-Saxon in Britain. Secondly, it examines textile fibres and leather and all the characteristics that can lead to preservation of these organic materials. Consequently, this study challenged how the degradation of textiles influences the interpretation of cultural variation. The final theme linked this research with the InterArChive project of the University of York. Some observations, analyses and comments were produced after collaboration with colleagues of the InterArChive team, who examined degradation of organics in archaeological and experimental burials by micromorphology and chemistry.

Funeral archaeology has been developed as a major field of interest since the beginning of the discipline. However, this subject has benefited from a more organised contemplative approach after Childe and then it has been widely questioned by processual and post-processual contributions, which have invigorated the theoretical debate, building a broad framework (ch. 1.2). However, the last forty years of theoretical discussion about funerary practises do not challenge detailed contexts (ch. 1.2), preferring instead to move from the general to the particular, neglecting the opposite approach (Fahlander 2013, 638).

Furthermore, Romano-British and Anglo-Saxon cemeteries are crucial contexts for investigating the passage from Britain under Roman control to England of Anglo-Saxon Kingdoms. Regrettably, Roman and Anglo-Saxon cemeteries have been studied differently (Millett 1995, 133), because of the traditional difference in interests between Romanists and Anglo-Saxonists. Moreover, the fragmentary representations of Roman and Anglo-Saxon contexts influence the archaeological researches (Cleary 2001). However, there are big archaeo-historical narratives based on the evidence of cemeteries and funeral practises of both Roman and Anglo-Saxon sites (ch. 1.3; 1.4; 1.5). Currently, archaeological discussion provides some interpretations on the transition from Roman Britain to Anglo-Saxon England, such as series migrations either peaceful or violent invasions of Germanic warriors followed by their families occupied England, annihilating Britons (Cleary 1989; 2001). It is also proposed acculturation and assimilation. Thus, native Britons changed their own identity from a Roman-Celtic background, accepting Germanic models, and in some parts also

Germanic elites in order to re-organise their existence after the abandonment of Britain by Rome (Cleary 1989; 2001). Between these extremities, a wide range of other possible historic events could have occurred and could be explained at a local scale of investigation (Thomas *et al.* 2006).

Burial clothing participates in this discussion because it contributes to an understanding of the transition from Romano-British to Anglo-Saxon costumes (ch. 1.6). Clothing is remarkably fragmentary evidence of the archaeological record and it seemed the perfect subject to apply a microarchaeological approach, starting from the small finds to a build big picture (Fahlander 2003; Cornell and Fahlander 2007; Fahlander 2013). Firstly, this work has examined selected cultural traits – e.g. fragmentary textiles and clothing related objects – of some Anglo-Saxon and Roman cemeteries with statistical methods, such as PCA (ch. 3.6) and, for the first time, CCL (ch. 3.7-3.8). These methods have been applied to evaluate variations in clothing assemblages. These quantitative methods resulted in:

- Highlighting variations in burial clothing across culturally and geographically defined contexts. Anglo-Saxon and Roman burial clothing are clearly different.
- Underlining distinctions between male, female and immature burials. These results are obvious when grave objects are associated with human remains. However, it may help to statistical identification of burials that not preserve identifiable bones.

The statistical calculations provide an explorative overview and address further enquiries about buried clothing. Thus, this research examined the taphonomic factors that may preserve fibre textiles and influence their presence in the archaeological record (ch. 2). Some experimental studies and wide ranging projects contributed to this field. For instance, the Earthwork projects of Wareham and Overton (Bell *et al.* 1996) and more recently the InterArChive project (ch. 2.17). Moreover, archaeology can also benefit from forensic studies, which share some common interests. Nevertheless, no attempts have been made to investigate the preservation of clothing evidence in a wide archaeological context. Assuming that preservation of textile fibres depends on a series of cultural (ch. 3.4) and natural factors (ch. 2.2, 2.10 and 2.11), data from archaeological reports of selected Roman and Anglo-Saxon cemeteries were collected in a digital archive and discussed (ch. 4).

5.2 Answers to research questions

This research enquired some aspects of clothing remains as documented in the archaeological record (ch. 3.2).

1. "What is the extent of preservation of clothing-related organic material in inhumation burials?"

The extent of degradable organic materials, such as textile fibres and leather, has been re evaluated in Roman and Anglo-Saxon cemeteries. Even if archaeological organic materials are subject to severe degradation (ch. 2), limited amount of textiles and leather remains do survive in the majority of the contexts examined and can provide significant information about the culture that produce and use that clothing. The improvement of scientific methods such as proteomics (Solazzo *et al.* 2011) delivers new lights on the subjects.

2. "What are the preserved materials and where do they occur? Are there identifiable associations between organic clothing material, environment and cultural factors? What are the most effective textile preservative factors in Roman and Anglo-Saxon cemeteries?"

Fragmentary textile and leather occur in a variety of contexts, as the analyses of 13 Roman and Anglo-Saxon cemeteries, has shown (ch. 4.2-13). Regardless different environments, minimal preservation occurs in these cemeteries. There are some cultural factors that appear to be conducive of such preservation (ch. 4.15). Copper and iron objects produce textile pseudomorphs. The presence and the type of coffin, whether was lead-lined or lime-packed, contribute to preservation. It is significant also the position of clothing in relation with the body. In fact, it is observed different survival of textile evidence, whether clothing was dressed or not.

Few exceptions are noted about the preservation of organic clothing materials, like the cases of Empingham II (Timby 1996) and the Eastern Roman cemetery of London (Barber and Bowsher 2000). Textile evidence of Empingham II was recorded during the excavation but the wrong techniques of cleaning impeded further analyses (Timby 1996). The Eastern Roman cemetery of London does not provide any record of textiles. This absence may be caused by the incessant human activity over the site, but it remains unexplained.

3. "What is the range of clothing indicators and other objects related to burial ritual? How are the clothing objects distributed by anthropological factors, such as sex and age?"

These questions have been examined with quantitative multivariate methods (ch. 3.6-3.8). PCA demonstrated that according to selected grave objects, Roman and Anglo-Saxon cemeteries are clearly distinct. It has been also proposed for the use of CCL, as further method of exploratory data analysis. CCL calculates the same cultural traits of PCA and it shows a clear difference between Roman and Anglo-Saxon cemeteries in the overall occurrence of the cultural traits and in their relative incidence. This result suggests that the funeral clothing distinguished between Roman and Anglo-Saxon cemeteries. The clothing assemblage reflects sharp differences in sex and age, meaning the men, women and children were dressed differently in burials. The result of CCL is not only important in itself, but it demonstrates to be a valid method to evaluate similarities and differences among large populations according to preselected factors.

5.3 Limitations on research design and originality of the study

This study has collected and examined a wide of data from secondary sources, namely published reports. Even if extra care has been made in the selection of the case studies, some inconsistencies were found in the reports. Some sites were excavated by rescue excavation, such as Empingham II (Timby 1996) and Alton (Evison 1988), which might have affected the analyses. Moreover, the author has not direct access to most of the materials reported in this work, apart for those comparative examinations which are labelled as made by the author in chapter 2 and Appendix 2.5.2. Ideally, all materials need to be examined in first person, but this limits the range of available data, as it was planned for this research. This research is also limited in the choice of archaeological contexts. Only ordinary inhumations have been selected. Cremations, mass graves, monumental graves and deviant graves have been excluded because of the extreme variety of rituals that could not be easily managed in the same work. Moreover, this research refers widely to experimental studies of others (ch. 2.17) designed for archaeological (Janaway 1985; Bell *et al.* 1996; Lawson *et al.* 2000; Solazzo *et al.* 2013; InterArChive) and forensic purposes (Lowe *et al.* 2013) but no experiment has been designed for this research. This is left for future works.

This study deals with numerous interpretative issues, and some of them cannot be properly resolved by quantitative methods. The cultural change from Celtic-Roman to Germanic England is evident from the archaeological sources and it can be assessed by different means. In this, the CCL statistic newly contributes in the field, comparing individual cemetery differences within one cultural context or across different cultural contexts.

Whether changes in funeral traditions were a sign of a massive migration of newcomers, who largely replaced a native population, or locals, who embraced Germanic traditions in order to adapt to new political and economic changes across Europe, remains debatable because the statistic cannot answer this question. In fact, this subject requires an approach of multiple integrated studies. For example, given a set of cultural characteristics, CCL can identify “deviant burials” (Reynolds 2009). Isotope analyses can also demonstrate that provenance of individuals, such as the buried skeletons of the mass grave at Ridgeway Hill, Weymouth that were Vikings (Chenery *et al.* 2014). In other cases, the statistic method is not helpful. For instance, CCL revealed that Lankhills inhumations were different from the other Roman cemetery. The reason was the presence of grave goods, like belt buckles, that were uncommon in Roman cemeteries. It would be expected that those graves were of immigrants. However, isotopes analyses confirm the local provenance of the burials containing buckles, while non local isotopes were found in some burials with ordinary Roman assemblage (Booth *et al.* 2005, 509-516).

Beyond the obvious, that archaeological finds can only provide partial records, this thesis represents a multivariate reality, which changed across time, space and human groups. The quantitative method applied here, has provided a new approach to quantify this data in a detailed way, but the CCL do not explain the variations, it should be considered as an explorative step of data analysis. The study agrees with ethnogenic theory (Härke 2011), which determined at least three different types of changes between native and immigrant traditions, without excluding other possibilities. It also matches with Carver's hypothesis (2010) of extreme mobility of early political groups, which produced complex archaeological evidence.

A limitation of this work has been the study of taphonomic aspects by the use of secondary sources. This approach does not replace direct observations but is inevitable when data on many sites are involved. Site reports were written by different scholars, at different times and with different means. There was no consistency of recording methods and data were extremely variable in quality. This means potential loss of information. However, analysing numerous published reports has provided a much wider view of taphonomic processes and it has informed on several aspects of preservation in a way that is not possible by the analysis of a single site. This broader review offers suggestions for future fieldwork and can offer critical comment on experimental studies.

5.4 Contribution to funeral clothing interpretation

The PCA and CCL formula took into account the proportional presence of textile finds and grave objects indicating clothing and personal belongings, which might have had traces of textiles or leather. Moreover, most of these objects were common in both Roman and Anglo-Saxon society, even if they had different frequencies (ch. 3). This calculation highlighted variations across cemeteries of the same culture and also between cultures – the Romano-British and the Anglo-Saxon – (ch. 3).

In fact, it revealed that populations in the Roman and Anglo-Saxon cemeteries are separated in their clothing assemblages (ch. 3.6; 3.7; 3.8). Moreover, there were deviations between female, male and immature individuals within the same cultural groups. The Anglo-Saxon groups show moderate variation, which distinguishes males, females and immature burials. These groups are similar in the overall proportional occurrence of cultural traits (size), while showing differential variation in cultural traits (shape). Anglo-Saxon male burial groups tend to be clustered along size values (ch. 3.8), while they are more spread in shape. In contrast, Anglo-Saxon female burials have less variation in shape, rather than size. The immature burials have the least variation among Anglo-Saxon burial groups, because of the limited number of selected objects related to clothing.

In contrast, Roman burials have more limited variation in the proportion of objects occurring. Almost all Roman groups are similar in the overall occurrence of selected objects, which is linked with the scarcity of these objects in the Roman graves. In contrast, Roman burials vary greatly across the categories of objects, which are represented in the shape axis. Finally, it is interesting to see the limited differences between male and female groups, while the immature tend to be separate and closer to the origin of the axes, which suggests stronger similarity of the Roman immature to the Anglo-Saxon counterpart.

The limited variation in Roman burials is partially linked to the funeral ritual. In fact, late Roman tradition preferred usually to bury the dead with limited numbers of metal clothing fasteners, which are the best indicators of clothing. However, this absence in the record cannot be simplistically assumed to indicate no clothing or naked burials. There are still other options, such as burial with clothes that do not have metal fasteners, or the presence of simple coverings. Occasional burials, especially during the latest phases, included more metal fasteners or other objects that keep textile traces. Usually, these finds are interpreted as army officers who were buried with their insignia or foreigners who were buried following their traditions. Generally, Roman funeral tradition included shrouds, which are well-known from archaeological and historical sources. Unfortunately, in Britain there are no definite archaeological finds of shrouds, but there are impressions of textiles from plaster burials that have been interpreted as imprints of shrouds.

Usually these impressions are found in fragments inside lime-packed coffins, like in Poundbury (Farwell and Molleson 1993). Hence, it is difficult to really say whether they belonged to a unique funeral piece, several cloth strips, clothing or a combination of these options. The most important outcome is that the statistical variation across different cultures is strongly affected by the taphonomy of the burial.

Preservation of organic fibres usually occurs because of the absence or reduced impact of at least one factor of degradation (ch. 2). Chemical breakdown is the degenerative process most difficult to slow down. Only extreme climate can effectively reduce chemical degradation, but this is not the case of Britain. Biological degradation is usually faster than chemical decay. Hence, when there are ideal conditions for slowing down biological decay, there is a good chance of preserving clothing, at least in a fragmentary state.

At this point, it seems more logical to suggest that the picture produced by the CCL analysis and the strong similarity of Roman burials when compared with the Anglo-Saxon inhumations, was intensely influenced by the burial taphonomy. When cultural data are superimposed over environmental information, the combination offers a better quality of interpretation. The limitation of metal artefacts within Roman inhumations restricted this most important factor of preservation: the presence of metals (ch. 4.14). Conversely, early and middle Anglo-Saxon burials have metal fasteners, which were part of the clothing dressing the dead. More specifically, female costumes were regularly equipped with some metal fasteners, while the presence of metal objects linked with clothing was more limited for men and sub-adults. This appears clear in the literature, where studies of Anglo-Saxon female costumes of the early period are common, because of the abundance of material in the archaeological record, while there are limitations for men and juveniles.

Additionally, it is evident that Anglo-Saxon men and the immature of the early stages were buried with limited metal artefacts providing an image of uniformity of their costumes but a restricted knowledge of textiles used for their clothing. Conversely, traces of textiles were found on shield bosses and spearheads in some male burials. This may indicate that the bodies of the adults also wore clothing. Other preservative factors for organic textiles are coffined burials and deposition of textiles on the body (ch. 4.15). Lime packed burials also can preserve evidence of textiles (ch. 4.19).

5.5 Contribution to the archaeological framework

Combinations of archaeology, stable isotopes and Y-chromosome DNA examinations in several contexts are delineating more structured and diverse series of events that cannot be easily generalised (Härke 2011). Hence, the investigation of population changes and costumes requires primarily regional and small-scale evaluations. For example, the cemetery of West Heslerton has been analysed by lead and strontium stable isotopes, (Montgomery *et al.* 2005) as well as oxygen and strontium (Budd *et al.* 2004, 134-136). This showed the presence of a low proportion of non-local people, likely of Scandinavian origin. Interestingly, presence and absence of grave goods were not correlated with the place of origin of the dead (Montgomery *et al.* 2005, 134-135). This implies that social identity was not simply linked with genetic provenance but rather it was something more mobile and symbolic (Pader 1982; Lucy 1998; Stoodley 1999; Carver *et al.* 2009, Härke 2011).

It could be argued that the results of this research harmonize with the hypothesis of periodic Anglo-Saxon migrations into Britain (Härke 2011). During the first phases, Germanic immigrants might move into Britain with different purposes. Some might be only bands of warriors that came into the island and when established they mixed with the local population by marriage. Other groups may be composed of peasants, who moved in large family groups seeking new land and keeping stronger contact with their original traditions. Other groups might be very small, likely elite, but extremely influential in native folk lifestyle. DNA and isotope analyses suggest high mobility of Germanic population towards Britain since the early stages (Thomas *et al.* 2006; Härke 2011). The sharp changes of funeral clothing between Roman and Anglo-Saxon burials highlighted by CCL and PCA (ch. 3) are connected with these migratory events. However, it must be taken into consideration that this is only a partial reconstruction of the past. For example, the mass grave of Ridgeway camp, which isotope analysis identified as male individuals coming from Northern countries (Chenery *et al.* 2014), is clearly a deviant burial from the ordinary Anglo-Saxon cemeteries presented in this work.

Moreover, it is important to keep in mind that the variation in burial clothing in the Anglo-Saxon cemeteries is a picture of a variable and not static process. In other words, social changes may be reflected in clothing and personal equipment buried with inhumations, but they can be different across time and regions. The values produced by the CCL method in this work refer to a wide chronological and geographical range, which roughly includes English sites from the 1st to the 7th century AD. Hence, these results are macro-scale interpretations, but the extent of the analysis can also be changed to other scales of investigation.

In Eastern and Southern Britain, communities of newcomers and natives might accept Germanic funeral traditions, rejecting the previous Romano-British culture, which did not correspond anymore to their ideology. This might be a plausible explanation of the mild consistency between the Anglo-Saxon groups, here analysed. Women were buried with clothing having metal fasteners, while during the Roman cultural influence they were likely to be buried wrapped in shrouds or wore tunics without metal fasteners. Men and sub adults show more uniformity in early Anglo-Saxon burials, because their clothing did not include numerous metal fasteners. This does not indicate that men and juveniles were buried naked or in poor graves, but just that they have less metal fasteners in their clothes.

Considering all the likely combinations that taphonomic and cultural factors can produce, we have only a partial picture of funeral clothing of regional Anglo-Saxon and Roman societies. By the statistical analyses based on the PCA and CCL (ch. 3.6-3.8), it is confirmed that there was variation amongst groups of burials, differentiating them into some clusters according with the cultures, e.g. Roman and Anglo-Saxon burials, and with sex and age, e.g. male, female and immature burials. Is this a reliable, even if partial, picture of past funeral costumes? Can we believe that these variations effectively represent cultural choice to provide clothing for the Roman and Anglo-Saxon dead? This analysis has demonstrated that textile degradation has seriously restricted our knowledge and understanding of the buried funerary dress, and consequently funeral practises and social traditions.

For instance, in the case of statistical analyses, it is clear that Anglo-Saxon female burial clothing is better represented because of the abundance of metal fasteners, while adult men and children have less variation because of the limited amount of metal objects in their graves. This example is also valid for the preservation of textiles. Anglo-Saxon female burials are the best preservative niches included in this research, mainly because of their high content in metal fasteners. It is evident that the correlation between preserved fibres and quantity of metal fasteners and representation of funeral clothing is strong.

Nevertheless, other mechanisms of preservation are found, implying that other non-metal cultural indicators can preserve traces or fragments of textiles. For instance, Roman burials often were covered with shrouds or maybe with clothing and archaeologically. This is demonstrated by lime-packed burials with textile impressions, such as Poundbury (Farwell and Molleson 1993). This fact demonstrates that the degradation of organics does not always delete all evidence of organic materials. These minor preservative niches deserve to be investigated on their own, and suggest that further examination may produce additional organic traces.

The position of the Anglo-Saxon groups shows a strong difference between burials of men, women and immature. Additionally, indeterminate Anglo-Saxon burials are also the poorest in selected grave objects. However, this result cannot be accepted without criticism. It would not be correct to present Anglo-Saxon immature or male burials as originally lacking clothing. Visible fibre evidence is significant but not the only part of the archaeological record. This research has also a small contribution to make in the relationship between traditional archaeology and the hard sciences. Generally, archaeological investigations have limits, which may be overcome, in specific cases, with the contribution of other disciplines. Preserved organic materials, e.g. textiles, and the archaeological environments that have preserved them, are examples where this collaboration appears to be extremely helpful. For instance, the sciences, such as chemistry, are fruitful in detecting elemental traces in soil. However, archaeologists or at least researchers who have a strong expertise in archaeological science should lead projects having archaeological problems.

Today, researches can be on a more microscopic scale, and are becoming more frequent, almost a standard. However, I would remark that the role of traditional archaeology cannot be set apart. This is valid especially when principal queries are archaeological. It seems extremely logic to lead a research from what it can be examined in the field. For example, a better knowledge of past burial structures and rituals may have improved the sampling strategy of the InterArChive project.

In fact, quality of scientific research should be a special focus of archaeology. Therefore, if excavations take place with respect to science (Janaway 1985, 29), quality of data improves, together with more accurate interpretations. The case of West Heslerton (Haughton and Powlesland 1999; 1999a) showed the extent of improvement in scientific research. Textiles and other organic finds are well-represented because there was an extensive sampling strategy, followed by accurate lab analyses and excavation.

5.6 Recommendation for future researches

It is appropriate to provide some recommendations on how to improve methods and techniques for the benefit of future researchers in the field and laboratory regarding burial studies. It appears evident that major shortcomings originated in the small number of field specialists in taphonomy and textiles present during excavation. This resulted in serious inconsistencies in data recording and analysis, which are clearly apparent in the reports. The following suggestions are made to help to improve data collection in the future.

In the field:

The presence in the field of taphonomy and textile specialists would be the ideal condition for all excavations. However, few projects could afford to pay such specialists, or they may be not available because of their restricted number. Hence, it seems crucial to provide basic training to field archaeologists on how to record and collect properly textile evidence, and other soft organic materials, during the excavation. Basic instruction on how to collect textiles during an excavation can be found in a handbook (Cronyn 1990; Gillis and Nosch 2007). Preferably, textiles should be collected with a support structure and always with the surrounding environment, thus avoiding dramatic changes. All interventions, like consolidation, should be avoided in the field.

From the experience of the InterArChive project and the report of West Heslerton (Haughton and Powlesland 1999; 1999a), the sampling strategy of burials can be improved by collecting soil blocks, not only in prearranged areas on the body, but also close to metal objects or following organic stains on the soil surface. Some textile finds may occur away from the body. Ideally, the whole inhumation should be lifted and examined in the lab, but this is difficult to do in the majority of cases.

In the laboratory:

Textiles can be successfully examined by a wide range of techniques. Recurrent use of the light transmitted microscope, as already done in conservation and research laboratories, and SEM, rarer because of the costs, are ideal for fibre identification. If the fibre is not entirely replaced by metal or corrosion products, the microscope can provide a view of the external and sometimes internal features of the fibre. It is the most efficient and reasonable way of identification. Chemical analyses, like Gas Chromatography Mass Spectrometry and Infrared Microspectroscopy, identify textile composition and possible presence of resins. The SEM combined with Energy Dispersive X-ray Spectroscopy analyses elemental traces, like proteins, salts and pigments. Accelerator Mass Spectroscopy can provide radiocarbon chronology to textiles. Finally, proteomics and DNA analyses can detect the species origin of fibre if microscopic methods do not work. Proteomics has the advantage to operate with limited amount of matter and also with damage materials (Solazzo *et al.* 2011).

Experimental projects:

Textile studies benefit from experimental reconstructions of clothing from different contexts (Andersson Strand *et al.* 2010). Experimental archaeology proved to be extremely fruitful in order to understand diagenesis of materials (Bell *et al.* 1996; Wilson *et al.* 2007; Solazzo *et al.* 2013; Von Holstein *et al.* 2014) and mechanisms of preservation (Janaway 1985).

The investigation of diagenesis seems an aspect that may still offer a wide range of improvement in understanding the taphonomic processes which allow textiles and other organics to preserve or degrade. For example, the different extent of preservation provided by iron and copper, like Sewerby (ch. 4.12), requires further investigation.

Moreover, careful examinations should be applied also for those sites that apparently do not produce textile evidence, like the Eastern Roman cemetery of London, where it is suggested soil sample collection (ch. 4.1). Hence, a large scale series of experimental burials prepared at the same sites where textile finds have been recovered, imitating similar burial conditions, may provide ideal details of the processes of deterioration of organic matter.

This approach could create experiments tailored to specific sites and may help in a better definition of taphonomic processes, which are linked to local contexts. Further experiments are suggested, because there are some aspects that require more investigation. Here, some ideas are proposed for future projects:

- Exploring the role of soil in the different rate of mineralization of iron and copper.
- Investigating the possible role of lead toxicity in textile preservation and assessing the mechanism.

- Testing the role of different types of coffins in organic textile preservation (e.g. wooden coffin, stone coffin, lead lined coffin and lime packed coffin).
- Assessing the role of burial depth for textile preservation.

5.7 Final concluding words

Finally, there is a remark on the importance of teamwork and a combination of different approaches. From personal experience, working as an associate with the InterArChive project, it became clear that archaeological, soil and chemical analyses can provide huge benefits in recovering further information at a microscopic and elemental level, which are not otherwise directly accessible in the field.

This study has focused on preserved clothing materials in burials, using data from reports. It has highlighted the limitations of past researches where some archaeological contexts offer less information than others. However, there is no reason to agree with this statement "the presence of worn ornaments,… , may have no greater significance than to demonstrate that the body was fully clothed at burial" (Philpott 1991, 155). More attention to grave objects and grave assemblages and the overall context, combined with soil sample examinations can improve our knowledge of funeral clothing and in funeral traditions. In this respect, statistical methods and diagenetic studies also have a significant part to play.

Appendices

Appendix 1: sites and skeletal remains

1. Eastern cemetery of London

The Eastern cemetery of London belongs to the Roman funerary system that provided cemeteries, which were aligned on the principal roads linking London town to other important centres of Britain (Hall 1996). Several surveys and studies explored and described the cemeteries of *Londinium*, but the quality of data is extremely variable. Hence, the system of Roman cemeteries of London is not entirely revealed by excavations and there are still some obscure areas. Fundamental contributions like that of Mortimer Wheeler (Royal Commission on the Historical Monuments of England 1928, Appendix 1) and the more recent synthesis presented by Jenny Hall (1996) tried to combine both antiquarian and archaeological finds and provide an organised view. These studies offered valuable information of the cemetery areas, but they have not provided extensive archaeological investigations.

The Eastern Roman cemetery of London was excavated by a series of campaigns from 1983 to 1990, but these excavations did not reveal the site in its entirety. Data and analyses of those excavations are published in a preliminary paper and in a report (Barber, Bowsher and Whittaker 1990; Barber and Bowsher 2000), providing the data source for this research. Barber and Bowsher excavations demonstrated that the cemetery previously defined as Eastern cemetery by Hall (1996, 65 fig. 9.2 and 73-74), was a North-eastern cemetery at Aldgate, which flanked the road between *Londinium* and *Camulodunum*. In fact, sites excavated by Barber and Bowsher are placed along a southerly road (Barber and Bowsher 2000, 2 fig. 1) and they refer to an “Eastern” cemetery (fig. 1).

The Roman Eastern cemetery was placed between the eastern side of the London wall and the southern side of the road between London and Colchester, but it was distinct from other cemeteries, which were centred on Aldgate. Unfortunately, this site has had limited investigations and is affected by the long continuity of use of the area, especially by the new urban developments of the Victorian period.

The first establishment of *Londinium*/London is dated around the middle of the 1st century AD. (Millett 1996). The city was founded by Western provincial traders, who moved in an area with no archaeological evidence of pre-Roman settlements. This is indicative of a high presence of newcomers also in the cemetery, especially during the early phases of the site. However, it is likely that natives moved into *Londinium* after the initial stages and they might be buried in the cemeteries. Burials of the Eastern cemetery can provide significant data on the population of the city because it has a similar chronology to the city from the 1st until the 4th century AD (Barber and Bowsher 2000, 303-304). By the end of the 4th century AD, it was abandoned and this chronology corresponds with the end of Roman authority in London (Perring 1991, 127-128). Notably, the final phases of the Eastern cemetery do not show evidence of dramatic changes in population, like burials revealing contacts with Germanic people.

Figure 1: map of Roman London. The area of the Eastern cemetery is circled in red, while the area of the Aldgate cemetery is circled in blue (modified by the author, Wikipedia accessed January 8, 2014 http://en.wikipedia.org/wiki/File:Map_Londinium_400_AD-en.svg).

Several excavations, organised between 1983 and 1990 at scattered sites, have exposed portions of the Eastern cemetery. The absence of an extensive excavation does not make clear, whether these excavations unearthed one cemetery or the burials belonged to separate cemeteries, which flanked the road to Colchester. No distinct boundaries have been identified between burials and the external limits of the cemetery are also unknown. However, here, like the report of Barber and Bowshe r, the Eastern cemetery of London is treated as a site on its own, even if it has been incompletely excavated.

The cemetery is known by 12 sites, 11 of them have been excavated and one was surveyed (Barber and Bowsher 2000, 3 tab. 1 and 4-5 fig. 5). Below, the list of those sites follows with their addresses and NGR coordinates. The codes of the sites are those that Barber and Bowsher provided in their publication.

1. Site A. East Tenter Street, Scarborough Street, E1. NGR TQ3399 8102. [Loamy soils with naturally high groundwater, naturally wet loamy soil, wet acid meadow and woodland]
2. Site B. Goodman's Yard, E1. NGR TQ 3370 8091.
3. Site C. 13 Haydon Street, EC3. NGR TQ 3370 8150.
4. Site D. Hooper Street, E1. NGR TQ 3420 8100.
5. Site E. 65-73 Mansell Street, E1. NGR TQ 3383 8002.
6. Site F. 49-59 Mansell Street, 2-8 Alie Street, 29-31 West Tenter Street, E1. NGR TQ 3380 8110.
7. Site G. 49-59 Mansell Street, 2-8 Alie Street, E1. NGR TQ 3382 8115.
8. Site H. 53-66 Prescot Street, E1. NGR TQ 3400 8100.
9. Site I. 9 St Clare Street, EC3. NGR TQ 3372 8106.
10. Site J. The Three Lords, 27 Minories, EC3. TQ 3365 8140.
11. Site K. 28-29 West Tenter Street, 59 Mansell Street, E1. NGR TQ 3384 8108.
12. Site L. West Tenter, E1. NGR TQ 3390 8101.

These archaeological campaigns revealed 136 cremations, 550 individuals from 545 inhumations and 165 additional features, which were interpreted as disturbed burials mostly with no preserved bones. The chronology of the cemetery spreads from the 1st to the 4th century AD. There was not chronological separation between cremation and inhumation rituals However, cremations tend to be more numerous between the 1st and the beginning of the 3rd century AD and inhumations started in the early phases and continued until the final use of the cemetery.

The unusual overlap of inhumations and cremations during the earlier centuries has been interpreted variously. It might represent immigrants from other British regions or other parts of the Empire where inhumation was a common practice (Whimster 1981, 37-59), but anthropological and archaeological evidence is not sufficient to confirm this hypothesis. It was also suggested that inhumation was a cheaper burial option than cremation. Thirdly, there is the chance that inhumation was the traditional funerary ritual of the native people from the region around London or of the founders of the city. These hypotheses cannot be conclusive on the current evidence (Barber and Bowsher 2000, 300).

Generally, inhumations offered poor preservation of organic matter and the examination of human remains was limited by this conditions. Dating and phasing the burials was also problematic. The chronology mainly relied on artefacts, but it is loose and do not allow precise chronological definitions. Inhumations were distinguished by five phases from earlier than 150 to 300 – 400 AD (Barber and Bowsher 2000).

The Eastern cemetery of London shares similarities with the Trentholme Drive cemetery in York (Wenham 1968), even if it has been underlined that the two sites might have better comparisons revealed by further excavations (Barber and Bowsher 2000, 302). They match in their long continuity of use, anthropological finds, male and female burials proportion, simultaneous presence of cremations and inhumations, and presence of different mortuary rituals. Moreover, the two cemeteries have two main inhumation alignments; burials are disturbed to a similar degree and density and *ustrina* were present in both sites. These similarities are likely because the two cemeteries belonged to Roman sites of new foundation. Therefore, it may be suggested that other urban cemeteries can have analogous features of the Eastern cemetery of London and Trentholme Drive.

Cemetery population and skeletal preservation

The anthropological examination of the human bones show a strong homogeneity and it suggests a common origin of these people, but exceptions are present as well. However, this assumption is affected by the poor preservation of human bones. Therefore, any conclusion on possible family groups cannot be conclusive. Moreover, it appears that the population is not a balanced sample because of the low representation of female and immature individuals. This situation is commonly found in urban Romano-British cemeteries.

Table 1 and graphs 1-3 summarise data on the skeletal remains of this cemetery. It is evident that the proportions between adult and immature and male and female do not portray a complete population. Adult women and juvenile individuals are under-represented. It has been suggested either that infants were raised away from London or that different funeral rites, which did not leave archaeological evidence, were arranged for them (Barber and Bowsher 2000, 313). Similar interpretations are possible even for adult female burials. Infant and female burials might be restricted to areas of the cemetery that have not been investigated, but it seems extremely unlikely. Otherwise, both categories had less visible burial rituals than for adult males. The disproportion between men and women could also reflect the real situation in the Roman London, where the majority of men lived without a regular partner, like soldiers or entrepreneurs who stayed in the city without their family. Wider comparisons with other British and Continental urban cemeteries may provide more data for interpretations.

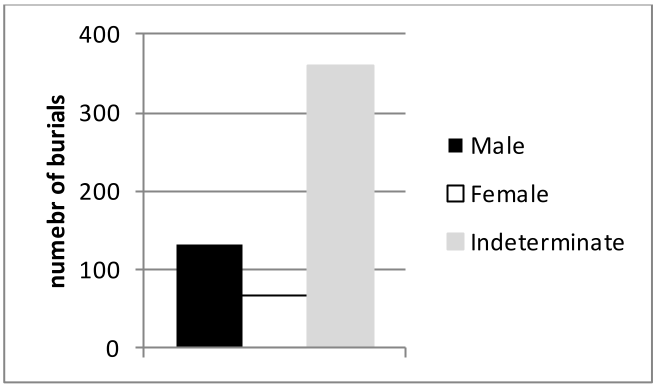
Generally, the preservation of bones is poor, but exceptionally some inhumations were found still well preserved. The degree of skeletal preservation is extremely variable and it cannot be reduced to any simple pattern considering the effects of burial depth and presence of coffin. The identification of the body disposal was not easy, but where it was successful, it was found different disposal of bones. Supine posture is the most regular. Another 14 burials were lying prone and nine were on one side. However, the report does not provide a complete record of all burial disposals. Hence, it was not possible to record body position accurately in the present database and in the following table 1.

Different burial rituals were present in this cemetery. Multiple burials were present, and they occurred both in piles and side by side burials. A large number of inhumations were coffined or covered by tiles or packed with stones. Coffins were made by different material: wood, lead, stone inhumations. The wooden coffins were the most frequent and they could be made with metal nails or without.

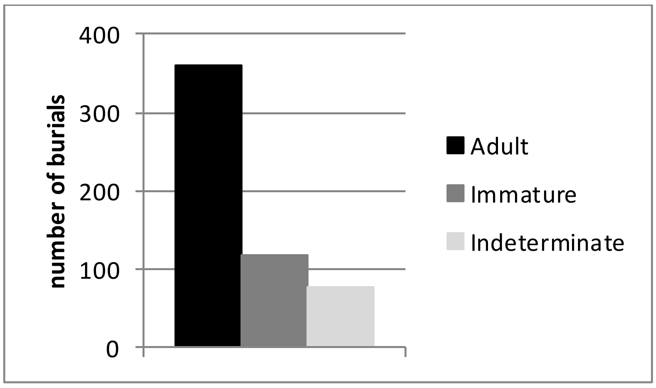
Six burials had the skulls displaced. Signs of cuts were found on the bones. However, on this evidence, it is not possible to define them as proper decapitations (Barber and Bowsher 2000, 89-91). The presence of chalk, namely calcite containing coccoliths, was found in 81 inhumations. The use of chalk in place of gypsum, might have been as a cheaper choice to use as a preservative material for the corpses (Barber and Bowsher 2000, 101-103).

Table 1: Eastern Roman cemetery of London skeletal remains: sex, age and preservation.

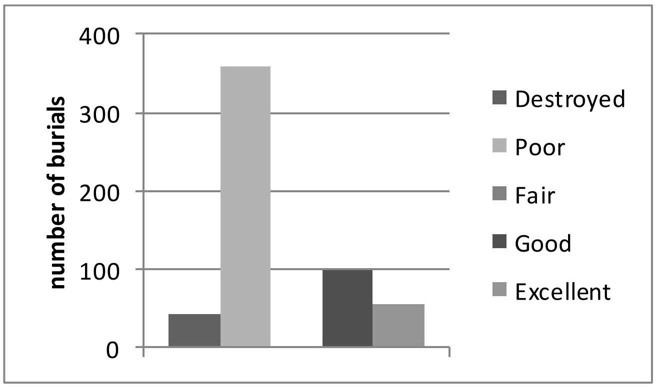
Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
66 (11.8%)	131 (23.5%)	360 (64.6%)	361 (64.8%)	119 (21.3%)	77 (13.8%)
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
0	42 (7.5%)	358 (64.2%)	3 (0.5%)	98 (17.5%)	56 (10%)



Graph 1: Eastern Roman cemetery of London, human remains; sex.



Graph 2: Eastern Roman cemetery of London, human remains; age.



Graph 3: Eastern Roman cemetery of London, human remains; preservation.

2. Poundbury

During World War I, some Roman burials were found on the east slope of Poundbury Camp, near Dorchester. They were the first evidence of what was revealed as a wider archaeological site, which included settlements, structures and graves from the Neolithic to the post medieval period. The cemeteries of Poundbury (NGR SY685911) are close to the Roman urban centre of *Durnovaria*. It seems more appropriate defining Poundbury as a series of cemeteries. Different funeral disposal is present: one grave dates to the middle Bronze Age, 59 crouched burials belong to the Iron Age. It is likely that the crouched inhumations perpetuated into the early Roman phase between the mid-1st and early 2nd century AD. This section is dedicated to the description and analyses of Late Roman inhumations and data from the original report published by Farwell and Molleson (1993).

As it has been written above, the site includes burials from different periods. The most ancient is **grave 455**, which dates to the Middle Bronze Age, but it is unique and it was an infant crouched inhumation (Farwell and Molleson 1993, 6). Other burials were placed during the Late Iron Age; overall there were 59, with 28 adult burials and 31 subadult burials (Farwell and Molleson 1993, 6-13). There were crouched inhumations, which continued during the early Roman period from the middle of the first and early second century AD.

Roman graves are the most numerous funeral features at Poundbury (Farwell and Molleson 1993, 14-83). The main report was divided into six groups, all inhumations as follows: main cemetery, site C, Northern peripheral burial group, Eastern peripheral burial group, outlying late Roman burials and later stages of the main cemetery. However, this study considers all the sites as a unique cemetery. The chronology spans from the late 2nd century to post-Roman times, the sites diverge in population composition, in grave object distribution and other features. Below, principal characteristics of all the sites are summarised according to the major report.

The **main cemetery** spans mostly the 4th century AD, but the chronology is based on a limited number of datable grave objects. 1114 burials were identified, but not all of them were fully investigated. Commonly, the rite was a single inhumation, while some spare bones were found in eleven burials. Numerous burials have traces of furnishing like wooden coffins, mostly indicated by iron nails and organic stains in soil. Some mausolea form part of this cemetery, and some of the graves included in this structure have wooden coffins with lead linings and traces of plaster. This cemetery included also three post-Roman inhumations (**grave 512**, **1188** and **1341**). After this phase, the site changed use and only occasional post-Roman burials have been found in this area. Ten mausolea were noticeable features of this cemetery (Farwell and Molleson 1993, 45-61). Unfortunately, they were only partially investigated and detailed descriptions can be acquired by the original report. Here, it is important for preservation purposes, to underline the fact that these funeral buildings had tiled roofs and plastered walls. Moreover, the mausolea contained some lead lined coffins and coffins filled with gypsum (**graves 99**, **517**, **529** and **530**) or limestone (**grave 514**).

The **Site C** included 91 excavated burials, mostly were extended and single inhumation. It is placed at the Southern side of the main cemetery, but slightly separated from it. It is suggested that it was demarcated by earlier borders. Stratigraphy and artefacts dated this cemetery to between the late 2nd and the first quarter of the 4th century AD. The site is noticeable for the 31 infant burials, less than one year old, a high number that is uncommon in a Roman cemetery. Wooden coffins were identified in some burials and stone linings were present. Grave objects are present in 13 burials out of 91, which seems a significant figure if compared with the lower occurrence and more congruent with standard grave object assemblages, for Roman burials, of the main cemetery.

The **Eastern peripheral burial group** comprised 89 excavated inhumations and three cremations, located on the Eastern side between site C and the main cemetery. This cemetery is distinguished from the main cemetery by grave orientation and the higher presence of grave goods. The most regular accompanying objects are hobnails, which are often close to the feet area, indicating possible clothed burials. Coffins were identified by traces of wood in more than half of the graves, but no evidence of lead linings or stone coffins were found. Chronology of this cemetery is based on coins and pottery dating, the span being between the 3rd and the 4th century AD.

The **Northern peripheral burial group** is close to the main cemetery and some burials overlap the two sites. However, 36 inhumations were included in this site and 33 were excavated. Usually, these were single burials. Wooden coffins were present, but no traces of lead linings, stone coffins and iron brackets were found. Adult males and females were evenly represented, while immature burials occurred less than the other Poundbury sites. Presence of grave goods is high, especially if compared with the other sites. Two thirds of burials contained objects. Most commonly occurring grave objects are hobnails and food offerings. The duration of use of this site was suggested to be within the 3rd and the 4th century AD, by some artefacts and the relations of the graves and close enclosures.

The **outlying late Roman burials** are a group excavated or only observed in the external areas and not included in the main cemetery and site C. These graves were pooled by common orientation west-east and extended position of the skeletons. Two graves (**graves 1425** and **1426**) contained beheaded burials and the same ritual was implied for **graves 1429** and **1430**. At Poundbury, beheading was registered only in **grave 116** of the main cemetery. It is not clear if these graves belonged to a defined area, as there were no clear limits. Traces of wooden coffins were also found. The chronology of these burials does not rely on dating grave goods, but mostly on general comparison of grave shape with the main cemetery and stratigraphic relationships, which suggest a late Roman chronology.

Excavations of funeral sites at Poundbury improved the general knowledge of burials of both late Iron Age and Roman cultures – and even Middle Bronze Age, although limited to only one grave. All cemeteries were compared with each other and then compared to a regional scale in order to outline possible funeral patterns in Southern Britain. Woodward (in Farwell and Molleson 1993, 219-

239) considered and analysed the four main Roman burial groups: main cemetery, site C, eastern and northern peripheral groups, and he also evaluated their results with the Roman cemeteries at Lankhills, Ilchester, Lynch Farm, Cirencester, Bradley Hill, Henley Wood and Ulwell. The discussion was addressed to examine material evidence like sex and age, bone disposal including unusual attitudes and rare body treatments like beheaded burials. Moreover, coffins, whether they were made in wood or in lead, other burial linings, funerary structures and grave alignment were also treated. Obviously, grave goods were analysed, and were grouped by selected categories. Besides material evidence, social and religious influences were also considered. The analyses were supported by tabulations, plans and histograms. Relevant outcomes from this research follow below.

1) Biological analyses (Farwell and Molleson 1993, 222). Adult female inhumations are relatively more numerous than adult male and immature. This is not a common feature for Roman cemeteries in Britain, but it is not a unique occurrence, because the same happened at Cannington, Ulwell and Bradley Hill cemeteries. Immature inhumations have an uncommonly high presence among Roman cemeteries. This may imply that sub-adults were buried in the same places as adults, a practice that did not occur often in Roman Britain.

2) Cultural analyses (Farwell and Molleson 1993, 230-233). Grave goods were grouped by selected classes of objects like coins, ornaments, equipment, hobnails, vessels and animal remains. The four Roman sites were split into two groups. The eastern and northern cemeteries contained grave goods, whereas the main cemetery and site C had a low occurrence of objects. The association between sexes and age with grave objects revealed that there was a balanced distribution among the groups, but a small bias was observed in young adult female and middle-aged male burials.

In conclusion, the cemeteries of Poundbury offer extensive data about interment practises during Roman times. There are some peculiarities, which distinguish these sites from most of the Roman cemeteries. Generally, they can be described as standard Roman cemeteries with likely influences derived from the native cultural background and new beliefs introduced from Europe and Africa, possibly linked to Christianity (Watts 1998).

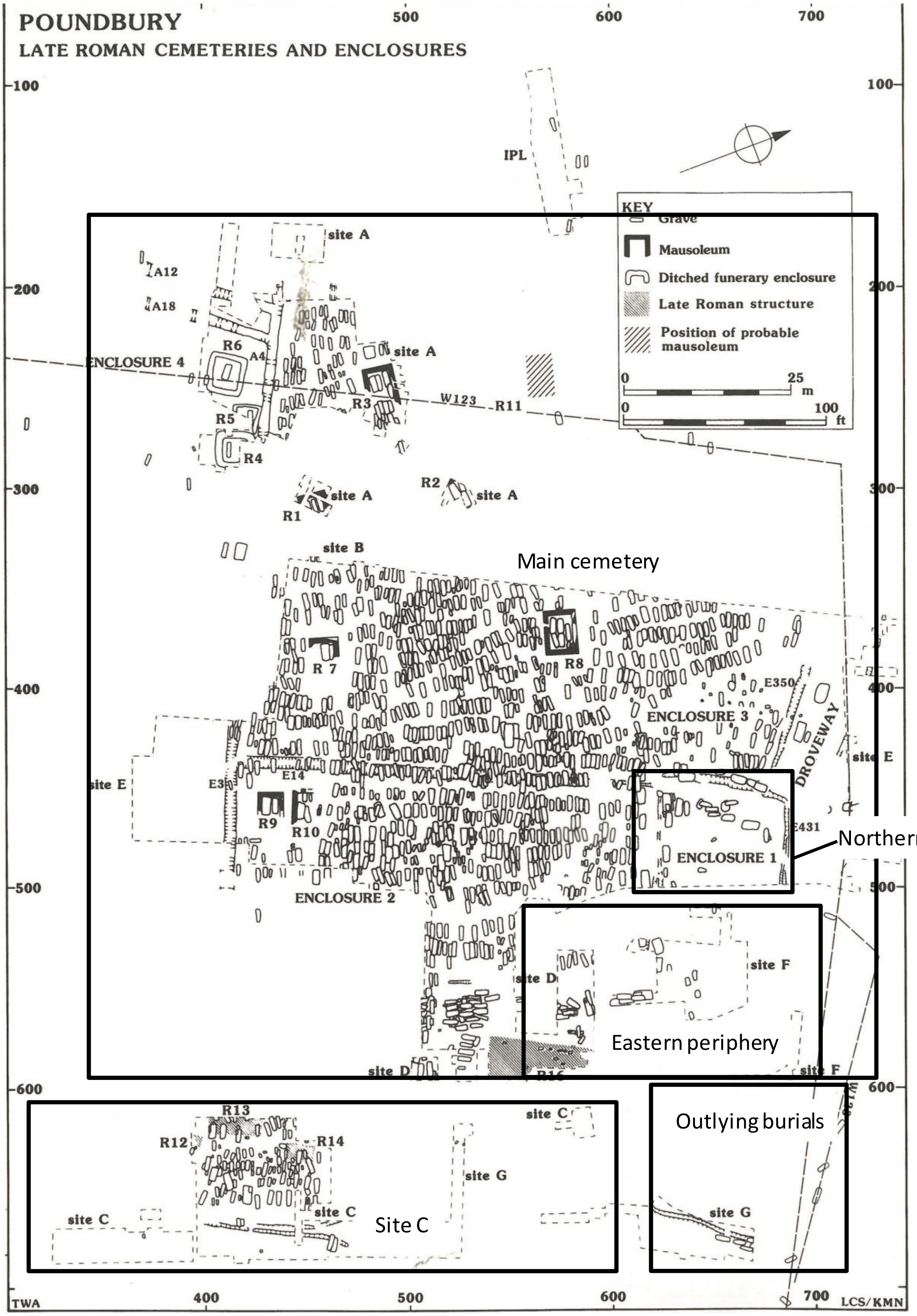


Figure 2: Poundbury cemeteries map (modified from © Dorset Natural History and Archaeological Society 1993, Farwell and Molleson 1993, 42 fig. 33).

Cemetery population and skeletal and hair preservation.

The skeletal remains of Poundbury cemeteries are here discussed as a whole, unless any peculiar characteristic arises in a cluster of graves. Generally, these burials show great care in body treatment. It is revealed by hairstyle of those inhumations, which preserved hair, as in male burial **graves 376** and **530** and adult female **graves 817** and **529**. Hair seemed to be oiled, combed and manually arranged before burial. **Grave 817** still had preserved hairdressing made by five and six strand plaits. Moreover, the good quality of body treatment appeared influenced by burial coverings. There are different choices in coffins and cists. There were used stone cists and coffins, or wooden coffins with lead linings. Sometimes these burial options were in combi nation, while wooden coffins were a regular preference. At least one burial seemed to have a coffin build to fit perfectly to the body (Farwell and Molleson 1993, pl. 50b, 148).

Female, male and subadult burials were scattered arbitrarily, which suggests there was no prearranged plan. There was no organisation of managing funeral space bigger than family preferences. Table 2 shows distribution patterns in terms of sex and age. Adult women and men have a ratio around 1.1, while adult burials are more than double those of immature graves.

Preservation of bones is included in table 2 even if the report did not provide enough data for this feature to be considered complete. Therefore, the discussion on human remains preservation is limited only to the recorded data. The range of bone preservation varies greatly, but two main clusters are of poor and good preservation, with reduced occurrences of the extreme preservation conditions. As it has been written above, some six burials preserved human hair (**grave 376, 478, 529, 530, 817, 862** and **1215**) and four burials kept hair marks on the skulls (**grave 599, 635, 935** and **1346**) (Farwell and Molleson 1993, 205-206).

Lead lining in wooden coffins and gypsum are likely correlated with the hair's preservation (fig. 3). The preserved hair has been analysed and described, but it was not discussed in detail. SEM analyses on a hair sample from **grave 1215** found actinomyces hyphae, both past and modern, attached to the hair. These saprophytes attack, among the other organic materials, keratin and cellulose (Betina and Frank 1993, 703-704). Hence, the clear signs of degradation on the hair of **grave 1215** are due to actinomyces activity (Farwell and Molleson 1993, 206). The actinomycetes are aerobic organisms that live in neutral or slightly alkaline soil high in organic content. They are generally responsible for the first degradation of organic matter (Betina and Frank 1993, 703-704). Some implications arise from this burial. The survival of hair, attacked by keratin – consuming fungi, of **grave 1215** may suggest original presence of a sort of textile, either clothing or shroud, which was readily consumed by the microbes.

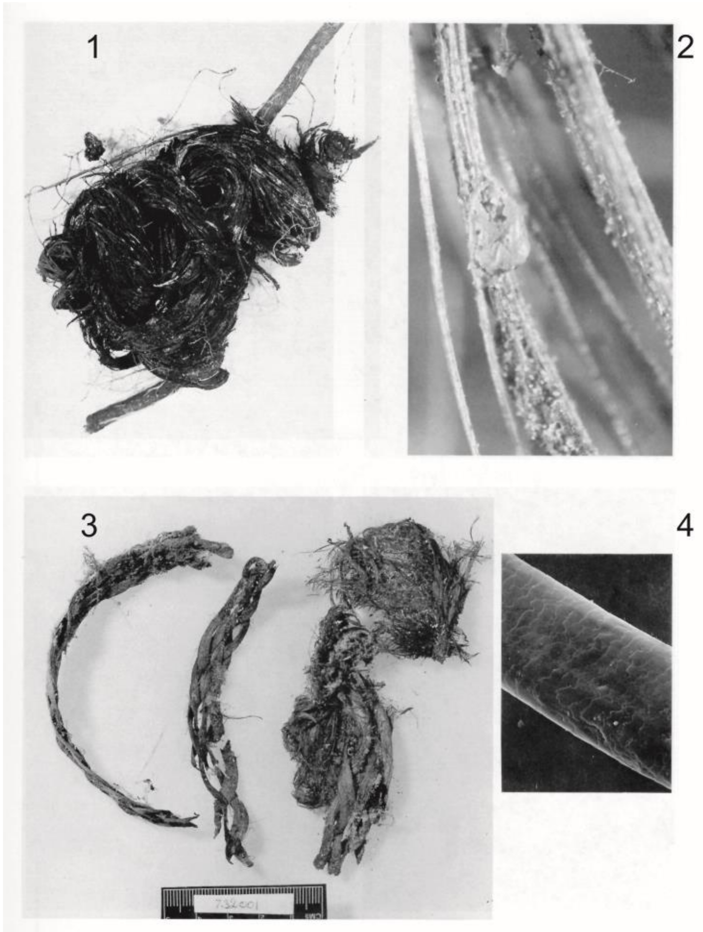


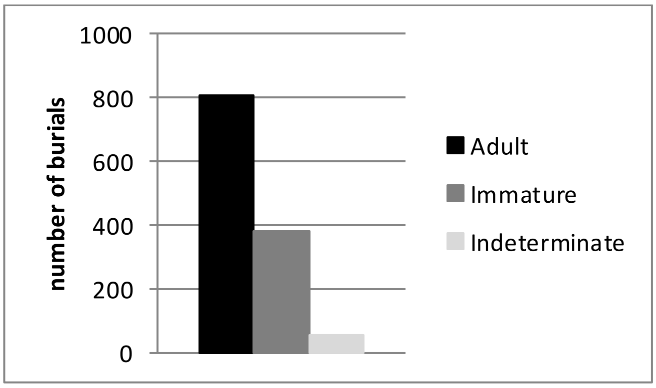
Figure 3: preserved human hair from some burials lined lead coffin of Poundbury. 1) grave 529; 2) grave 376 3) grave 817 and 4) grave 530 (© Dorset Natural History and Archaeological Society 1993, Farwell and Molleson 1993, plate 49).

Supine disposal was the prevalent posture and, rarely, crouched burials occur that seem to be linked to the Durotrigian late Iron Age burial tradition. The population buried at Poundbury cemeteries has metrical and non-metrical bone measurements, which were homogeneous. This uniformity indicates that at Poundbury local people, with only a few immigrants, mainly composed the late Roman population.

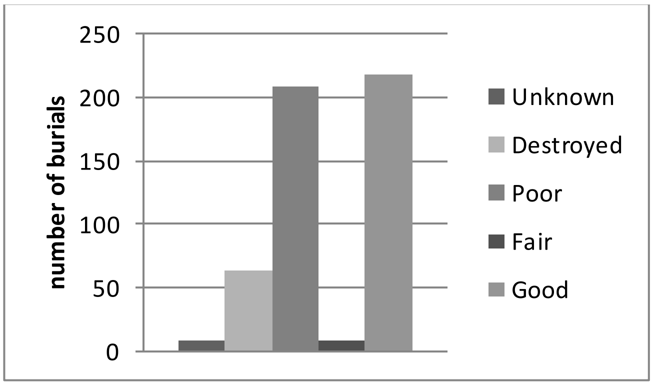
Table 2: Poundbury Roman cemeteries skeletal remains: sex, age and preservation. The numbers in the box are the sum of the main cemetery; eastern periphery; northern periphery; site C; outlining graves. Percentage values are not provided for bone preservation.

Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
416 (33.5%)	376 (30.2%)	449 (36.1%)	807 (65%)	380 (30.6 %)	54 (4.3%)
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
9	63	208	8	218	0

Graph 4: Poundbury, human remains; sex.



Graph 5: Poundbury, human remains; age.



Graph 6: Poundbury, human remains; preservation.

3. Alington Avenue

The site of Alington Avenue, Fordington, Dorchester (NGR SY 702899) was discovered during archaeological campaigns between 1984 and 1987, which also revealed indications of human presence in that region from the Neolithic up to the Middle Ages. The archaeological investigations consisted of one extensive excavation, plus some rescue and evaluative excavations. The result of this investigation produced an historical and environmental reconstruction from the Neolithic to post-medieval times.

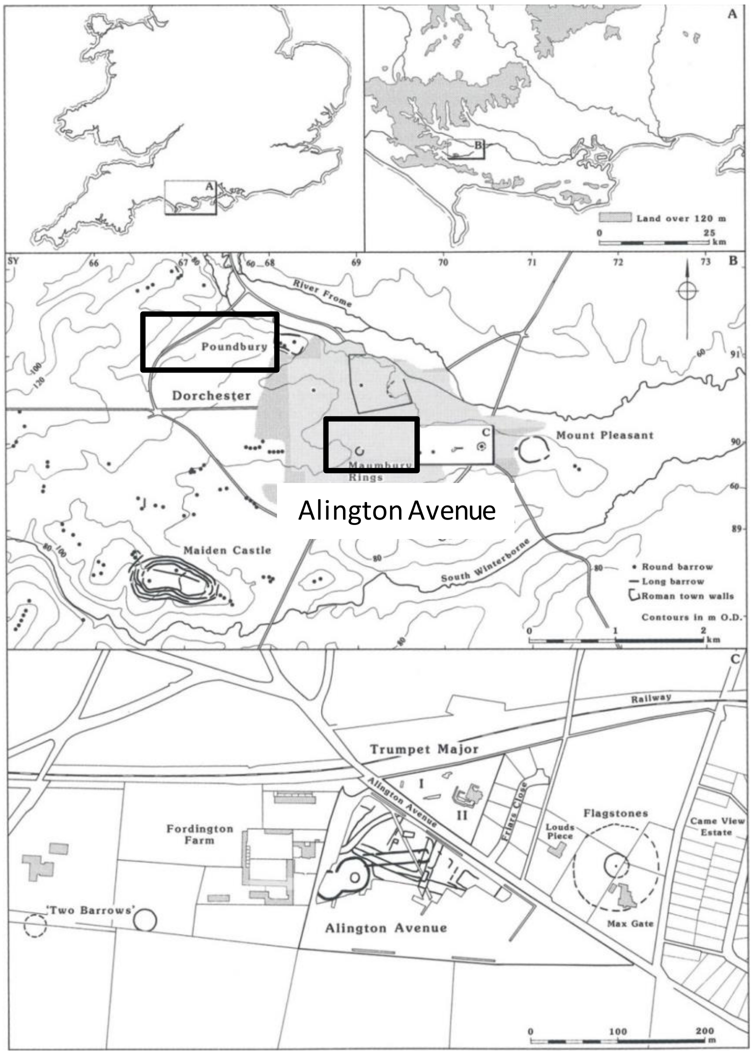


Figure 4: Alington Avenue and Poundbury Roman cemeteries positions (modified from © Wessex Archaeology Davies *et al.* 2002, fig. 1, 2).

Prehistoric ditches were discovered and evidence for Iron Age settlement. Some buildings, enclosures and other structures constituted a Roman settlement. Structures were also dated to post-Roman and early medieval times and some features were post-medieval. The site included burials with both cremation and inhumation rituals, of Iron Age, Roman and Late Roman period. Medieval structures and post-medieval features were also present.

This section is based on the main report of those excavations (Davies *et al.* 2002) and it takes into account data related to the Roman, Late Roman and Iron Age inhumations of the principal site of Alington Avenue (Davies *et al.* 2002, Appendix 2), excluding those of Trumpet Major I and II.

The cemetery belonged to the settlement, which was part of a series of peripheral farming centres around *Durnovaria* and they were subordinate to it. The cemetery was close to a Roman road. Hence, it can be a good example of a rural cemetery, to be compared with the urban cemeteries.

The principal site includes 77 late Roman burials and some 14 earlier Roman inhumations, which includes **grave 2614** found completely empty. The site also incorporated nine Iron Age burials, which are also called *Durotrigan*. The chronological sequence of the graves is affected by the chalky texture of the soil, which often makes preserved stratigraphic relationships difficult. Some of the burials did not contain artefacts and they were more difficult to date. Iron nails were the principal evidence of coffins, while some of the graves were without coffins.

Durotrigan inhumations were nine at Alington Avenue and three were from Trumpet Major I, which are not considered here. These late Iron Age inhumations were close to the settlement area and were likely last phases of a bigger funeral area (Davies *et al.* 2002, 196). Grave goods accompanied seven of the nine burials, but only a few grave objects were related to clothing and personal ornaments. It is clear that the low number of graves does not stimulate fruitful debate about the population, but these low figures and the presence of other late Iron Age burials in close sites may indicate that those of Alington Avenue were part of a bigger burial area. This study examines only the Roman inhumations and the Iron Age burials are not included in the present analyses.

Roman burials are related to the foundation of *Durnovaria* and they were linked to a rural settlement. The quality of graves and their grave goods suggested that most of the burials were of a low social class. The grave goods were evenly distributed among male, female and immature burials, without any clear distributive pattern (Davies *et al.* 2002, 142).

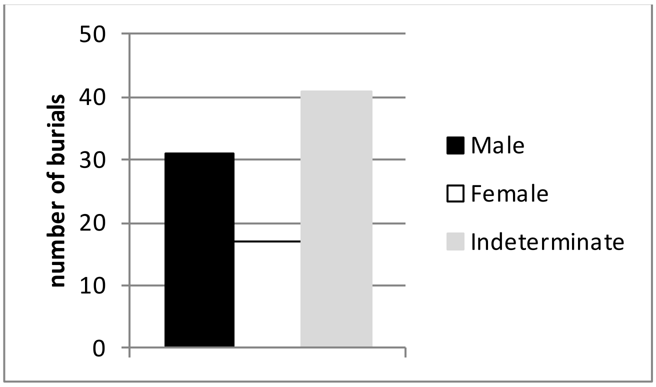
Cemetery population and skeletal preservation

The present calculations are based on the data reported in Appendix 2 of Davies *et al.* 2002. The same report has some incongruities in the recorded figures in chapters 4 and 5. For instance, six infant burials found in a building are briefly reported in chapter 4 (Davies *et al.* 2002, 69) and not described in detail in Appendix 2. About the Romano-British burials, the report confirms that the site had “In total, ninety-one extended inhumation burials” (Davies *et al.* 2002, 126), but the figures in Appendix 2 are different and the Roman and Late Roman burials are 98, even including the empty graves. Moreover, table 24 at page 127 reports that there are 13 earlier Roman burials, but the list counts 14 burials.

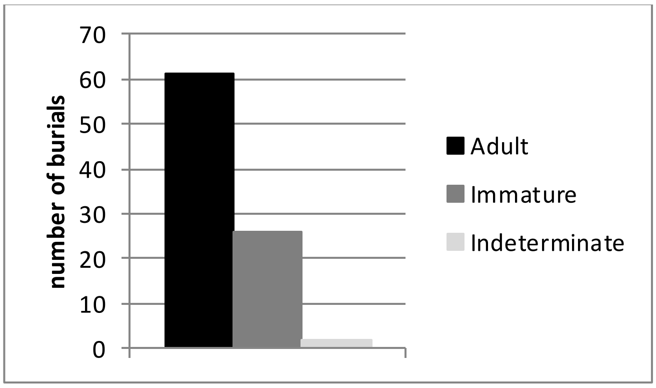
Keeping in mind those inconsistencies, Roman and Late Roman interments are 107, including ten graves with no bones left. The population of this site does not have a balanced demography of sex and age. Adult male individuals are the best represented in comparison with women and young people. Most of the burials are extended and the bone preservation is generally poor or very poor (tab. 3). The water drainage is facilitated by the soil texture and it is a major factor in the poor preservation of bones.

Table 3: Alington Avenue, skeletal remains: sex, age, preservation and posture.

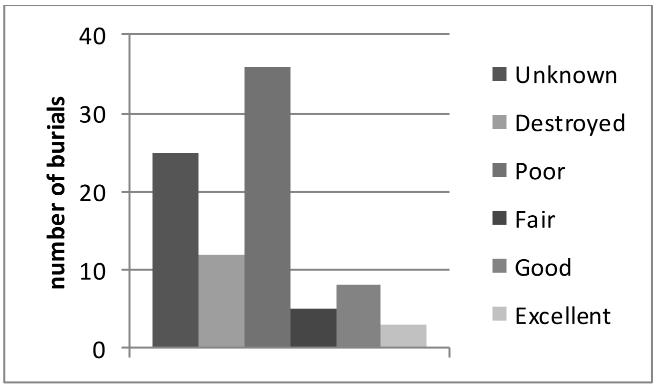
Sex			**Age**		
Male	Female	Indeterminate	Adult	Juvenile	Indeterminate
31 (34.8%)	17 (1.3%)	41 (3.3%)	61 (68.5%)	26 (29.2%)	2 (2.2%)
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
25 (28%)	12 (13.4%)	36 (40.4%)	5 (5.6%)	8 (8.9%)	3 (3.3%)



Graph 7: Alington Avenue, human remains; sex.



Graph 8: Alington Avenue, human remains; age.



Graph 9: Alington Avenue, human remains; preservation.

4. Lankhills

In 1961, the late Roman cemetery of Lankhills (NGR SU479304) was accidentally discovered in a construction site. The first series of campaigns lasted from 1967 to 1972, initially founded by Winchester College and then Winchester Schools Archaeological Committee (Clarke 1979). Second series of archaeological excavations were accomplished by Oxford Archaeology Unit (from now abbreviated as OA) between 2000 and 2005 (Booth *et al.* 2010), because new building work was in the surrounding areas of the previous excavation. The site is positioned out of the north gate of the wall *Venta Belgarum* (Winchester). It was part of the Northern cemetery, which served the Roman city, and it flanked the road from *Venta Belgarum* to *Corinium* (Cirencester).

The site was published in two reports, which referred to two separate archaeological investigations (Clarke 1979; Booth *et al.* 2010). The first mission excavated 451 graves including seven cremation burials and 439 inhumation burials. There were excavated also five grave-pits, one of those still contained partial human remains (Clarke 1979, 12-14). The second series of digging campaigns discovered further 355 inhumations and 35 cremations and unearthed 313 graves and all cremations (Booth *et al.* 2010, 17-26).

The site is considered of extreme importance for Roman archaeology in Britain, not only for its long continuity in use and number of graves, which have characteristics common with other urban cemeteries. Inhumations are uniform, but some include peculiar elements and they appeared important for this study. Clarke (1979, 377-403) stated that Lankhills hosted two groups of graves containing incomers, establishing his interpretation on comparisons of artefacts found in British and Continental contexts. Chronology, number of graves, presence of grave goods and type of grave objects distinguished the two groups. Then, he showed parallels with all known case studies, which might have similarities with those foreign burials. The first group was composed of 16 inhumations, dated between AD 350 and 410 that were indicated to be of migrants from Pannonia and Sarmatia (Clarke 1979, 378-386). Another six graves, dated between AD 390 and 410, possibly including newcomers, were suggested to be Anglo-Saxon, even if it was admitted that there was difficulty in identifying the origin of this heterogeneous group of graves (Clarke 1979, 390-398).

In the publication (Booth *et al.* 2010, 421-428), which followed the second excavation project, strontium and oxygen stable isotope values were produced and examined in a sample of 40 individuals. This analysis showed that a portion of the population were incomers from the Mainland, especially North-Western Europe, with three individuals of Mediterranean origin. Only one of those sampled was from Pannonia, while Clarke suggested that most of the migrants had origin in Central Europe, mostly in Pannonia. A stable isotope bias can occur when local children are analysed, even if their parents were immigrants. Hence, combinations of studies on artefacts and stable isotope analyses demonstrated how likely geographical origin could not be always correlated with the culture expressed by grave goods and can raise more questions than answer. For example, **graves 81** and **426** (Clarke 1979, 377) contained grave goods – belt assemblage and brooch - of Central European style, while **grave 1175** (Booth *et al.* 2010, 309) included a local type buckle and any brooch.

Another peculiarity of Lankhills is the rare high occurrence of grave goods compared with other Roman cemeteries (Clarke 1979, 201-327; Booth *et al.* 2010, 247-338). This might have some relevance in the cultural size and shape calculations. Moreover, this site has been crucial in the discussion on the Christian penetration in Britain. Clarke observed that possible Christian marks like grave orientation, lack of grave goods and care of the burials, which were present at Lankhills, might be interpreted differently, but still he did not deny the Christian presence in Late Britain, he just reduced its expansion and influence (Clarke 1979, 424-433). A similar and stronger position was taken by the more recent study on Lankhills (Booth *et al.* 2010, 521-522). It was stated that there were numerous Christians in Late Britain burials 'but this does not mean that there was at this time a common rite of burial which would have been characterised by contemporaries as distinctly Christian in character, much less one that can be identified as such on the basis of archaeological evidence (Booth *et al.* 2010, 522). Hence, the interest in this cemetery is based on a relatively high number of grave goods, but not easy to interpret.

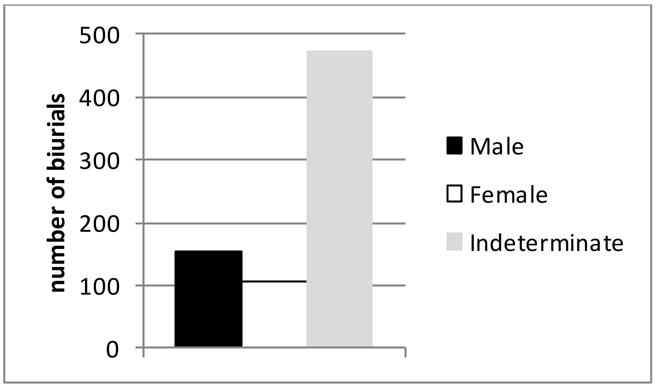
Cemetery population and skeletal preservation

Here, data of skeletal remains of Lankhills burials are examined. Figures are assembled from both reports dedicated to Lankhills Roman inhumations (Clarke 1979, 123-127 and 342-344; Booth *et al.* 2010, 339-403).

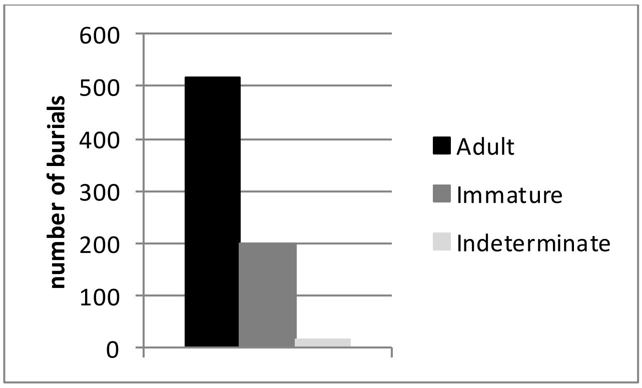
Biological examinations identified sex successfully in 35.5% of burials and age in 98% of inhumations (tab. 4). Among identified burials, men were more numerous than women and sub-adults were less than adult. These figures (graphs 12 and 13) are consistent with the general trend of urban Roman cemeteries. Bone preservation is good (graph 14), and numerous skeletons had a good integrity, only missing small bones. The standard disposal of the body was supine, which occurred in more than 70% of excavated burials, other disposals were rarer, like lying on the side, prone or crouched. These features of skeletons at Lankhills are similar to the common trend in Roman urban cemeteries. The bone preservation appears to be somewhat superior to the average. Local soil, which is high in chalk content, and the wide use of coffins and other burial linings likely protected bones from major damage. The use of coffins and other covering systems was extensive, because 603 out of 761 graves were coffined.

Table 4: Lankhills Roman cemetery skeletal remains: sex, age, preservation and posture.

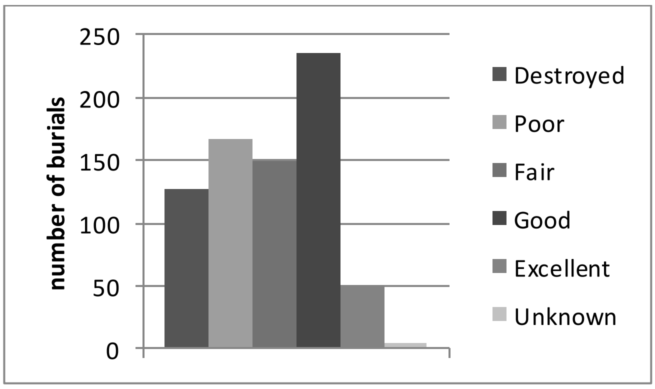
Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
106 (14.4%)	155 (21.1%)	471 (64.3%)	518 (70.7%)	199 (27.1%)	15 (2%)
Preservation					
Destroyed	Poor	Fair	Good	Excellent	Unknown
123 (16.8%)	167 (22.8%)	150 (20.4%)	236 (32.2%)	51 (6.9%)	5 (0.6%)



Graph 10: Lankhills, human remains; sex.



Graph 11: Lankhills, human remains; age.



Graph 12: Lankhills, human remains; skeletal preservation.

5. West Heslerton

West Heslerton cemetery (NGR SE 911759) has been selected as primary case study because its cultural facts and soil characteristics provide a considerable number of observations. Quantity and quality of data have been crucial in the choice of this site. The report and data analyses are the ideal model in publishing the results of a cemetery excavation (Haughton and Powlesland 1999 and 1999a). The method and the techniques of excavation were refined in order to obtain better quality of data. For example, the strategy of collecting soil blocks, in selected graves (**graves 86**, **107**, **113**, **119**, **132**, **139**, **141**, **143**, **152** and **167**) appeared productive both for excavation and post-excavation studies. Specialists from different disciplines have contributed for detailed analyses on human remains and pathologies, object types, object conservation, metals and textiles.

The number of graves (185) is appropriate for cluster analyses and statistic evaluations. Furthermore, the grave objects associated with burials are enough numerous to calculate differences between the five groups: female, male, indeterminate adult, immature and male-female difference, by the use of the CCL (ch. 3.6). Textiles are documented by several finds; they were mostly attached to metal objects. However, there were some pieces of fabrics found not fixed to fasteners (**graves 132** and **152**). Even if, it is implied, they were part of something bigger, such as a purse.

West Heslerton excavation was an excellent fieldwork and it produced interesting results on an Anglian cemetery. The main reports provided detailed information on artefacts, graves, soil features and human remains. The local environmental conditions are not the best for organic preservation. Therefore, all organic materials both human and not human remains preserved are of extreme interest, despite organic preservation is poor. However, the quantity of the found fibres shows undoubtedly that several burials were clothed. Initially, it appears difficult to reduce in simple patterns the preservation of textile with a macroscopic analysis, but there are identified variations among the graves, which suggest the utility of further investigation on these data. In addition, the physical traits of skeletons are often unidentified because of the poor bone preservation.

The Anglian cemetery at West Heslerton, East Yorkshire, was discovered in 1977 accidentally and it was dug by rescue excavations. The site is located in the southern fringe of the Vale of Pickering, at the base of the northern escarpment of the Yorkshire Wolds. The area shows signs of intensive prehistoric presence from the Late Neolithic to the Iron Age. Additionally there is evidence of Iron Age and Roman settlements having a widespread diffusion.

The Anglian cemetery was in use between the late 5th and first half of the 7th centuries (475-650 AD), so it spanned at least two centuries. It is placed over a previous Late Neolithic and Early Bronze Age ritual site, which includes 13 prehistoric burials, 10 inhumations and 3 cremations. The Anglian cemetery was not totally excavated, so it has been estimated that it comprised approximately between 300 and 350 burials. The excavation has detected 201 graves, 15 of which are cremations, 185 are inhumations and one is a grave for one horse (fig. 5).

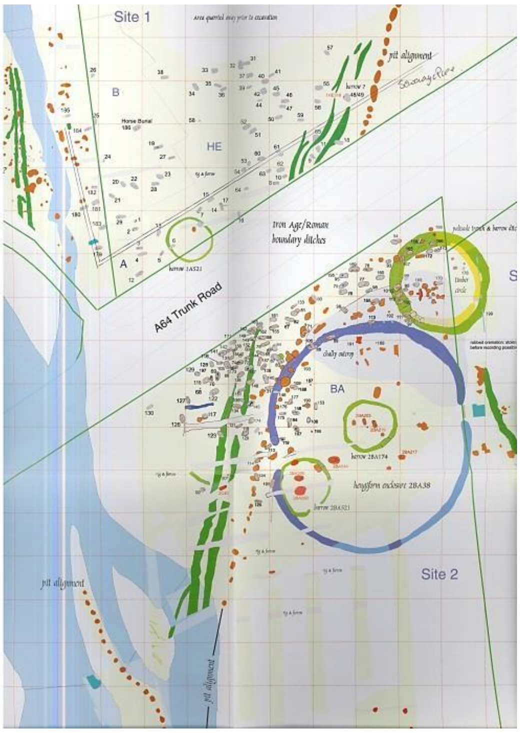


Figure 5: West Heslerton map (© Haughton and Powlesland, Haughton and Powlesland 1999, enclosed map).

Cemetery population and skeletal preservation

The inhumations were placed in graves at variable depths. There are any chances to know their original depth, because some areas have been affected by erosion, while wind has deposited further layers of sand on other areas. However, the catalogue recorded the actual grave depth, and in their comments, archaeologists have underlined the absence of a direct relation between the current grave depth and the grave contents preservation (Haughton and Powlesland 1999, 88).

Generally, the ritual is a singular burial for graves, but there are at least two certain cases of multiple inhumations in the same grave (**graves 42** and **101**) and one possible (**graves 118** and **120**). Most commonly, the skeletal remains were found in a supine extended position, or a crouched or flexed position. Often it is hard to distinguish the angle between the legs and torso, which varies from a crouched to a flexed position. Bound and prone burials are also represented and there are three cases of multiple burials.

55 inhumations were not identified as adult or juvenile, 104 are adult inhumations and 34 are juvenile inhumations. Considering the sex of the adult human remains, 23 are female plus one possible female and 15 are male plus four possible male individuals. Just one infant burial has been found. Burying in a coffin is a practice attested in some graves by coffin wooden stains and **grave 86** has contained a fragment of oak planking, which is the best evidence of a coffin at West Heslerton. In contrast, metal fittings have not been found, which implies wooden joints or other methods for coffins construction.

The geological conditions at West Heslerton are contradictory. The current pH of the soil is alkaline, which is good for bone preservation, but the diffused sandy texture produces rapid drainage for water, which affects the burials and causes extremely poor conditions for skeletal remains. 16% of the graves did not contain any human bone, while 34% of the graves show just fragmentary bones and teeth. The remaining burials have not showed any case of excellent preservation. In contrast to the bad survival of skeletons, sandy soil has produced better circumstances for the formation of body stains. The archaeologists did not find any logical pattern by which to predict human stains in these burials. Neither difference in colour or in texture helped. In order to improve the resolution of stains, chemical analyses were done to detect variations in phosphate concentrations. However, this approach was not successful and did not help to distinguish the stains better. It has been noted that decay of metal artefacts, especially those of a copper alloy, promote better preservation for bones that were nearby.

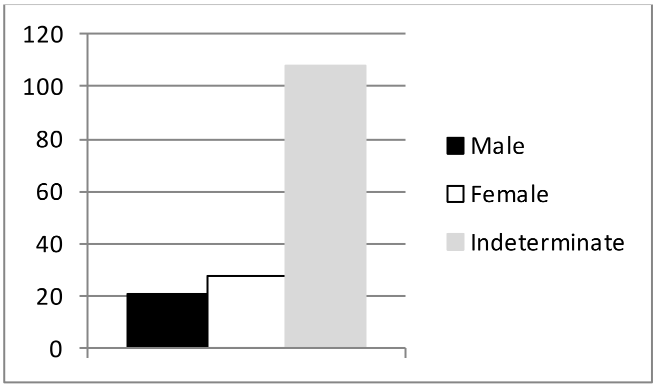
At West Heslerton 164 out of 185 Anglo-Saxon graves contained human remains in different degrees of preservation, but usually skeletons were poorly preserved. Table 5 summarises these data, which are expressed in raw numbers, while percentages are in brackets. 52 burials have been sexed by anthropological analysis, 21 are male and 28 are female burials (graph 13). The majority of sexed burials belong to adults, just few in cases sexed juvenile burials occur. The original report has gendered some burials by the associated objects (Haughton and Powlesland 1999 and 1999a). However, here these identifications are not considered and those graves are defined as indeterminate. Consequently, the remaining 112 are defined indeterminate graves (graph 16). The age is spread by 103 adult burials and 32 immature burials, of which 29 are juvenile and three infants. The age is indeterminate for 22 of burials (graph 14).

104 skeletons are poorly preserved and 37 are in destroyed condition. Only 16 are in an appreciable state of preservation (graph 15). The poor preservation affects the identification of the postures. More than half of human remains are classified as indeterminate posture. The remaining burials have different disposals like crouched, supine, prone, at side, tumbled and bound postures.

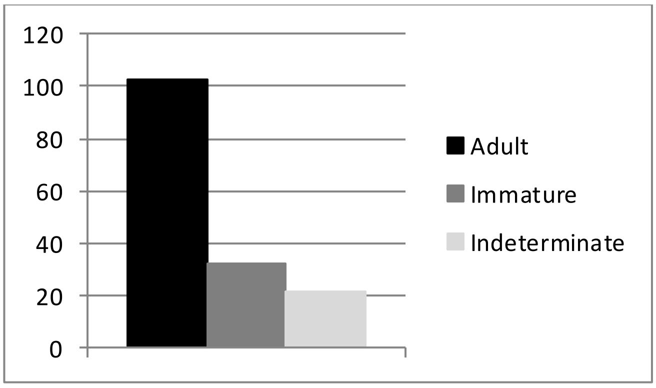
Table 5: West Heslerton Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
28 (17.8 %)	21 (13.3 %)	108 (68.7 %)	103 (65.6 %)	32 (20.3 %)	22 (14 %)

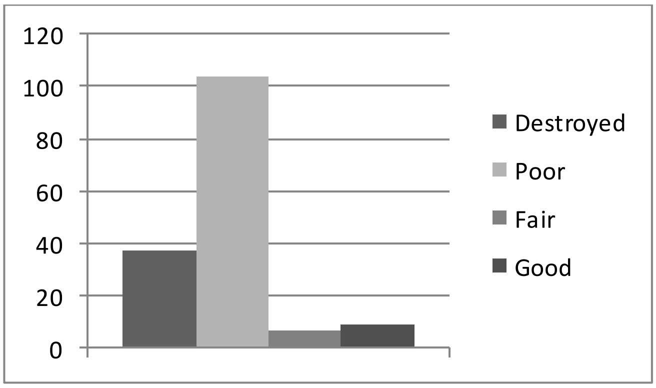
Preservation				
Destroyed	Poor	Fair	Good	Excellent
37 (26.5%)	104 (66.2 %)	7 (4.4 %)	9 (5.7 %)	0



Graph 13: West Heslerton, human remains; sex.



Graph 14: West Heslerton, human remains; age.



Graph 15: West Heslerton, human remains; preservation.

6. Alton

In 1960, the unexpected discovery of skeletons with grave goods revealed an Anglo-Saxon cemetery at Alton, Hampshire (Evison 1988). The find happened during construction work for a new bungalow. Therefore, archaeologists planned a more extensive excavation, which exposed other graves with human remains and grave goods, dated from the second quarter of the 5th century to the first half of the 7th century AD.

Unfortunately, the rescue excavation was limited by the presence of other buildings and by the lack of permission of local owners to dig their gardens. However, the disturbances on the site were limited to recent activities. Excavators did not find other signs of human presence after Saxon use. The investigation lasted about one month and a half from the end of August to the last part of October. The complete dimension of this cemetery is unknown, but it is likely that its size was bigger than the excavated area. This section presents and analyses data acquired from the published report (Evison 1988).

This cemetery is included in the list of case studies because it contains traces of organic textiles studied by a specialist (Crowfoot in Evison 1988) and it reaches the minimum number of graves to compare with the populations of the other cemeteries, even if the excavation of the cemetery cannot be considered complete. The site has been included also because of its geographical position and soil characteristics, which are different from the other sites. Alton cemetery (NGR SU 718388) is in Southern England, which is considered a Saxon area. In cultural terms, it is relevant to compare this cemetery with the other sites.

The cemetery is placed in an urban area in Alton, Hampshire, which is on the top of a sharp declivity on the east flank of the valley, which confines the source of the River Wey. The site includes Anglo-Saxon inhumations and cremations and unassociated finds both Roman and Anglo-Saxon. The inhumations are distributed in 49 graves, while cremations are 46 (fig. 6). Therefore, the Alton cemetery can be defined as a mixed cemetery, because of the equal presence of both funeral rituals.

Buried artefacts span from 425 to 650 AD (Evison 1988, 41-44). This cemetery likely served the earliest German settlers who moved in to Southern England. According to the conventional subdivision of Anglo-Saxon peoples, the grave goods confirm the identity of the buried remains as Saxon.

Figure 6: Alton cemetery map (modified © Hampshire Field Club from Evison 1988, fig. 2).

Cemetery population and skeletal preservation

Human remains were examined and reported by specialists (Brothwell and Powers in Evison 1988). The human bones from **graves 1-4** were recorded but not analysed for the publication, while **graves 10** and **48** were not dug, but only identified. **Graves 18** and **38** did not contain bones. The bones from **grave 5** were studied, but their position was unknown. Consequently, it was possible to record the position of 42 burials out of 49.

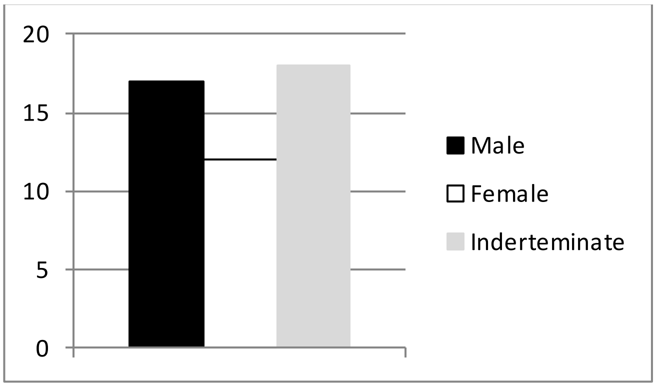
The preservation of bones is uneven; soil chemistry consistently ruined the surface and cortex of bones (Evison 1988, 59). Scavenger activities were noticed in **grave 42** and **35**. Anthropologists are unsure regarding **grave 37**. The position of the head is not natural and the interpretation is still open, even including animal disturbance or the more unlikely possibility of beheading. Interestingly, **graves 7** and **45** have the uncommon position of the spear at the knees. Both are male burials and the remains show defects at the back in burial **7** and at a leg in burial **45** (Evison 1988, 29).

Usually, burials contain one skeleton. The only multiple burial was in **grave 49**, which contained the bodies of a juvenile and an adult male. Even if the excavation does not reveal the cemetery in its completeness, the type of object assemblage and some osteological similarities allowed the differentiation of clusters of graves (Evison 1988, 37). The grave outlines are recorded with regular shapes and rounded extremities. Coffins or stone furnishing were not found. Data of this cemetery population are summarised in table 6 and in graphs 20-23.

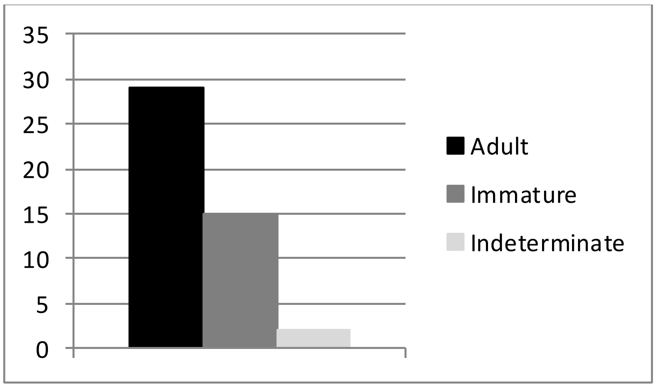
Table 6: Alton Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			Age		
Male	Female	Indeterminate	Adult	Immature	Indeterminate
17 (36.1%)	12 (25.5%)	18 (38.3%)	29 (61.7%)	15 (31.9%)	3 (6.3%)

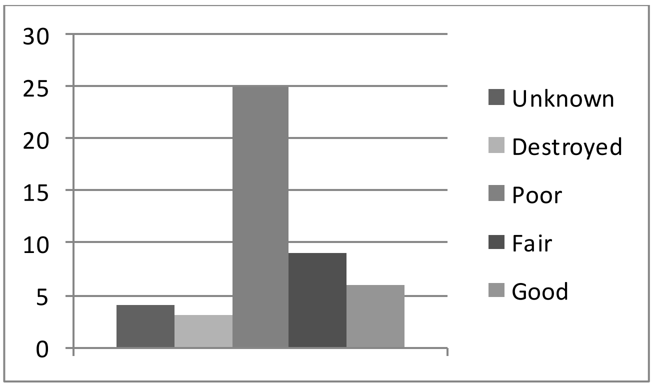
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
4 (8.5%)	3 (6.3 %)	25 (53.1 %)	9 (19.1%)	6 (12.7%)	0



Graph 16: Alton, human remains; sex.



Graph 17: Alton, human remains; age.



Graph 18: Alton, human remains; preservation.

7. Beckford A and B

Two Anglo-Saxon cemeteries were discovered in the parish of Conderton, close to the village of Beckford (NGR SO972360), during the fifties. In the area near Carrant Brook, gravel-digging works revealed human bones and two Anglo-Saxon brooches in 1954. That was the first discovery of cemetery A. A few years later, cemetery B was found in similar circumstances at 550 metres of distance from cemetery A (fig. 7 and 8). Archaeologists dug up the cemetery partially from 1954 to 1959. They were rescue excavations, which might affect in some way the data. This section refers to the field information in the original report by Vera Evison and Prue Hill (Evison and Hill 1996). Gravel-digging partially destroyed both cemeteries. Therefore, excavations did not find all limits of the sites and both are considered incomplete. However, calculations have estimated that archaeologists missed just small portions of cemetery B and around a half of cemetery A (Evison and Hill 1996, 27 and 31).

The cemeteries A and B of Beckford are presented in the same section but they are analysed separately because there are good reasons to suppose they both served the same unidentified settlement. Hints of this come from the geographical position and the chronology of these graveyards. Both sites can be dated by artefacts chronology to between 475 and 550 AD. In that period, Beckford and Conderton areas were at the western border of Anglo-Saxon control. The two sites were isolated from the main routes, which connect the other Anglo-Saxon kingdoms and the Continent. The grave goods analyses indicate limited contacts and even the absence of Romano-British cultural traits.

The number of inhumations, position of the sites, soil features and report on the textile fragments are good reasons to include these cemeteries as case studies in the present research. These sites provide a good representation of western Saxon settlement and its funeral customs between the end of the 5th and the middle of the 6th century AD. A final note explains the analyses provided in this work. Separate analyses were preferred for the two cemeteries following the approach of Evison and Hill (1996). The two cemeteries were coincident and very close. Hence, it is extremely likely that one remote settlement created both of them. So what is the reason for the presence of two cemeteries rather than only one? Moreover, a different degree of preservation was observed. Inhumations of cemetery B were poorly preserved compared with those of cemetery A and this difference demands analyses.

28 inhumation burials were found in cemetery A (fig. 7), while 106 graves were dug in cemetery B plus 4 cremations (fig. 8). All graves contain at least one burial. Two cases of multiple burials were found in cemetery B (**graves 12** and **33**). As it has been reported above, the two cemeteries were not

fully excavated but archaeologists estimated that complete cemetery A would be around 56 graves and cemetery B would comprise around 115 graves (Evison and Hill 1996, 40).

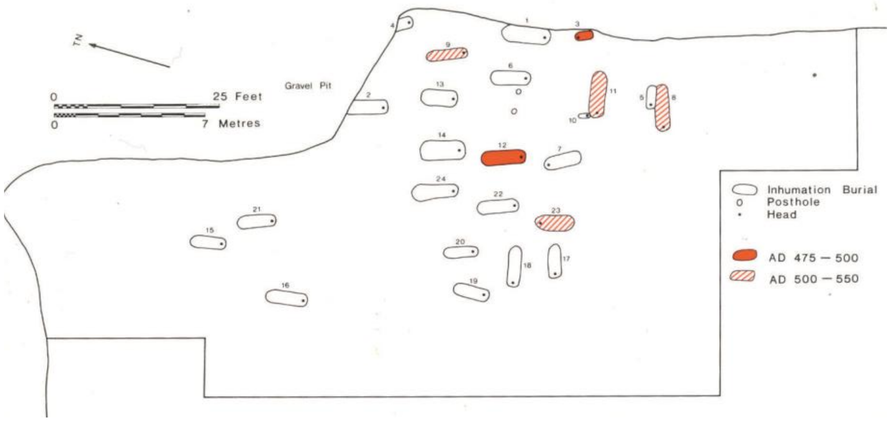


Figure 7: Beckford cemetery A map (modified, © Council for British Archaeology, Evison and Hill 1996, 142 fig. 57).

Figure 8: Beckford cemetery B map (modified © Council for British Archaeology, Evison and Hill 1996, 143 fig. 58).

The position of graves was examined in order to find possible similarities and so possible family groups. Both cemeteries show some clustering according to orientation, grave layout and grave finds. Cemetery A inhumations were clustered into three groups (fig. 7), while cemetery B was divided into eight groups of burials (fig. 8). Coffins or other grave structures did not leave any traces in both cemeteries.

Cemetery population and skeletal preservation

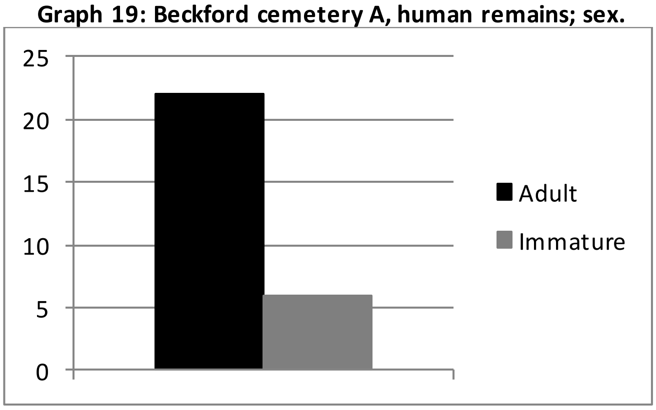
Specialists studied the human remains from Beckford cemeteries. The diversity in preservation affected even the anthropological analyses, so cemetery A has more accurate reports than cemetery B. However, the study by Dr Calvin Wells (Evison and Hill 1996, 41-62) identified 12 females, 14 males and 2 unsexed burials in cemetery A. Cemetery B has 34 males, including adult, adolescent and juvenile, and 55 females, and 19 unsexed. Only one case of infant burial was recovered. Generally, women had a shorter lifespan than men did. It was hypothesised that a different diet might have made a difference in health (Evison and Hill 1996, 23).

Three cases of leprosy in cemetery A (**graves 8**, **11** and **22**) were identified. **Grave 8**, a male burial and **grave 11**, a female burial, were likely related because they showed similar osteological anomalies. However, these burials do not have peculiarities in the grave goods compared with the others. The body positions were supine, at side and prone. The cemetery populations are summarised in the following tables (tab. 7 cemetery A; tab. 8 cemetery B) and graphs (graphs 19-21 cemetery A; graphs 22-24 cemetery B).

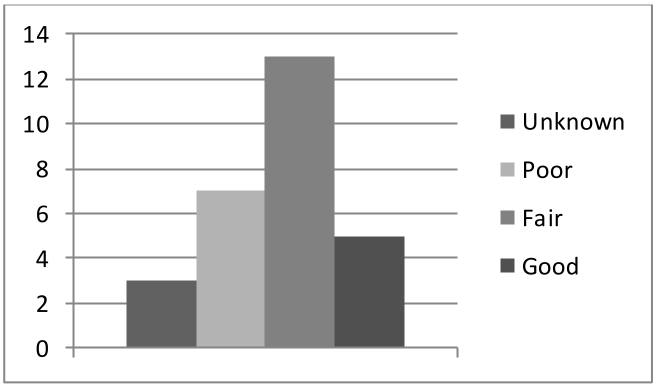
Table 7: Beckford cemetery A. Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			**Age**		
Male	Female	Indeterminate	Adult	Immature	Indeterminate
13 (46.4%)	9 (32.1%)	6 (21.4%)	22 (78.5%)	6 (21.4%)	0
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
3 (10.7%)	0	7 (25%)	13 (46.4%)	5 (17.8%)	0

Graph 19: Beckford cemetery A, human remains; sex.



Graph 20: Beckford cemetery A, human remains; age.

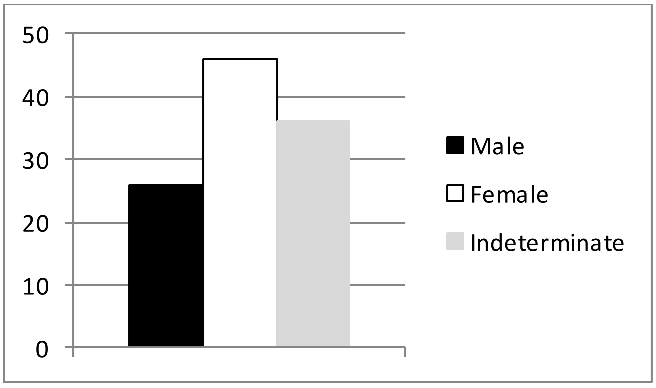


Graph 21: Beckford cemetery A, human remains; preservation.

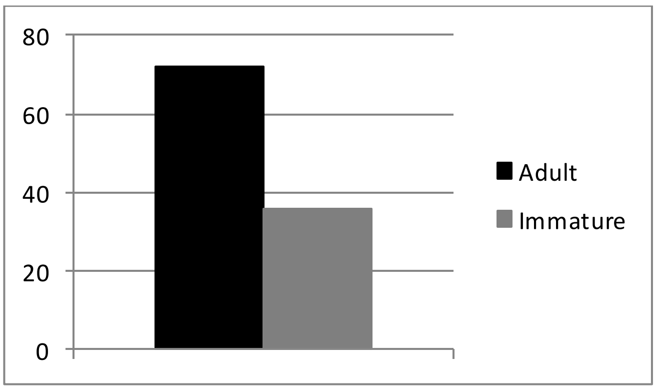
Table 8: Beckford cemetery B Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			**Age**		
Male	Female	Indeterminate	Adult	Immature	Indeterminate
26 (24%)	46 (42.6%)	36 (33.3%)	72 (66.6%)	36 (33.3%)	0

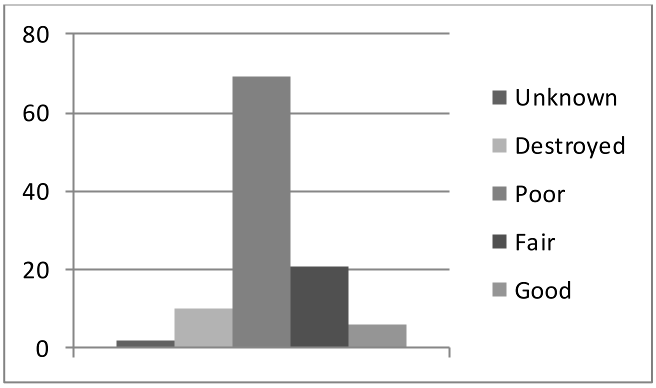
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
2 (1.8%)	10 (9.2%)	69 (63.8%)	21 (19.4%)	6 (5.5%)	0



Graph 22: Beckford cemetery B, human remains; sex.



Graph 23: Beckford cemetery B, human remains; age.



Graph 24: Beckford cemetery B, human remains; preservation.

8. Butler's Field, Lechlade

Butler's field is an Anglo-Saxon cemetery placed at 750 m north-west of Saint Lawrence's church at the northwestern limits of Lechlade (NGR SP 21160014). It was discovered by the Oxford Archaeological Unit (OA) in 1985 during the activities of a wider project, which was surveying the prehistoric and Roman landscape in the Lechlade and Fairford region. The original project of research aimed to examine cropmarks of possible prehistoric and Roman date in that region. The unexpected discovery of Anglo-Saxon burials led to a change in the plans and strategy of excavation. There were dug six trenches. Trench 1 embraced the Anglo-Saxon graves (fig. 9), even if other graves of this cemetery might have remained unrevealed in areas of excavation. This section will use data from the excavation report (Boyle *et al.* 1998) and the analyses on grave goods (Boyle *et al.* 2011). Butler's Field is a good case study, which represents a Saxon cemetery placed in the Upper Thames valley. It has a considerable continuity of use, even if its chronology is mostly based on artefacts.

The area was influenced by human activity since prehistory. Neolithic and Bronze age and Iron Age monuments are present. The Roman occurrence was proven by settlements at Roughground Farm and Claydon Pike and other similar sites. In contrast, the Anglo-Saxon presence does not show continuity from the Roman settlements. The only Anglo-Saxon evidence found has no definite chronology. Field and aerial surveys imply the possible presence of a settlement contemporary to the cemetery.

Earth over the cemetery had irregular depth, which varied from circa 0.30 m at the southern edge to 0.60 m at the northern edge of the field. Cremation burials lied at a superior level, while inhumations were more in depth in the gravel, so they were mostly not disturbed by the ploughing. According to the recovered artefacts, the cemetery has been used in two phases, part of the burials date from the half 5th to the 6th century AD and the other group date to the late 7th or early 8th century AD.

This cemetery includes 199 inhumations, 29 cremations, 3 charnel groups (**inhumations 167 1, 167 3** and **187**) one vacant grave (**inhumation 200**). Overall excavations have discovered 219 individuals, distinguished as 50 males, 89 females, 5 unsexed adults and 75 juveniles. The identification of unsexed human remains was by association with grave goods. Thus, 29 of the juveniles have been interpreted as female, while 4 have been identified as male. Four of the five unsexed adults have been identified as female and one male.

It was possible to define the body position of 198 inhumations. 154 of those lay in a supine position. 22 are buried on their right side, 17 are buried on the left side and 4 are interred in a prone position. Excavators suggest that the last inhumation seems to be seated. There are even several multiple burials. **Inhumation 81** has two phases of use, it is bordered by stones and contained 5 individuals. Three multiple burials consist of one adult woman and an infant or a newborn baby. **Inhumation 80** is the only grave, which shows clear signs of reuse after the first inhumation.

There is evidence of structures, because some graves have residues suggesting wooden coffins (**inhumations 18** and **92**) or are covered by stones (**inhumations 18** and **80**). The two ledges found at the sides of **inhumation 180** might be the basis for a grave marker or a lid. Additionally, possible traces of a woven mat are identified in **inhumations 92** and **106**.

Generally, the graves of the first phase are aligned to the south east following the Roman ditch; while it seems that part of the graves of phase 2 are parallel to **inhumation 180**. Excavators have not identified any clustering rationale for both phases (Boyle *et al.* 1998, 35-41).

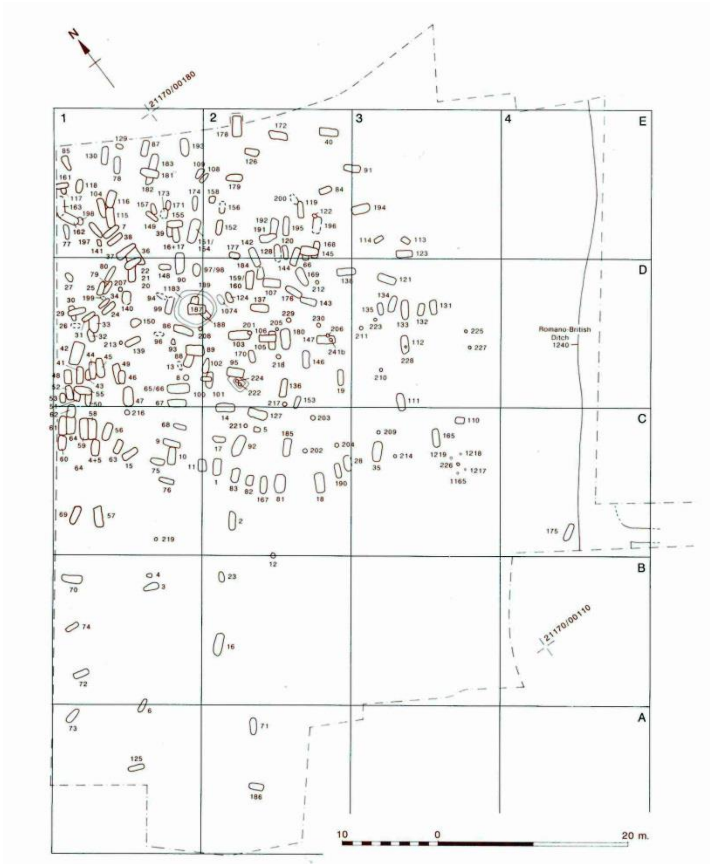


Figure 9: Butler's Field trench 1 map (modified ©Oxford Archaeology Unit from Boyle *et al.* 1998, 36 fig. 3.1).

Cemetery population and skeletal preservation

The following data is relevant only to inhumation graves (tab. 9; graphs 32-35). The human remains and single bones found in the 3 charnels and in grave fills are not considered. Overall, 219 inhumations are buried in 200 graves. All graves contain at least one individual except for grave **200**, which is empty. The majority of bones are considered well preserved, one tenth of skeletons were in excellent conditions and the remaining is poorly preserved. The general good bone preservation may be related with the soil characteristics. However, the sex and age identification was not entirely accomplished, resulting in high number of indeterminate skeletons. Osteological analyses reveal sporadic grave clustering due to possible family relations in life (Boyle *et al.* 1998, 43-52).

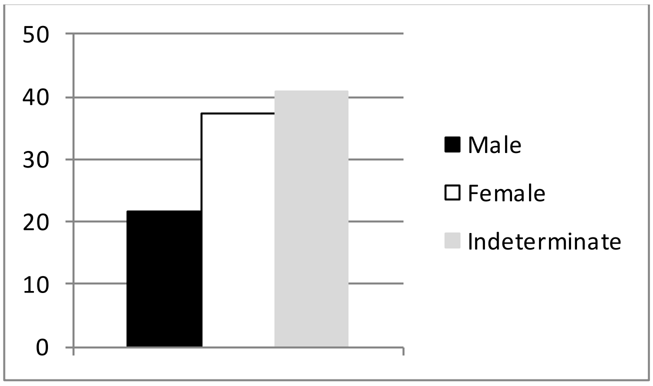
Overall, there are found 222 skeletons. The population of the excavated graves is not considered a typical biological sample (Boyle *et al.* 1998, 44) because of the sex difference and for the low number of babies. There is no balance between female and male figures, where the latter are almost one third less than the first. The number of immature includes 13 babies under one year old (**1 2, 5, 12, 95 2, 96, 107 2, 119 2, 120, 122, 132, 141, 188 2** and **198**). Five infants were in multiple burials (**1 2, 95 2, 107 2, 119 2** and **188 2**) the multiple burials. **Inhumations 95 1** and **2** are of special interest as it contains remains of an adult woman buried with a foetus of seven months. It has been hypothesised that the infant remains belonged to an earlier burial replaced in that grave.

The recurrent dead disposal is supine posture, followed by skeletons, which lay at one side. Only three burials were found prone (**inhumations 15, 74** and **126**) and other three appeared tumbled (**inhumations 38 1, 62** and **80 1**).

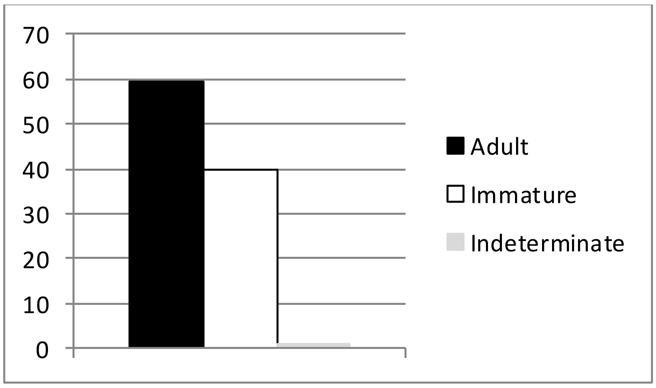
Table 9: Butler's Field Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			**Age**		
Male	Female	Indeterminate	Adult	Immature	Indeterminate
48 (21.6%)	83 (37.3%)	91 (40.9%)	132 (59.4%)	89 (40%)	2 (0.9%)

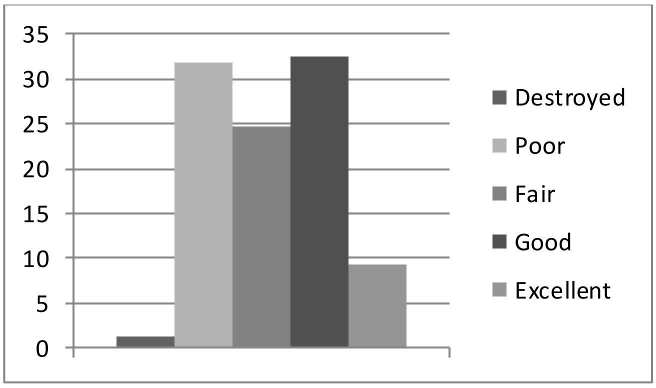
Preservation				
Destroyed	Poor	Fair	Good	Excellent
3 (1.3%)	71 (31.9%)	55 (24.7%)	72 (32.4%)	21 (9.4%)



Graph 25: Butler's Field, human remains; sex.



Graph 26: Butler's Field, human remains; age.



Graph 27: Butler's Field, human remains; preservation.

9. Empingham II

Empingham II was discovered in 1974. During the construction of Rutland Water reservoir, Anglo-Saxon graves were revealed and a rescue excavation was planned (Timby 1996, 1). The site is around 1.5 km west from Empingham village (NGR SK936082). The area around Empingham II was extensively surveyed and archaeologically examined. There were found Iron Age settlements, Romano-British buildings, villas and farmsteads and Anglo-Saxon settlements and cemeteries (Cooper 2000).

Empingham II superimposes on Iron Age ditches and pits. The cemetery is limited on one side by a trackway dated possibly to the late Iron Age. The area has other two Saxon cemeteries. Empingham I, entirely published by Cooper (2000, 23–45), which included 14 excavated burials dated at the early Anglo-Saxon phase. Another Saxon cemetery is Empingham III, which is placed on the remains of a Roman villa and is still unpublished (Timby 1996, 1).

Timby (1996) wrote the main report for Empingham II and its catalogue is the data source for this section. The cemetery was dug for rescue purposes, but archaeologists did their best to record all possible data. The site was also observed by magnetometer survey and some grave were identified by metal detector exams. The site has been included in the list of case studies because of presence of textile fibres, number of inhumations and type of soil. Moreover, the geographical position, in the East Midlands and the chronological range suggested its inclusion in the list. The site is dated exclusively on artefact typologies, mostly on metalwork. The chronology obtained in his way covers from the late 5th to the 7th century AD, even if most of the finds are placed in 6th century. Attempts to provide chronology that is more precise were unsuccessful (Timby 1996, 93-96). This case study can offer good comparison with the other Anglo-Saxon cemeteries.

However, the final analyses will be partial because of some limits of this site. The activity of heavy machinery damaged numerous skeletons and the site experienced vandalism and thefts. Therefore, artefacts and human remains evaluations cannot be considered complete. Furthermore, specialists examined organic materials but textiles were not subject to identification analyses. Finally, it was underlined that documentation can be uncertain, especially for grave goods position and drawings. These conditions are obvious limits for the present analysis that must be taken in consideration.

The cemetery includes 135 inhumation burials and one cremation (fig. 10). Some graves are multiple burials and one grave does not contain any bone (**grave 132**). It must be highlighted a discrepancy in the count of inhumation. The original publication reports **grave 55** empty from human bones like **grave 132** (Timby 1996, 16). However, both the correspondent form in the catalogue and the figure (Timby 1996, 111 and fig. 68) describe the bones as extremely fragmented but still present. All graves can be surely ascribed as Saxon, except **grave 133**, which leaves interpretative doubts (Timby 1996, 16). However, this grave is included in the calculations of this research.

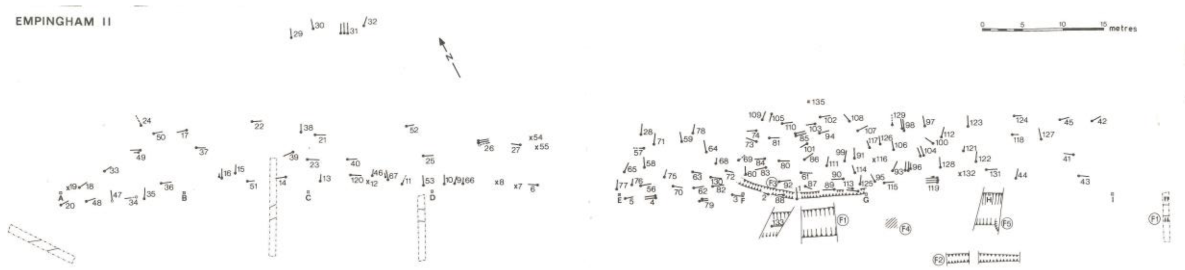


Figure 10: Empingham II cemetery general plan (© Oxbow Books 1996, Timby 1996, 4-5, fig. 3).

Cemetery population and skeletal preservation

Human remains were studied by specialist (Mays in Timby 1996, 21-33). Over 136 burials there were found 153 individuals. Graves were dug in the soil, coffins or other burials structure were not evident and the burial depth was not reported. The recurrent ritual was single inhumations, but some graves contained more than one body. **Graves 4, 11, 16, 49, 67, 79, 85, 98, 104** and **113** were double burials. **Graves 26, 31** and **96** included three skeletons and **grave 119** contained remains of four individuals. As it has been above surely **grave 132** was found without skeletal remains (tab. 10).

Overall 38 (24.8 %) inhumations are adult female, 45 (29.4 %) are adult male, 16 are unsexed adult (10.4 %) (graph 28). Ageing burials was successful in the majority of cases. 83 burials contain adult remains (54.2 %) and immature burials are 54 (35.2 %), this figure includes only one burial one year old (**grave 49 b**). Age identification is not achieved for 16 inhumations (10.4 %) (graph 29).

The general preservation of bones is not good, due machinery activities first the archaeological excavation started. 18 inhumations are destroyed (11.7 %), 59 burials are in poor conditions (38.5

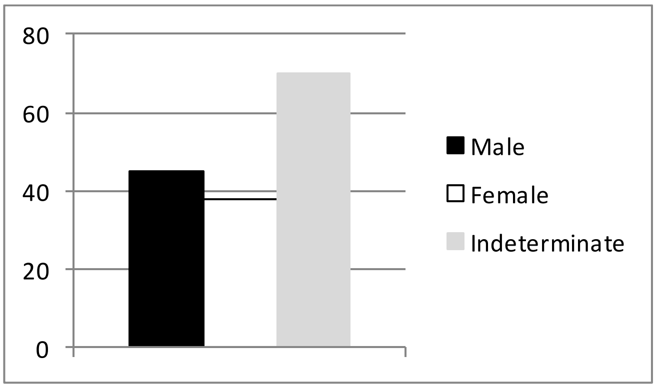
%), 42 inhumations are preserved fairly (27.4%), 20 skeletons are in good conditions (13 %), 7 are extremely well preserved (4.5 %) and 7 burials are not described (4.5 %) (graph 30).

The dominant disposal of skeletons is supine, whether they were found entirely extended or partially curved in 79 cases (51.6 %). Less recurrent are other disposals, 33 skeleton lie at one side (21.5 %), 3 burials are prone (1.9 %) and one burial seems crouched (**grave 78**, 0.6 %). 37 burials are fragmentary and do not allow a clear disposal identification (24.1 %).

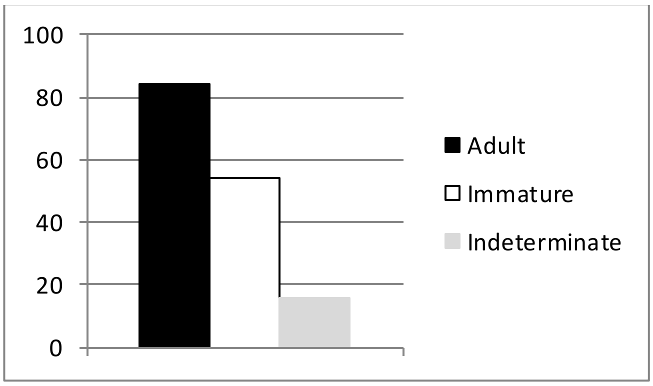
Table 10: Empingham II Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
38 (24.8%)	45 (29.4%)	70 (45.7%)	83 (54.2%)	54 (35.2%)	16 (10.4%)

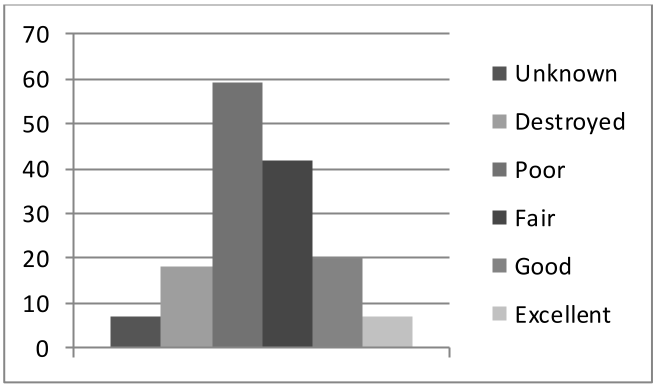
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
7 (4.5%)	18 (11.7%)	59 (38.5%)	42 (27.4%)	20 (13%)	7 (4.5%)



Graph 28: Empingham II, human remains; sex.



Graph 29: Empingham II, human remains; age.



Graph 30: Empingham II, human remains; preservation.

10. Norton, Cleveland

The Anglo-Saxon cemetery of Norton on Tees (NGR NZ 44882256), Cleveland was discovered by the fortuitous retrieval of one grave in 1982 (Vyner 1984). A subsequent resistivity survey and one pilot excavation indicated the presence of more graves. From 1983 to 1985, apposite dig campaigns revealed an almost complete Anglian cemetery and earlier ditches. Data presented and analysed in this section come from the main report written by Sherlock and Welch (1992). This site offers a good selection of grave goods assemblages, which sketch well 6th century AD Anglian funeral costumes north to the Humber. The study on this site is limited by the loss of organic finds, dissolved by the acidic soil and because there was not found any settlement close to the cemetery. However, its report includes specialist analyses on textile remains, which helped in few fibre identifications.

This cemetery is placed in Tees valley, Yorkshire, a liminal area which was on the historical boundary between Bernicia and Deira. 120 graves were documented, 117 inhumations and 3 cremations (fig. 11). The grave finds associated with the burials suggest a chronological range between the 6th and the early 7th century AD. This site is considered crucial for understanding archaeological relations between the Northern regions of the Tyne valley and the Southern regions of Yorkshire, Lincolnshire, Midlands, and East Anglia. Data are derived from the original report of the excavation (Sherlock and Welch 1992), and then have been collected in the digital archive and processed.

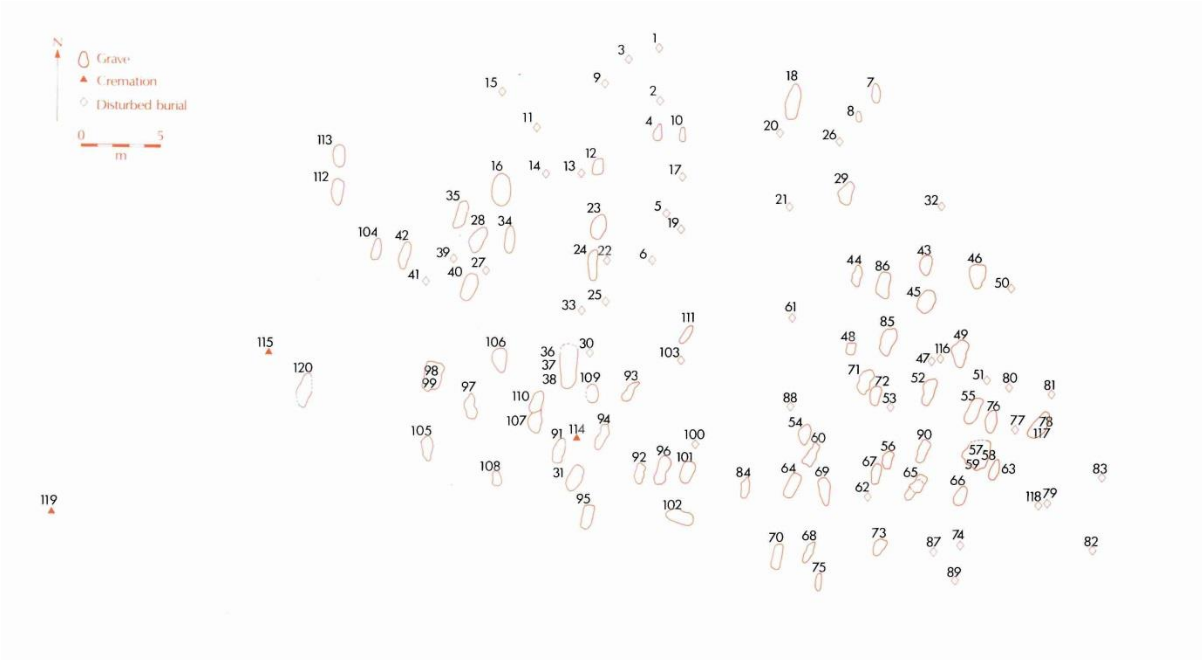


Figure 11: Norton, cemetery plan (© Council for British Archaeology; Sherlock and Welch 1992, fig. 22).

Cemetery population and skeletal preservation

The human remains were studied on their biological traits, metrics and pathologies by specialists (Marlow, Birkett and Parker in Sherlock and Welch 1992, 107-120). The population of Norton cemetery has been described as largely "tall" and "gracile" (Marlow, Birkett and Parker in Sherlock and Welch 1992, 107). Moreover, the sexual attributes were not emphasised, so often the sex was in doubt. The ratio between identified adult male and female is 1 to 1.

126 individuals have been buried in 120 burials. Overall, there were 117 graves, but three had no bone evidence (**graves 75, 92** and **102**). Additionally, three cremations (**graves 114, 115** and **119**) complete the number of burials at Norton cemetery. There are twelve multiple burials (**graves 2, 9, 14, 19, 25, 34, 36, 37, 41, 55, 67** and **113**). Usually the remains of the second body are in extreme by poor condition in these burials. All other inhumations contain remains of one body, except for the three empty graves mentioned above.

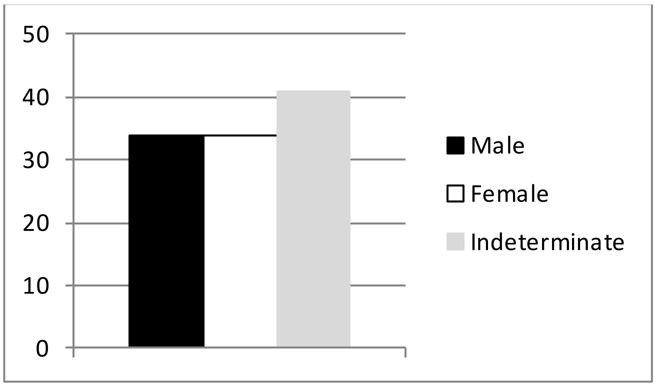
Table 11 summarises data about skeletal remains and their preservation. Sex is evenly represented between male and female (graph 31), while adult remains are slightly more than double than immature burials (graph 32). It should be remember that immature group includes all the remains aged under 17 years. Only few burials could not be determined by ageing.

At Norton, skeletons were mostly displaced in two ritual postures. Supine position is the most recurrent, followed by crouched burials. Prone and side burials have minor frequency. However, the posture of a significant number of burials was not identified due to poor preservation bone. The published report does not provide a good record of bones preservation. Consequently, it is not possible to provide more details on this aspect (graph 33).

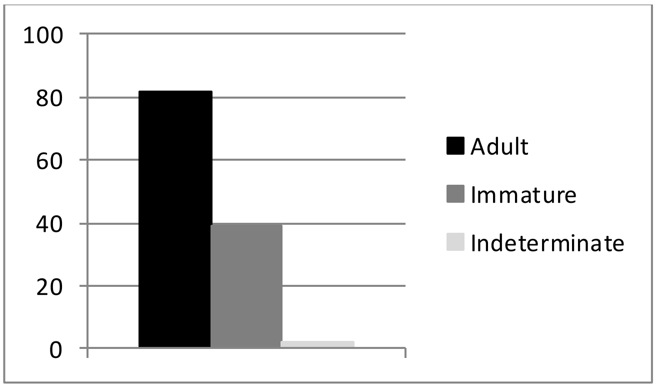
Table 11: Norton, Anglo-Saxon cemetery skeletal remains sex, age, preservation and posture.

Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
34 (31.1%)	34 (31.1%)	41 (37.6%)	82 (75.2%)	39 (35.7%)	2 (1.8%)

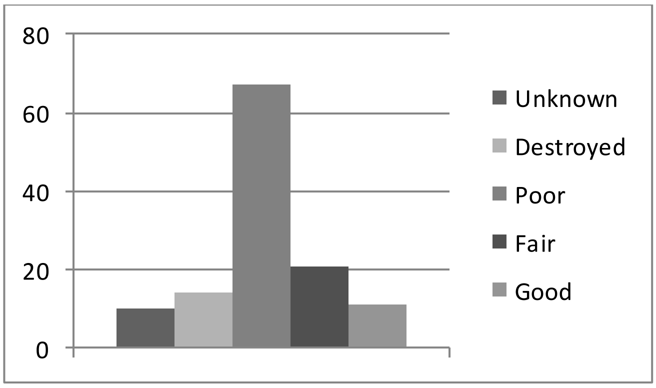
Preservation				
Destroyed	Poor	Fair	Good	Unknown
14 (11.3%)	67 (54.4%)	21 (17%)	11 (8.9%)	10 (8.1%)



Graph 31: Norton, human remains; sex.



Graph 32: Norton, human remains; age.



Graph 33: Norton, human remains; preservation.

11. Sewerby

The Anglo-Saxon cemetery at Sewerby (NGR TA 205691) was dug up by two distinct archaeological rescue excavations. The first one directed by Rahtz and Addyman in 1959 and the second one directed by Hirst in 1974 (1985). This makes of Sewerby, beside West Heslerton, the first Anglo-Saxon cemetery in northern England to be excavated in the twentieth century. The site was only partially excavated.

Hirst published a comprehensive report of both excavations in 1985 (Hirst 1985). The publication is the main source for data of this research. The report provides general geological and soil descriptions. It even includes more details on the cemetery, the graves characteristics and the human remains. Finally, the grave goods are described and classified by their functions.

Even if the cemetery of Sewerby is incomplete, it has potential to provide information about northern Anglo-Saxon burial costumes. The comparison of Sewerby with close cemeteries like West Heslerton, or distant Saxon sites in the South, may suggest possible regional patterns and local funeral costumes. Moreover, specialists examined the fragmentary textile and leather remains (Crowfoot and Appleyard in Hirst 1985, 48-54), which it provides good comments on fibre identification.

The site lies on a farm area and its discovery was unexpected. The cemetery of Sewerby, East Yorkshire, is collocated on the northern margin of Bridlington Bay, at 6 km southeast of Flamborough Head and 1 km west of the south end of Danes' Dykes. The funeral ritual is only inhumation and there were dug 58 graves, containing 59 individuals (fig. 12). The analyses of artefacts date the grave from the late 5th century to the 7th century AD.

In some cases, the ritual includes incongruous materials in grave fills. **Graves 41, 50, 51** and **53** included burnt material. A considerable quantity of charcoal was incorporated in the fill of **grave 51**, where there found only grave goods and no human remains. **Grave 50** fill contained a small piece of charcoal and **grave 53** fill had a scorched oak hunk and two burned stones. A fragmentary and burnt beehive quern was buried on the pelvis in **grave 41**. Interpreting these presences is difficult and usually they are referred having some roles in the burial ritual. However, it is an interesting aspe ct to consider in terms of fibre preservation. Any possible influence of these burn materials grave on textile preservation will be recorded.

In addition, examination of textiles on a brooch (**grave 19**, 4) reveals the superficial presence of grass or other plant matter. This ritual was noted even in German mercenary graves of 4th century AD in Gaul and at Mucking (Hirst 1985, 31). It is related with likely attitude to throw grass and flowers over the dead. Another hint on burial ritual was given by the retrieval of a fly puparia on a brooch (**grave 12**, 4). This discovery implies that some days passed between the death and the burial of the corpse.

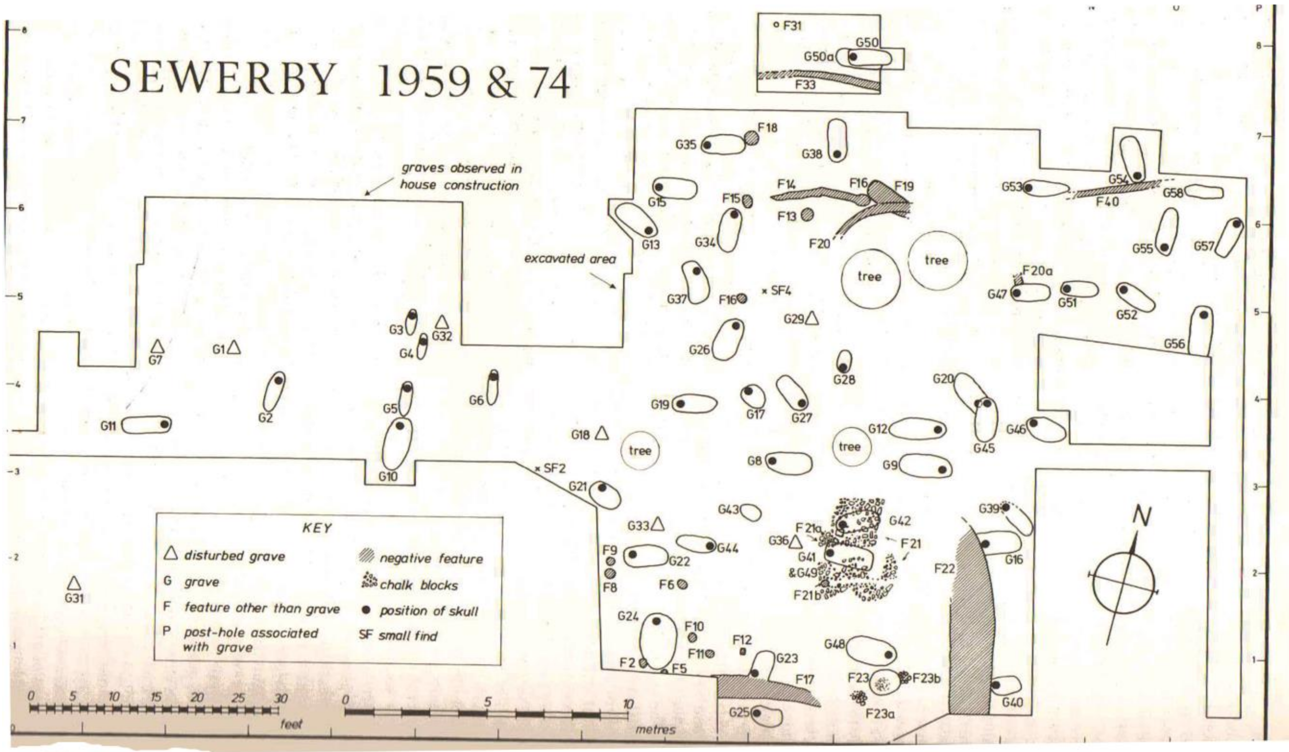


Figure 12: Sewerby cemetery general plan (Hirst 1985, 26 fig. 7).

Cemetery population and skeletal preservation

The human remains were analysed in both excavations by the anthropologists Brothwell and Bayley (in Hirst 1985). The bones were in poor conditions and so the anthropologists proceeded in recording biological data, but no restorative measure was recommended due to their general low level of preservation (tab. 12; graphs 34-36).

Despite the soil features, bones preservation varies greatly. The specialists tried to compare the skeletal remains with the soil, but any clear pattern of bone preservation was identified (Hirst 1985, 33, fig. 11 and 81). Generally, the so-called layer 3 and sandy soil provide the worst preservation conditions, while gravel soil resulted in best for preservation. Furthermore, the depth of graves even affected preservation of organics, because more organic finds were found in deep burials rather than the shallow ones.

Sex identification was determined by combination of biological and cultural traits and when there was incongruence between bones sex characteristics and associated artefacts, the preference was for the cultural gender interpretation. The poor conditions of skeletal remains affected even interpretation of the original corpse disposals. However, posture was classified in 32 out of 59 inhumations. Supine posture, both with extended or flexed legs, was the most occurring. Prone disposal occurs only twice (**graves 26** and **41**). Burials at side are nine (**graves 8, 9, 16 1, 21, 22, 23, 37, 39** and **53**) and two graves are crouched (**25** and **27**).

It is worth describing the unusual double burial including **grave 41** and **49**. **Burial 49** contained bones of an adult woman with the face turned on the left. "The right arm was bent back, the right fingers clenched, at the same level as the trunk. The left arm was also bent back on the other side of the body but not so much…. The shoulders had subsided round a large piece of limestone which lay immediately beneath them… The right leg was bent back and rested with the knee at the same level as the rest of the body with the foot up at the subsoil surface level." (Hirst 1985, 39). Underneath, there was **grave 49**, a burial of a young adult female. Traces of wooden coffin were present as stains in the soil and oak fragments attached to the base of metal cauldron in **grave 49**.

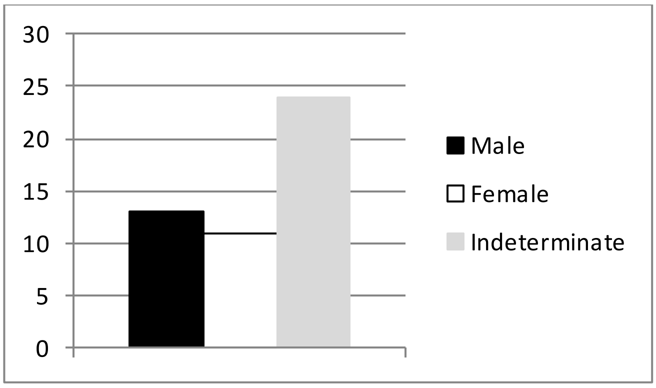
It is extremely likely the two graves were contemporaneous; **grave 49** was the deepest burial in the cemetery (around 60 centimetres from the subsoil surface). The features of the hole, the similar orientation and disposal of the bodies suggest this double burial was excavated intentionally. Finally, this was possibly covered by a cairn, which the top layer of chalk lumps testifies it.

Traces of wooden coffins were found in five graves (**15, 35, 49, 51** and **55**), they are mostly marked as dark brown and leathery soil stains. The survival of wooden traces is supposed to be related with the original depth of burials. Wooden traces were mostly found in deep graves. This fact is not surprising, in Sewerby soil, deep burials have moisture and anoxic environment. Consequently, there is the chance that coffined burials were more diffused than the archaeological record could identify. Anthropological features are summarised below in table 12 and graphs 34-36.

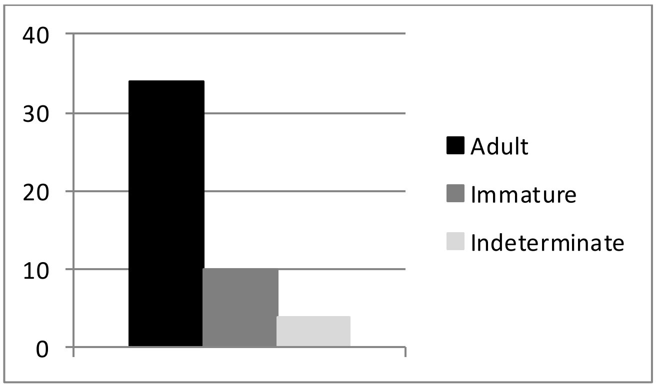
Table 12: Sewerby Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			Age		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
11 (22.9%)	13 (27%)	24 (50%)	34 (70.8%)	10 (20.8%)	4 (8.3%)

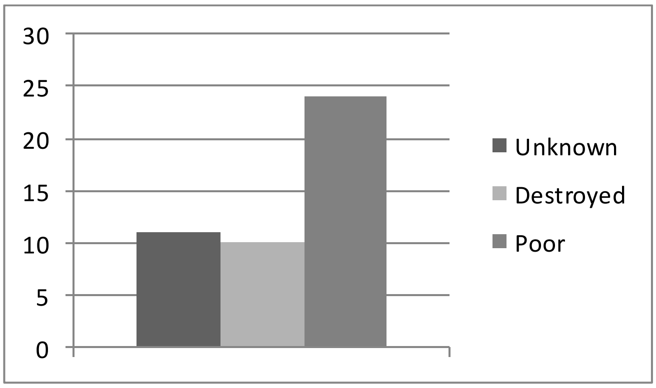
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
12 (20%)	10 (16.6%)	24 (40%)	10 (16.6%)	3 (6.2%)	1 (1.6%)



Graph 34: Sewerby, human remains; sex.



Graph 35: Sewerby, human remains; age.



Graph 36: Sewerby, human remains; preservation.

12. Spong Hill

The Anglo-Saxon cemetery of Spong Hill (NGR TF 9818 1954) at North Elmham displays all interesting characteristics for the aim of this research especially a great number of excavated inhumations, high standard of data recording. Moreover, the excavation was part of a planned research project, which was intended to be the initial step of a broader archaeological investigation in East Anglia, whereas all the other Anglo-Saxon cemeteries were dug by rescue excavations in that region (Hills 1977, 6). Anglo-Saxon cemeteries have been explored in East Anglia from the 18th century and the surveys became more scientific when archaeologists took the place of antiquarians. East Anglian archaeology has been even remarkably published by the homonymous series, which contains archaeological reports from Prehistory to Middle Age and including numerous Anglo-Saxon cemeteries. Consequently, the macro regional scene is more detailed and complete than other regions (Penn and Brugmann 2007).

The site was found during agricultural works in 1711 and then it became object of interest for antiquarian surveys. Hence, Spong Hill Anglo-Saxon cemetery was well known earlier than scientific excavation. However, differently, from the majority of the sites included in this research, Spong Hill was dug for academic interest and not for rescue purposes (Penn and Brugmann 2007, 1). Apart for the Anglo-Saxon cemetery, there were revealed other archaeological features, like late Iron Age ditches and early Roman enclosures. The cemetery likely served the close Anglo-Saxon settlement contemporaneous with it.

This section includes data from the original report (Hills, Penn and Rickett 1984). Further data are reported in other volumes of East Anglian Archaeology series (especially, Hills 1977 which is the introductory volume of the series. Penn and Brugmann 2007, which is the volume dedicated to inhumation ritual in Norfolk cemeteries), while chambered **grave 31** was published apart earlier than the final report (Hills 1977a). This section includes even data from the Norfolk Heritage Explorer database online.

Spong Hill represents a good sample for middle Saxon cemetery in the South East England. It has been included in this research because of its soil characteristics and geographical position. Moreover, human remains are badly preserved, but textile fibres and other organic remains were well studied by specialists (Crowfoot *et al.* for textiles and Watson for organics in Hills *et al.* 1984).

Spong Hill is the biggest Anglo-Saxon cremation cemetery discovered until now. It had more than 2200 cremations dating from the early Anglo-Saxon phase. It is considered a mixed cemetery, because beside cremations there are inhumations, which are partially contemporary with cremations dating from the 5th to the 6th century AD (fig. 13) (Penn and Brugmann 2007, 8).

The cemetery is placed at North Elmham in Norfolk. It lies on a low bank, which faces on South and it creates a small valley beside the flow of river Blackwater. Initially, archaeologists counted 58 inhumations, but later **grave 21** was established to be a periglacial disturbance in the soil and not a grave, so 57 inhumations are included in this site (Hills *et al.* 1984, 1). There is the chance that unexcavated graves are beyond the northern and western limits of the examined area. Spong Hill inhumations do not have absolute dates provided by C14 or coins.

The chronology was determined by artefact typologies and comparisons with contemporary continental productions. Most of metalwork dates from the end of 5th to the end of 6th century AD. It was underlined a chronological discrepancy, because female inhumations resulted to be somewhat later than male. Even if the majority both male and female graves are concentrated on the 6th century (Hills *et al.* 1984, 13-15).

The inhumation area of Spong Hill is a cluster of burials placed at the north-eastern corner of the main cemetery and it also includes some cremations. The chronology of this group of burial is slightly later than the main the cemetery. The internal sequence of the group is different. Inhumations and cremations may overlap slightly, but generally, inhumations are earlier than cremations. Moreover, cremations appear mostly to neglect the previous inhumation burials. The grave goods are encompassed in a narrow chronological range, revealing that cremations superseded inhumations. Inhumations do not have many artefacts, which correspond to Germanic pottery and metalwork – possibly except a sword scabbard found in **grave 40** (Hills *et al.* 1984, 93). Conversely, some cremations showed grave objects with Continental links.

The interpretation of inhumations is uncertain. They might be burials of immigrants or of locals with different traditions. Whether the first or the second interpretation is right, there may be a reason behind the distinction of inhumations and cremations in the same site. Maybe a dominant household used that ritual and then it turned into cremation, or it lost its predominant position or it moved in another undiscovered cemetery that dated between Spong Hill and the later North Elmham (Hills *et al.* 1984, 41).

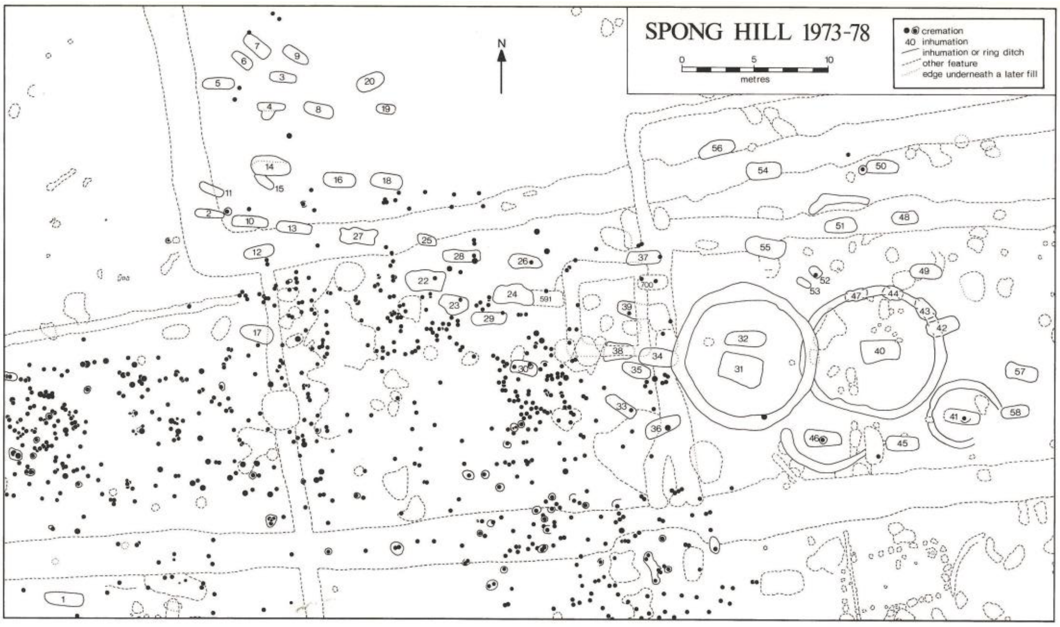


Figure 13: Spong Hill cemetery, inhumation plan map (© Norfolk Historic Environment Service, Hills *et al.* 1984, 3 fig. 1).

Cemetery population and skeletal preservation

Specialist studies were applied on human remains (Putnam in Hills, Penn *et al.* 1984, 15-17). Bones were found very poorly preserved, which it was an expected consequence of acidity and soil texture. Therefore, it was difficult to observe the general orientation of all burials, but the few preserved were mainly oriented toward west. It was even hard identifying the disposal of the bodies. Often still, the identification of sex and age was not successful. Over 57 graves, nine did not contain bones at all (**inhumations 6, 7, 15, 25, 33, 34, 35, 52** and **53**). The present sub-section describes skeletal remains characteristics according to parameters provided in chapter 3, a summary of these data are in table 13 and in graphs 48-51.

Sex identification was accomplished in burials **1, 23, 36, 50** and **55**, which were male. 18 burials were female (**inhumations 2, 5, 9, 14, 17, 19, 22, 23 2, 26, 29, 37, 38, 39, 42, 44, 47, 56** and **57**), whereas 18 burials do not have sex identification (**1, 3, 4, 8, 10, 16, 18, 20, 24, 28, 31 2, 36, 45, 46, 51, 54, 55** and **58**) (graph 36).

Age was positively identified in 32 cases. 29 skeletons were adult (**inhumations 1, 2, 4, 5, 8, 9, 10, 13, 14, 17, 19, 22, 23 1, 23 2, 26, 29, 30, 31 1, 36, 37, 38, 39, 42, 44, 47, 50, 55, 56** and **57**), while three were juvenile (**inhumations 3, 16** and **31 2**) and there were not found infant remains. Age was indeterminate in the other nine cases (**inhumations 18, 20, 24, 28, 45, 46, 51, 54** and **58**) (graph 37).

Since numerous burials did not have enough bones to understand the posture of skeleton in graves, so archaeologists have considered as extended burials all graves, which could contain an adult extended body (Hills *et al.* 1984, 1-2). 34 inhumations were indeterminate body posture (**inhumations 1, 2, 3, 4, 5, 8, 9, 10, 14, 16, 17, 18, 20, 22, 23 1, 23 2, 24, 26, 28, 29, 30, 31 1, 31 2, 37, 38, 39, 42, 45, 46, 54, 55, 56, 57** and **58**). Supine position was recognised in three graves (**13, 36** and **51**), while **inhumation 50** seemed to be buried laying at side and three burials were likely crouched (**inhumations 19, 44** and **47**).

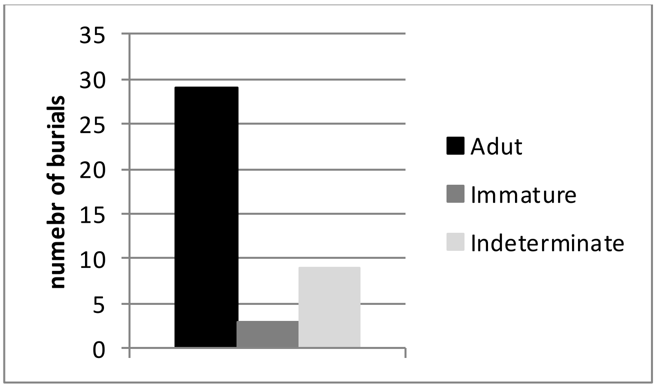
Not surprisingly, 32 burials preserved bones in destroyed conditions (**inhumations 1, 2, 3, 4, 8, 9, 10, 14, 16, 17, 18, 20, 22, 23 2, 24, 28, 30, 31 1, 31 2, 37, 38, 39, 42, 45, 46, 47, 51, 54, 55, 56, 57** and **58**). The other burials had poorly preserved bones (**inhumations 5, 13, 19, 23 1, 26, 29, 36, 44** and **50**) (graph 39).

The majority of grave contained likely only one inhumation, but **graves 23** and **31** revealed having bones of two individuals, so they are possibly multiple burials. The preponderant ritual was coffined burials and wood fragments and stains found in the soil were indicators of the coffins. Additionally, there were discovered also two chamber graves, which were **31** and **40** (Hills 1977a; Hills *et al.* 1984, 2).

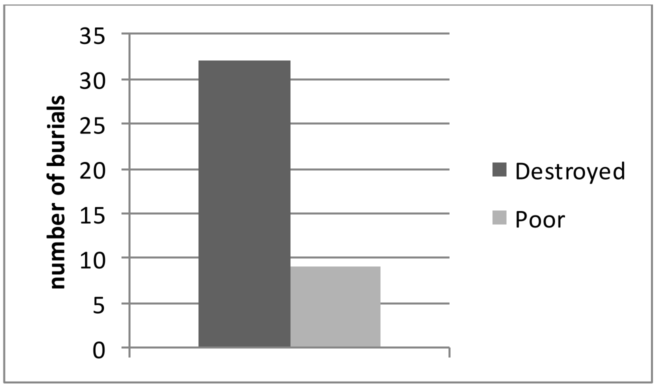
Table 13: Spong Hill Anglo-Saxon cemetery skeletal remains: sex, age, preservation and posture.

Sex			**Age**		
Female	Male	Indeterminate	Adult	Immature	Indeterminate
18 (43.9%)	5 (12.1%)	18 (43.9%)	29 (70.7%)	3 (7.3%)	9 (21.9%)
Preservation					
Unknown	Destroyed	Poor	Fair	Good	Excellent
0	32 (78%)	9 (21.9%)	0	0	0

Graph 37: Spong Hill, human remains; sex.



Graph 38: Spong Hill, human remains; age.



Graph 39: Spong Hill, human remains; preservation.

13. Raw data of Roman and Anglo-Saxon burials

The following tables sum up chronology, geographical position and soil types of the sites (tab. 14 and 15).

Table 14: Roman cemeteries chronology and geographical distribution.

Cemetery	Chronology	Region	Soil type
Eastern Roman London	1st – 4th century AD	London	Man-made soil; sandy acidic pH; free drainage
Poundbury	From 2st – 5th century AD	Dorset	Brown soil, chalky, alkaline pH, free drainage
Alington Avenue	final 1st – 4th century AD	Dorset	Brown soil; silty and chalky, acidic pH, free drainage
Lankhills	2nd – 4th century AD	Hampshire	Brown soil; chalky, pH not described; free drainage

Table 15: Anglo-Saxon cemeteries chronology and geographical distribution.

Cemetery	Chronology	Region	Soil type
West Heslerton	5th – 7th cent AD	East Yorkshire	Brown soil, sandy, alkaline-neutral
Alton	second quarter 5th – first half 7th cent AD	Hampshire	Brown soil, loamy, acidic pH
Beckford A	final 5th – first half 6th cent AD	Gloucestershire	Brown soil, loamy, alkaline-neutral pH
Beckford B	final 5th – first half 6th cent AD	Gloucestershire	Brown soil, loamy, alkaline-neutral pH
Butler's Field	late 5th or early 6th - end of the 7th or the beginning of the 8th cent AD	Gloucestershire	Lithomorphic soil, loamy, acidic pH
Empingham II	late 5th – 7th century AD	Rutland	Gley soil, loamy, alkaline pH
Norton	6th – early 7th cent AD	East Yorkshire	Gley soil, loamy, acidic pH
Sewerby	late 5th – 7th cent AD	East Yorkshire	Brown soil, loamy, acidic
Spong Hill	5th – 6th cent AD	Norfolk	Gley soil, loamy, acidic

Appendix 2: textile preservation, case studies

More details of textile preservation in archaeological contexts are reported in this appendix. The case studies are referred in chapter 2.

1. Textile pseudomorphs

1.1 Hochdorf, Germany

The case of the “princely” barrow in Hochdorf, in Baden-Württemberg, Germany (Biel 1981; 1985) is an excellent discovery for scholars of ancient textiles. It is considered a milestone by the specialists because of its archaeological context, the quantity of materials, the types of textiles but also for the critiques in some analytical procedures and results (Banck-Burgess 2012, 140).

The site is a famous Celtic inhumation of a high-ranking adult man, who was buried with extremely rich funerary gifts (Biel 1981; 1985). Under a mound, there was an outer chamber that contained a second inner chamber. The organic grave goods were found only in the inner chamber (Biel 1981; 1985). Among the grave goods were a birch bark hat, a Greek bronze cauldron decorated with lions, a bronze couch, weapons, gold jewels, a wagon and valuable textiles. Not only the quality and quantity of grave goods of this tomb deserve interest, but also the exceptional preservation has allowed numerous studies on the artefacts. The corpse was inhumed, wrapped and placed on a bronze couch within the funerary chamber (Biel 1981, 17).

Colourful draping cloths covered the cauldron, other objects and even the floor and the walls of the chamber. The proximity of bronze objects with clothing and the tapestry promoted the mineralization of numerous textile fragments (Biel 1981, 17). Moreover, the collapse of the chamber shortly after the burial created an almost anoxic environment, which helped to preserve materials, including the textiles (Banck-Brugess 2012), and avoided looting. However, the anoxic atmosphere was destabilised by the archaeological excavation and the textile started a rapid process of disintegration in front of the archaeologists (Banck-Burgess 2012). Textile fibres were examined microscopically (Körber-Grohne 1988). The fibre analyses on survived textiles identified sheep wool in the majority of cases, but there were also horse hair and fur of badger and marten (Körber-Grohne 1988, 74-75). Among the plant fibres, hemp fabrics (fig. 1) survived more than flax, which had the worst preservation conditions. In some cases, hemp and wool fibres had been woven together in the same fabric (Körber-Grohne 1988, 75-76; Banck-Burgess 2012) (fig. 2).

As it has been cited above, this site has been at the centre of a debate about fibre analysis and interpretation, namely for silk presence. It was stated that at Hochdorf were found the most ancient evidence of silk in northern Europe, by comparison with the material found at grave VI Hohmichele, Germany (Riek and Hundt 1962, 208). This case shows how interpretation based only on analogies is subject to errors. In fact, the earlier conclusion was rejected by new ones based on amino acid analyses (Banck-Burgess 2012, 140; Möller-Wiering 2012; Bender Jørgensen 2013, 583), which demonstrate that those fibres were not silk.

Nevertheless, the tomb of Hochdorf is an exceptional retrieval for ancient textile studies. The range of fibres identified is unique and does not have comparisons with other sites in northern Europe. The discovery of wool, leather, hemp, flax, tapestry, cords and disputed silk fibres makes this site of extreme interest for textile specialists. The huge quantity of materials stored in the chamber and the specific conditions created by the collapse of the tumulus contribute to textile preservation. The proximity of textiles with metal objects was crucial for mineralization. After the collapse, the room became an anoxic environment, which saved even the colour of textiles. However, the preservation was in a delicate balance and the excavation easily destabilised that special environment, destroying many textiles in front of the excavators (Banck-Burgess 2012).

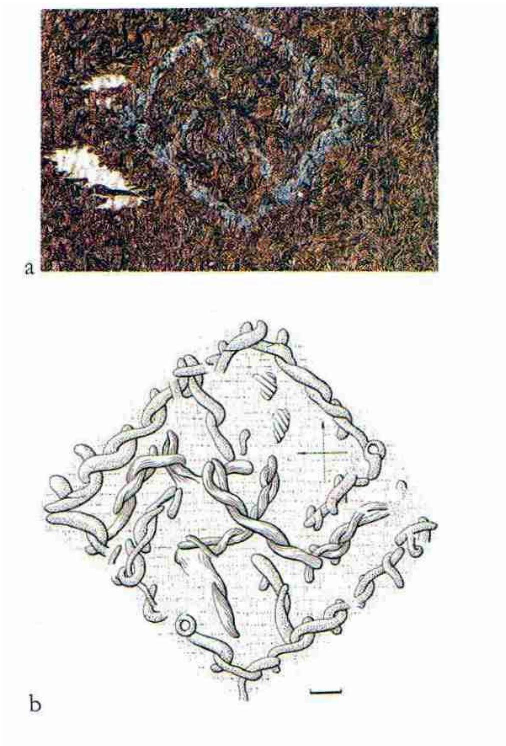


Figure 1: hemp and woollen fibres in the same fabric Hochdorf (© 2012, Banck-Burgess 2012, fig. 10 A and B).

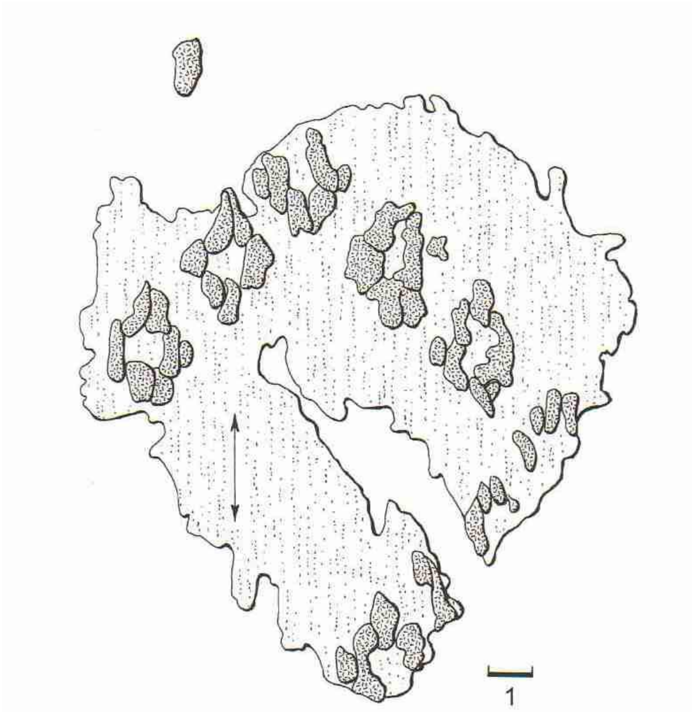


Figure 2: hemp and animal fibres Hochdorf (© 2012, Banck-Burgess 2012, fig. 5.5).

1.2 Harewood cemetery, graves 3-2 and 3-3, Charles Town, West Virginia

The excavation of a family cemetery at Harewood, Charles Town, West Virginia has given the chance for a fruitful cooperation between archaeologists and forensic scientists (Rowe 2010). The use of several techniques of analysis on textiles, such as polarised light microscopy, SEM, Fourier transform infrared spectrometry, and pyrolysis-gas liquid chromatography, has provided good information about the origin of their preservation and their identification (Rowe 2010, 44-45).

The graveyard belongs to a plantation house, which was apparently built by Samuel Washington, a younger sibling of George Washington. The main purpose of the excavation was to detect the grave of Samuel Washington, which was supposed to be buried in that cemetery. Unfortunately, no corpses were discovered but wooden and metal coffin fragments and numerous hair and fibre finds (Rowe 2010, 46). Namely, graves 3-2 and 3-3 provided numerous coffin fragments and a large amount of textile fibre. The preservation of fibres has been attributed to the presence of copper tacks, which presumably decorated the coffins. The textile fragments were found under many of those tacks. In fact copper, produced by Cu ions leaking into the soil, have efficiently deterred microbial activity and mineralized fragmentary textiles (Rowe 2010, 50).

The study on those textiles revealed that they were of two types. The first, called Type I, was found in grave 3-2 and it was a friable brown and white yarn. The Type II was a friable brown yarn, found in grave 3-3. The microscopic studies showed that the white threads of Type I are cotton (fig. 3). The microchemical examination revealed the brown threads in both types are animal in origin and the microscopic analyses matched them with silk (fig. 4). The infrared technique confirmed that the brown fibres are silk (Rowe 2010, 46-47).

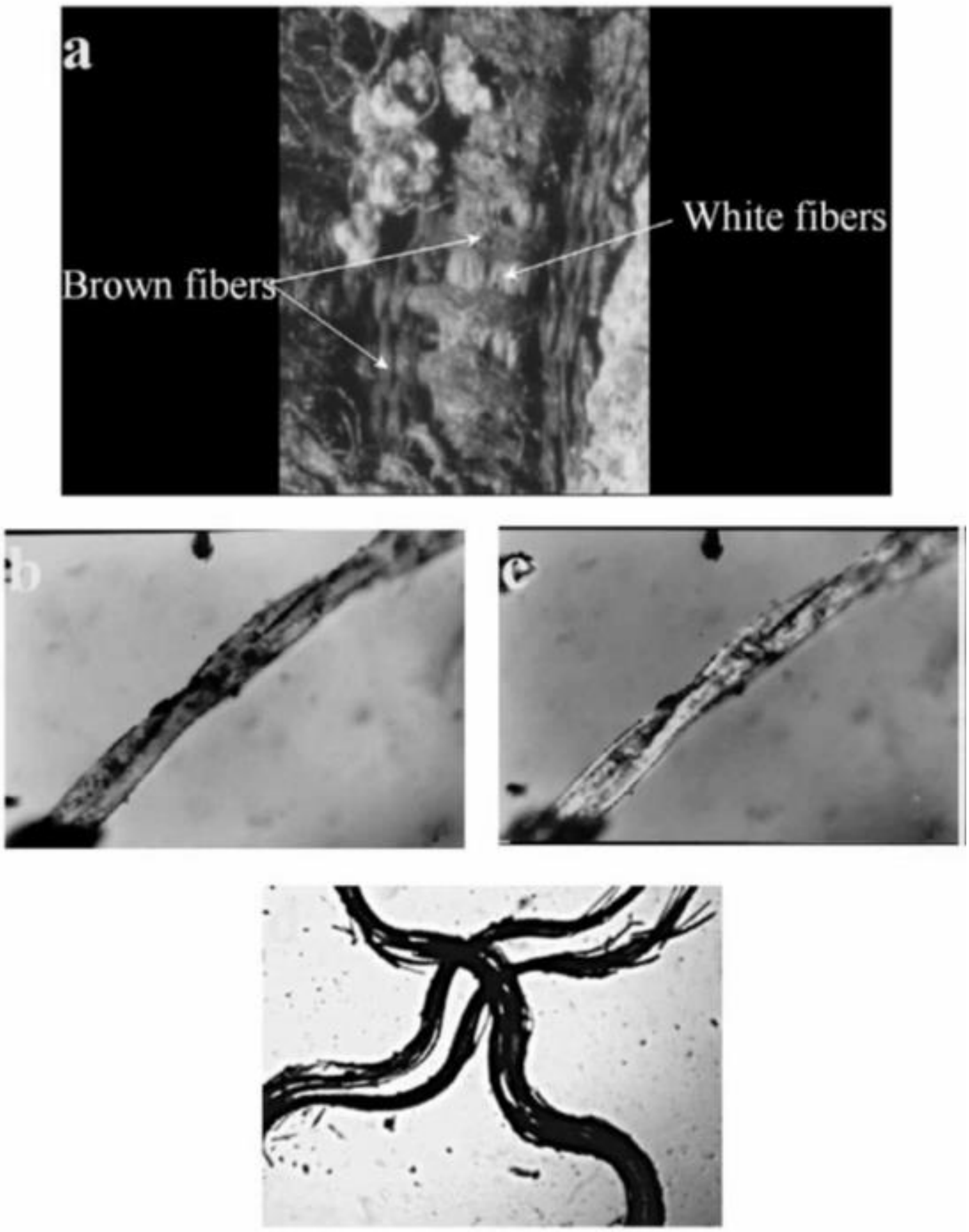


Figure 3: microscopic pictures of Type I fibres from grave 3-2 Harewood cemetery. *(a)* textile in situ on back of tack; *(b)* white (cotton) fibre; *(c)* white (cotton) fibre, partially uncrossed polars; and *(d)* brown (silk) fibres (© 2010; Rowe 2010, fig. 3).

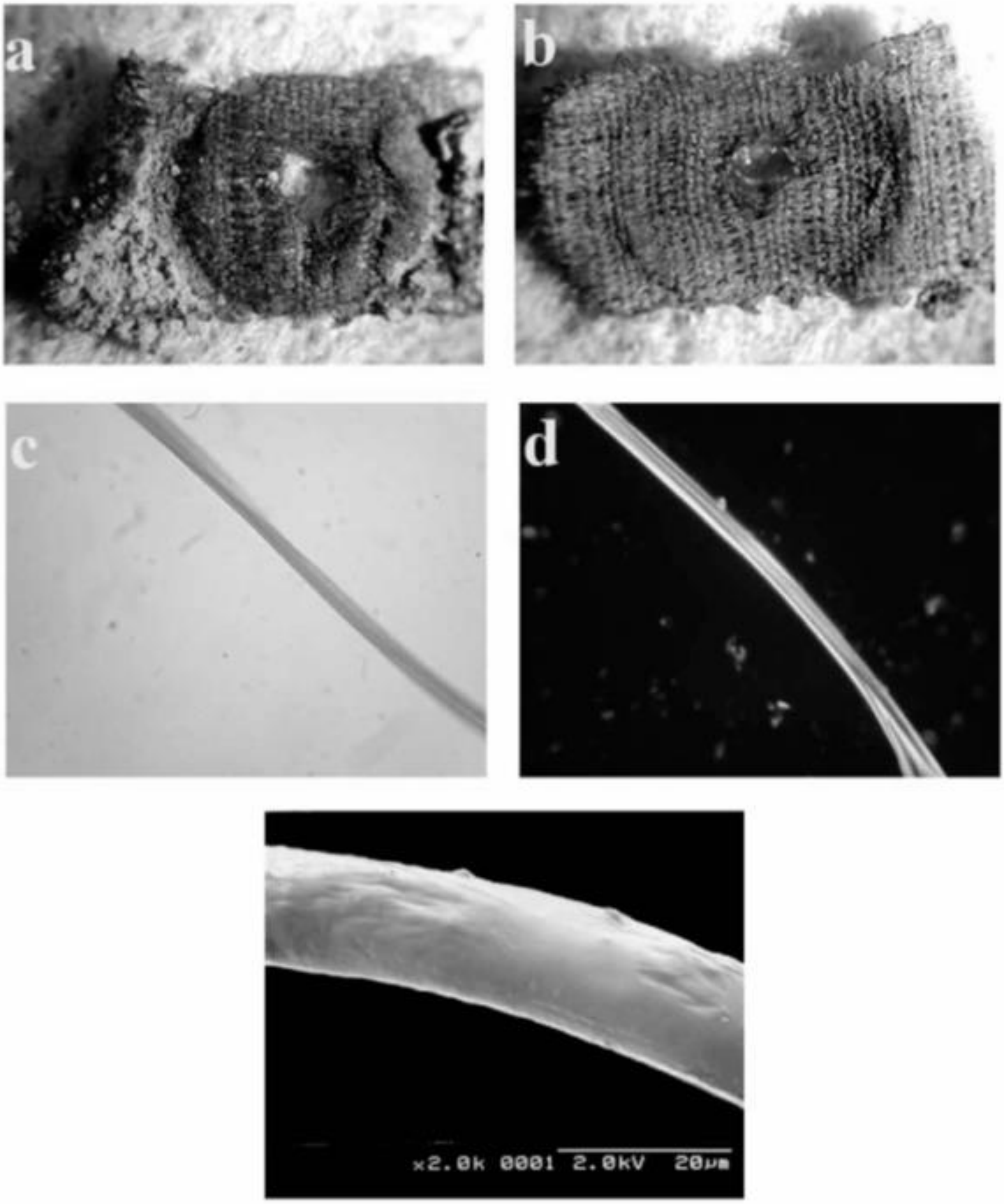


Figure 4: microscopic pictures Type II fibres from grave 3-3 Harewood cemetery: *(a)* upper surface of textile, showing impression of tack head; *(b)* lower surface of textile *(c)* brown (silk) fibre; *(d)* brown in the original picture (silk) fibre, crossed polars; and *(e)* SEM of brown in the original (silk) fibre (© 2010; Rowe 2010, fig. 4).

1.3 Agora Excavations, Athens, Greece

The excavations at the Agora in Athens have recovered numerous examples of pseudo-morph textiles in the soil with a wide chronological span from the Bronze Age to the Byzantine period.

Consequently, archaeologists gave more attention during the excavation to keep this evidence. Then, the textile analyses in the conservation laboratory were accomplished by a thorough examination (Unruh 2007).

In 2000, the sherd base of an amphora was excavated and interpreted as a paint palette cover. Lumps of red and yellow pigment were found within the sherd. The lab examination detected the presence of vague but regular “grid patterns of three dimensional reliefs” in the soil on the sherd (fig. 5). The edges of the amphora sherd seemed to display sheet-like soil. This was identified as a fragment of brownish textile. The lab analyses revealed that the grid patterns were soil structure, which had reasonably formed by the prior existence of textile, and traces of actual textile were still preserved.

It is not entirely clear how the soil had kept the textile evidence (Unruh 2007, 169). The best interpretation of this case of preservation is described as partial mineralisation due to the presence of calcium carbonate (Cronyn 1990, 28) in the Agora soil. The analyses by the Fourier Transform Infrared spectroscopy and micro-chemical examinations have confirmed the presence of calcium carbonate in those grid structures. The logical assumption is that calcium carbonate had just partially replaced the fibres, allowing the preservation of the shape of the textiles (Unruh 2007).

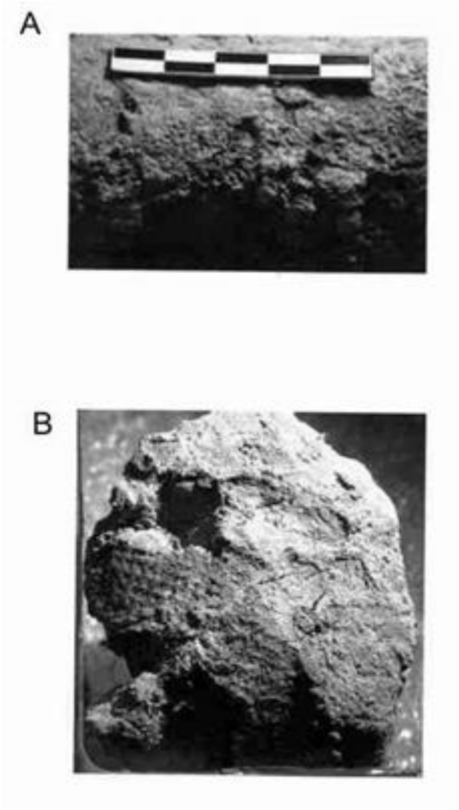


Figure 5: A and B, textile impressions in soil, from Agora 5th century BC, Athens (© Oxbow books 2007, from Unruh 2007, fig. 27.2, 27.3).

1.4 College site, Sidon, Lebanon

Preservation of textile fibres is provided by extremely warm and dried environments. College site, Sidon (Doumet-Serhal 2010) offers an example of textile fibres preserved in warm arid conditions through mineralization. The burials of the Middle Bronze Age lay upon sandy ground (Doumet-Serhal 2010, 118), which promoted quick drainage and dry environment. The case of burial 102 is interesting for the different conditions of thirty pieces of mineralised flax linen (Gleba and Griffiths 2011-2012). The textiles were discovered approximately beneath the spine of a female burial. All these remains were mineralised into calcium carbonate (Gleba and Griffiths 2011-2012, 285). Even if apparently this process does not preserve organic substances, it saved the structure of the textile, which in some cases is still identifiable (Gleba and Griffiths 2011-2012, 289-291). The SEM elemental analysis carried out by Dr Margarita Gleba at the UCL laboratory, revealed the calcium carbonate mineralised fibres. Calcium carbonate had ruined the fibre surface in some cases, and it was not possible to get a clear identification for all samples even with the SEM (Gleba and Griffiths 2011-2012, 289). However, the presence of splices and the size of fibre diameter were comparable with flax fibre (fig. 6).

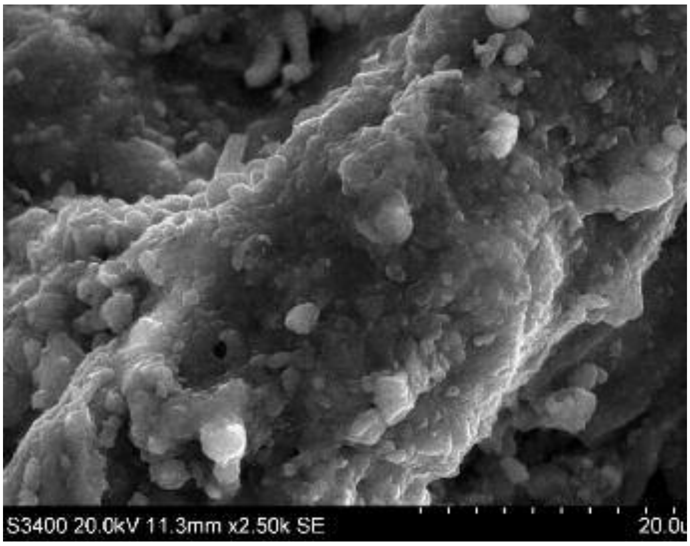


Figure 6: SEM picture of mineralised flax fibre from burial 102 College site, Sidon, Lebanon. (© Copyright 2012 Archaeology and History of Lebanon from Gleba and Griffiths 2011-2012, fig. 7).

1.5 Charred textile pseudomorphs. Ben Hinnom Valley, Jerusalem, Israel

The burial chamber B at Ben Himmon valley, near Jerusalem, Israel, offered a good example of charred animal and plant textile fibres. The burial is a rock cut grave with two chambers, A and B (Shamir 2007, 2015). The chambers are arranged into *loculi*, where the human remains were deposited. The funeral ritual disposed of the human remains in these ossuaries and archaeologists recovered 28 of them in chamber 2. The bones were spread in the chamber, which had been looted before the archaeological recovery (Shamir 2007, 77).

However, one *loculus* was discovered still sealed by the archaeologists who found bones mixed with a black mass, apparently composed of organic matter: human hair and fabric. Those materials were analysed by C14 and dated to the 1st century AD (Shamir 2007, 77-78). The DNA analyses on the bones revealed the dead body was a male who suffered from leprosy (Shamir 2007, 78). This disease was considered socially dangerous and it may explain why his remains were not moved in a secondary disposal, as was the funeral tradition at the time. The textiles received microscopic analysis by polarised light (Shamir 2007, 79). The fibres were identified as wool and linen in plain-weave technique. They were found carbonised with minor damage probably produced by insects, the humidity of the chamber and the body decomposition (Shamir 2007, 78). These textiles were interpreted as the remains of funerary shrouds, which wrapped the corpse (Shamir 2015, 3-4). The report (Shamir 2007) does not provide detailed information about the carbonization process of the fibres. However, it is known that charring organics at low temperature up to 300^{o}C is conducive to preservation, because it impedes microbiological activity (Hillman *et al.* 1993, 95).

1.6 Dedoplis Gora palace, Georgia

Multiple textile finds were recovered in the soil of a workroom at Dedoplis Gora. This site had a long continuity of use and it suffered some destruction caused by the seismic activity of the area (Kvavadze and Gagoshidze 2008). The textile finds belonged to the 1st century AD. During that period, an earthquake, followed by a fire, destroyed the palace. Excavations showed textile evidence of this phase particularly in room 18. The floor of this chamber was covered by charred fibre, ropes and a clump of yarns, and also textile impressions were kept on the surface of some bricks (Kvavadze and Gagoshidze 2008, 213). Archaeologists carried out a sampling collection in order to do palynological and fibre examinations. The results were not always completely satisfactory, but successful samples contained evidence for silk, cotton, flax, *Juncus* (rush) and *Cannabis* (Kvavadze and Gagoshidze 2008, 213-214) (fig. 7).

Even if all the fibres were found in a carbonised or fossilised condition, their preservation was sufficiently good to allow identification. The elevated presence of textile fibres relies on the original function of room 18, which was probably a weaving workshop (Kvavadze and Gagoshidze 2008, 212). Cotton was the fibre more frequently found and it was interwoven with silk, likely to produce cloth that was more precious (Kvavadze and Gagoshidze 2008, 213-213, fig. 3). The fibres were interpreted as being used for tapestries in the palace (Kvavadze and Gagoshidze 2008, 214). It is of the most interest that a wide range of fibres were preserved by a dramatic event that caused a quick carbonization and sealed archaeological layer (Kvavadze and Gagoshidze 2008, 211). Hence, transformation of the organic matter into inorganic states caused their resistance to biota and other decay factors (Hillman *et al.* 1993, 95). The absence of wool was explained to be caused by the arid environment rather than a cultural selection (Kvavadze and Gagoshidze 2008, 214).

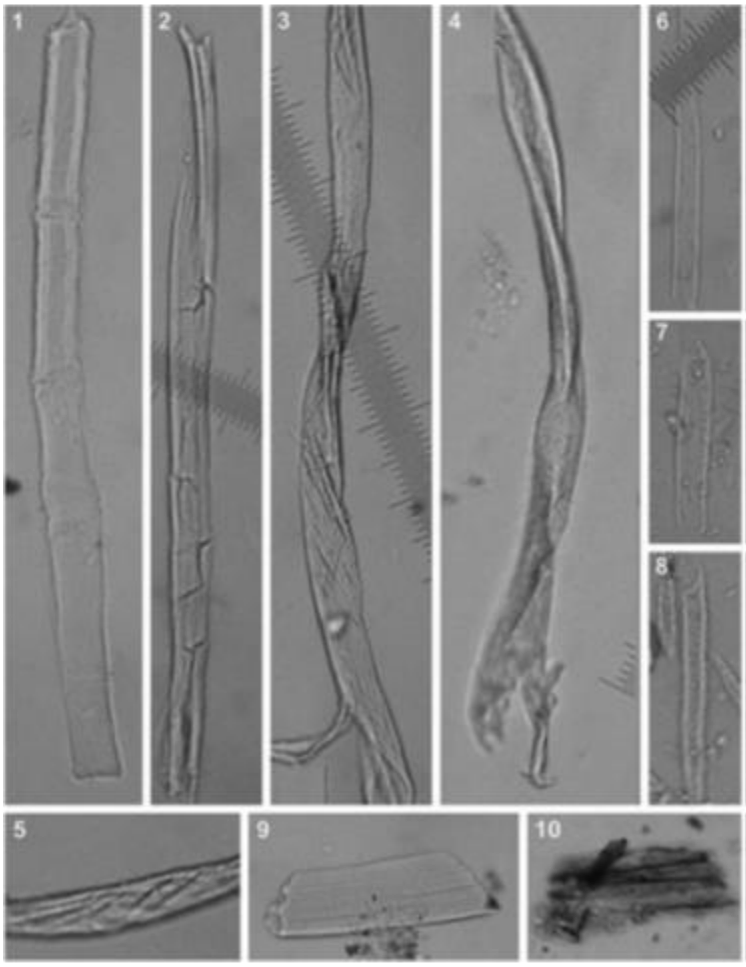


Figure 7: microscopic pictures of sampled fibres from Dedoplis Gora. 1-2 flax fibres; 3-5 cotton fibres; 6-8 silk fibres; 9 Juncus (rush) fibre and 10 Cannabis fibre. (© 2008, Springer-Verlag from Kvavadze and Gagoshidze 2008, fig. 2).

2. Textile impressions

2.1 Begash, Kazakhstan

Bronze Age Central Asian sites have not returned much direct evidence of textiles, because the local environment does not offer good preservation conditions. Therefore, even indirect hints are extremely important to support the topic of prehistoric textiles. Since Bronze Age pottery was produced even by textile-lined moulds, this type of evidence is recurrent in Central Asia (Doumani and Frachetti 2012, tab. 2). The most ancient evidence of textiles in that area comes from Begash, Kazakhstan, a settlement characterised by a pastoralist economy and dated to the occupation from the first phase from 2460 cal BC to the 14th century AD (Frachetti and Mar'yashev 2007).

The study of Doumani and Frachetti (2012) has examined 18 samples from the Bronze Age phases (phase 1 2450-1700 cal BC; phase 2 1650-1000 cal BC). The moulding technique consisted in casting white baking clay in cloth; so that the more pressure was given to the clay on the cloth, the more visible the textile impression became. The analytical studies on those impressions were done by hand magnification and macro photography X 10 magnification (fig. 8).

The analysis on Begash impressions cannot suggest the original fibre, even if the surrounding area of Begash provides wild fibre sources, such as *Cannabis ruderalis*, *Artemisia* spp., *Urtica* spp. and *Celtis* spp., and the shepherd economy implies even wool. Therefore, archaeologists may generally assume that one or more of those fibres were used to produce the pottery moulding cloths. Conversely, the impressions can furnish details about the mould in itself, if it was cloth or cordage and even textile technology, the weaves, yarn and thread. (Doumani and Frachetti 2012, 370 and tab. 1).

The preservation of organic component of textiles is extremely limited in the case of Begash. The actual fibres have completely gone. Hence, the current technology cannot identify correctly the original fibre sources of those moulding cloths. However, the impressions are still relevant in providing hints about textile existence even in environments, such as on the central Asian steppe, which are commonly hostile to organic preservation.

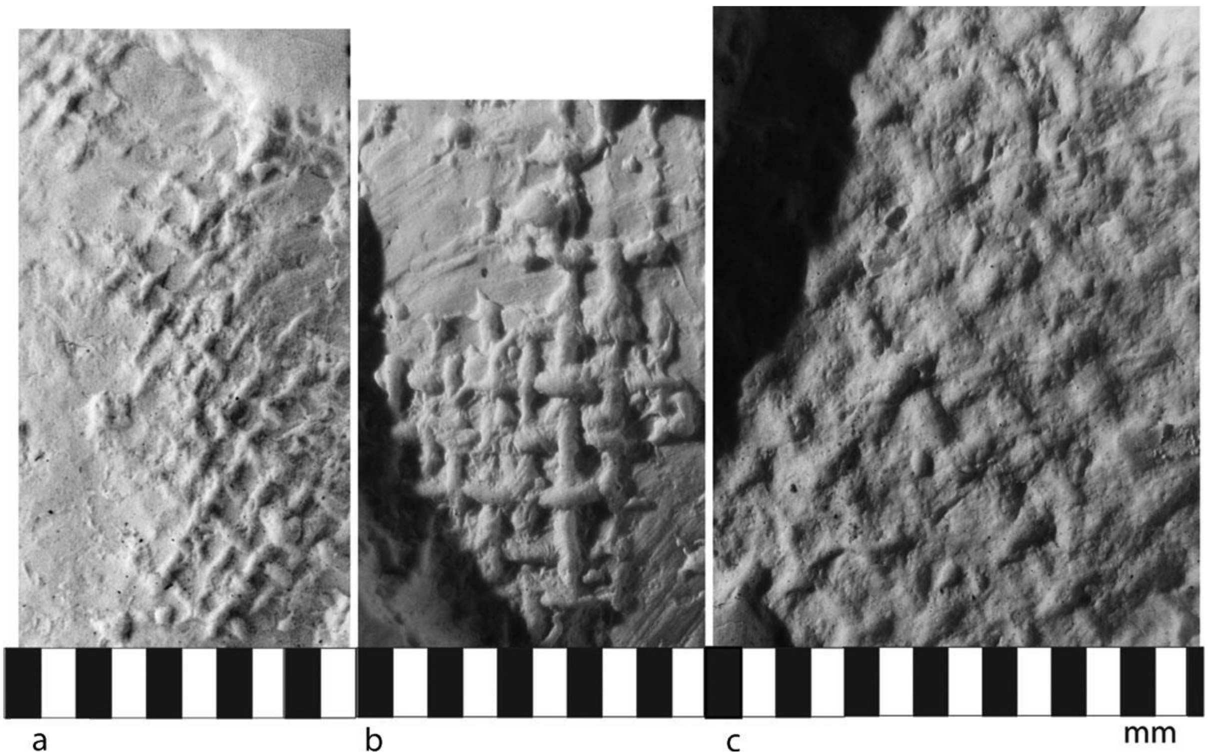


Figure 8: textile impressions from Begash, 1650–1000 BC. A) sample 6; b) sample 7; c) sample 9 (Doumani and Frachetti 2012, fig. 4).

3. Anaerobic environments

3.1 Rylstone, England

A burial site at Scale House, near Rylstone, a village in the Craven district originally recorded as Rylston, Yorkshire has preserved evidence of fragmentary woollen cloths that date back to the early Bronze Age (Wild 1988; Greenwell 1877, 375). The characteristics of this burial suggest that the absence of available oxygen creates anaerobic conditions, which prevented the activity of aerobic bacteria and fungi.

The burial was in a clay barrow found in poor conditions. It was 1.524 m high and 9.144 m in diameter; a close shallow trench delimited the mound. A layer of flat stones was arranged under the surface at the centre of the barrow. A layer of compacted clay with dark earth rich in charcoal was underneath the stones. A second processed and finer clay layer followed the charcoal. Finally, the last layer covered an oak coffin, which laid upon clay. The coffin was made by a trunk split in two and then hollowed out. It was nearly 2.13 m long and 0.58 m wide. Both extremities of the trunk were cut and then rounded. The internal space of the coffin was roughly shaped and its sizes were 1.93 m long and 0.30 m wide. Remains of the body were preserved, together with the presence of an "unctuous" whitish material, which chemical analysis proved to be of animal origin (Greenwell 1877, 375-376).

The only artefacts found in this coffin were textile fragments, which now are kept at the British Museum (fig. 9). They are woven plain tabby with irregular thread counts and irregularities in texture. Warp and weft have the same quality of wool; spun on a worsted principle. The fabric has a dark brown colour and is in poor condition. No other artefacts have been found associated (Greenwell 1877, 376).

This case study is still relevant because it shows the relative accuracy in soil and burial description despite the time of discovery, and the soil is acid loamy clay slowly permeable and seasonally wet (Cranfield University 2012). The preserved pieces of fabric were analysed microscopically, but there are no comments on the microscopic quality of the wool preserved (Grewell 1877, 376). Further chemical analyses were ordered to identify the unknown substance accompanying the human remains (Grewell 1877, 376). The recorded whitish, soap-like material of animal origin might be residual degraded adipocere (Forbes *et al.* 2002, 226; Forbes *et al.* 2005, 35; Lew and Matshes 2005, 541-542). The type of wet soil (Forbes *et al.* 2002, 228; Forbes *et al.* 2005a, 37) and the oak coffin enhanced the formation of adipocere (Fielder and Graw 2003, 294). Interestingly, similar preservation of textiles and human remains are recorded in Scandinavian Bronze Age barrows that contain oak coffins (Holst *et al.* 2001).

Humic acids (Visser 1985; Allison 2006) and tannins (Benoit and Starkey 1968; Kraus *et al.* 2003) affect soil microorganisms activities. The antibiotic effect of tannins works in several ways "(1) inhibition of extracellular enzymes, (2) deprivation of substrates required for microbial growth, (3) direct action on microbial metabolism including disruption of oxidative phosphorylation or electron transport and (4) deprivation of metaloenzymes through complexation of metal ions such as Fe" (Kraus *et al.* 2003, 51). Humic acids reduce the microorganisms that participate in organic degradation (Neilson and Allard 2008, 208) because of the inhibition of extracellular enzymes "through complexation or covalent binding reactions that impede substrate access to the enzyme active site" (Allison 2006, 362).

If it is the case, here, it is suggested that the burial environment was anaerobic, because such condition is certainly conducive of adipocere formation (Fiedler and Graw 2003, 295-296; Dent *et al.* 2004; Forbes *et al.* 2005; Forbes *et al.* 2005a, 35-36; Schoenen and Schoenen 2013). Additionally, the activity of microorganisms was inhibited by tannins (Benoit and Starkey 1968). Hence, this environment supports textile preservation.

Figure 9: textiles from Scale House, Rylstone (© Trustees of the British Museum).

3.2 Aquincum, Hungary

Another example of textile preservation in anoxic burial was offered by sarcophagus of Aquincum, which was the name of Budapest during Roman times. The burial was a female grave dated 4th century AD (Hollendonner 1917; Nagy 1935; Wild 1970, 20). In 1912, two graves were discovered, one was already looted, but the other was undisturbed. The latter was the burial of an upper-class woman, in contained her mummified body, grave goods and the sarcophagus was hermetic raw limestone coffin (Maeder 2008, 113). Several layers of linen wrapped her body. The linen was impregnated with resin. Moreover, a fragmentary brownish textile was found between the legs of the dead (Nagy 1935; Wild 1970, 20; Maeder 2008, 113-5). The analyses classified the remains as sea-silk (Hollendonner 1917). The description of this burial and the presence of resin show some similarities with other Roman burials containing resin residues (Brettell *et al.* 2013)

The first analyses described the textiles as extremely brittle and degraded (Hollendonner 1917). The fibres of the fragmentary fabric found at the legs of the mummy were analysed by microscopic examination of cross section. It was found positive identification with sea-silk of *Pinna nobilis* (Maeder 2008, 115). That hermetic burial offered apparently good conditions for organic preservation. In fact, as well as the mummified body and the linen of the bandages and sea-silk textiles, there were found fragments of cork sandals, bronze fittings of a wooden casket (Hollendonner 1917). Further details have not been reported which show the other causes of preservation. A possible explanation may be because the grave kept an anoxic environment, which preserved different organic materials. Additionally, some special treatments, such as the observed resin on the linen, might have improved the preservation of some materials such as the sea-silk fabric.

3.3 Lady Dai tomb, Changsha, China

Not surprisingly, the best evidence of ancient preserved silk clothing comes from China. Silk was associated with high rank burials as clothing and covers (Zhu *et al.* 2014, 681). It is likely that a considerable quantity of archaeological silk evidence is extremely degraded, but a recent study has shown that it is possible to identify silk fibroin traces in burial soil through proteomics (Zhu *et al.* 2014). Here is presented a case study from the Han dynasty 206 BC – AD 220 (Wright 2001, 50-53). The tomb of Lady Dai, whose personal name was Xin Zhui, had preserved the body and the associated grave goods in exceptional conditions. The reasons for the high quality of preservation may be due to the specific and careful burial disposal (Buck 1975).

The excavation at Ma-wang-tui began in 1972. The funeral site consists in two mounds where archaeologists found three burials (Buck 1975, 30-31). The tomb I belonged to Lady Dai. It is a funeral chamber, made within the mound. It was built as a long pit, measuring 19.5 X 17.5 m and it was 20 m deep. The chamber was constructed with large cypress planks, and a second inner chamber was built in cypress, repeating the shape of the external one (Buck 1975, 33-36). The second chamber has been identified as a casket, which contained four coffins, put one into another. The free space between the funeral chamber and the casket is organised into four sections where the grave goods were disposed (Buck 1975, 34). The northern section was draped with silk cloth and there were wooden figures and ritual food offerings. Interestingly, during the discovery, a “liquid containing mercury and various acidic and organic compounds” (Buck 1975, 34) waterlogged this part. The interpretation of this liquid is not definitive, but it appears to be linked with the idea of intentional preservation of the offerings (Buck 1975, 34). The western of section of the tomb kept mats and bamboo cases and baskets, all of them were containers of clothing and food (Buck 1975, 34). The eastern area conserved wooden figurines (Buck 1975, 34), like the southern, which even included a bamboo strip catalogue of the funeral offerings deposited in there (Buck 1975, 34).

The funeral chamber was buried under a 0.4/0.5 m deep layer of charcoal and over it there was another layer 1 metre thick of white clay (fig. 10). This tomb was built with a technique, which is considered fundamental for the excellent preservation of human remains and grave goods. In fact, the double covering layer insulated the tomb from oxygen and moisture (Buck 1975, 34). Even the presence of four coffins influenced the perfect state of Lady Dai’s corpse, which was wrapped in twenty layers of shrouds. Under the shrouds there were nine bands and under the bands other clothing and shrouds. The body was fully examined by autopsy (Buck 1975, 35-36).

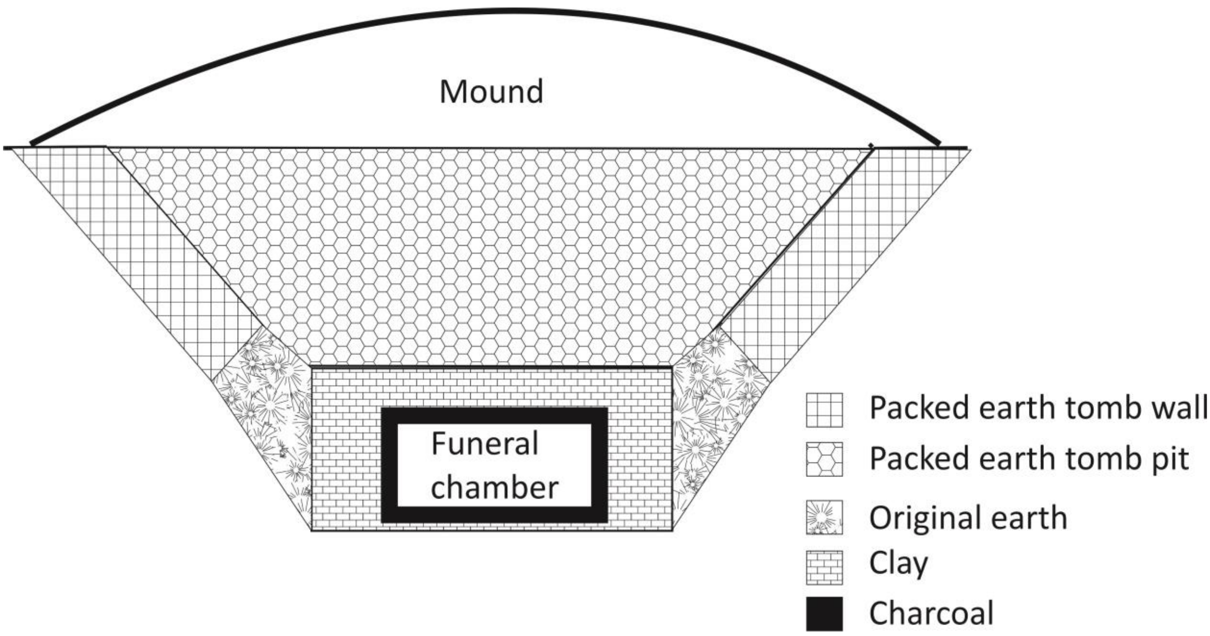


Figure 10: scheme Lady Dai’s monumental tomb (reworked image of the author based on Buck 1975).

Among the rich grave goods, a large silk funerary banner was folded in the deepest coffin with Lady Dai. The garment is decorated and it still keeps its colourful paintings, which interested scholars more than other aspects (Buck 1975, 37). This burial offered conditions for organic preservation because of anaerobic environment.

3.4 Vergina, Royal Tomb II

The case of the Royal Tomb II of Vergina, Greece, is illustrative of the importance of oxygen for textile deterioration. This monumental burial is supposed to be the royal tomb of Philip II (Andronikos 1984). Even if there is not a general agreement about the identities of the dead (Borza 1987), the quality and quantity of grave goods reveal that these tombs belong to the royal family of Macedonia. The monumental tumulus is dated to the 4th century BC and it comprises three funeral chambers. Two marble sarcophagi were placed one in the main chamber and the other in the antechamber (Andronikos 1984). The sarcophagi housed golden larnakes, which are Greek containers for cremains (Darvill 2008, 238-239). The larnax found in the antechamber contained the cremated remains of a young woman wrapped with two pieces of golden and purple cloths (Andronikos 1984, 164). These textiles were extremely degraded and it was not possible to reconstruct the original structure of the cloths (Gleba 2008, 65).

However, further examinations identified some of those fibres as cotton fibres and other as purple wool (Spantidaki and Moulherat 2012, 196). The identification of cotton for some of those textile fragments derives from the microscopic analysis that has revealed they may have the typical cotton convolution (Moraïtou 2007, 6). However, there are still doubts about the identification of these fibres because they were seriously damaged and their identification should be considered tentative (Gleba 2008, 65). It is underlined that the Vergina textiles were kept separately from soil, inside two containers, like the marble sarcophagus and the golden larnax. However, this covering offered limited preservative environment to the textiles.

4. Waterlogged sites

4.1 16-22 Coppergate, York, England

At 16-22 Coppergate, York five sites were excavated and they are well known for the interesting amount of archaeological organic material preserved (Walton 1989; Walton-Rogers 1997; Mould *et al.* 2003). The sites are placed on a ridge between two rivers, the Ouse and the Foss, and the excavations highlighted the archaeological phases from the Roman times onwards (Hall in Walton 1989, 285-297, tab. 11). Environmental characteristics were good for preserving organic matter, because deposits were high in water content (Jones 1982, 69; Walton-Rogers 1997, 1709). Moreover, deposits were multilayers deeply stratified. In fact, finds of wood and leather were frequent in layers of different periods (Walton 1989). Conversely, preserved textiles, including cordage and raw fibres, were mostly concentrated in Anglo-Scandinavian and Medieval layers, whereas the soil did not preserve any textile in the Roman layers (Hall in Walton 1989, 292).

Walton-Rogers (Walton 1989, 300) distinguished identified fibres into three categories: woollen fibres, silk and plant fibres (fig. 11). These materials have different degrees of preservation. Soil was more preservative for animal fibres than for plant materials (Walton 1989, 300). Hence, wool and silk fragments survived in a variety of conditions, while flax and hemp based textiles were mostly preserved by carbonization. Excavations at Coppergate also found a great amount of leather and leatherworks (Mould, Carlisle and Cameron 2003). Most of the leather remains were fragmentary and the objects were limited in number. These materials were recovered from pit fills, build-up deposits and dumps. The majority of this leather was waste of a leatherworking activity or activities, which was not found, and a small part was manufactured objects, likely from domestic waste Mould, Carlisle and Cameron 2003, 3245-3246). It seems likely that this waste was collected by different places and was deposited in one episode to flatten the ground level.

The five sites of 16-22 Coppergate offered the same environment: numerous layers, seasonally waterlogged, which created anoxic sediments. However, different mechanisms of preservation protected the textile finds of Coppergate, which have been classified into three categories according to the process of preservation (Walton 1989, 300). One group was preserved because of anaerobic environment, the second group was formed by charred fibres and the third were mineralized textiles. Moreover, leather, either as artefacts or as fragments, was found in different degrees of preservation. It was recognised that vegetable tanning contributed to preservation of the majority of these materials (Spriggs in Mould, Carlisle and Cameron 2003, 3213-3221).

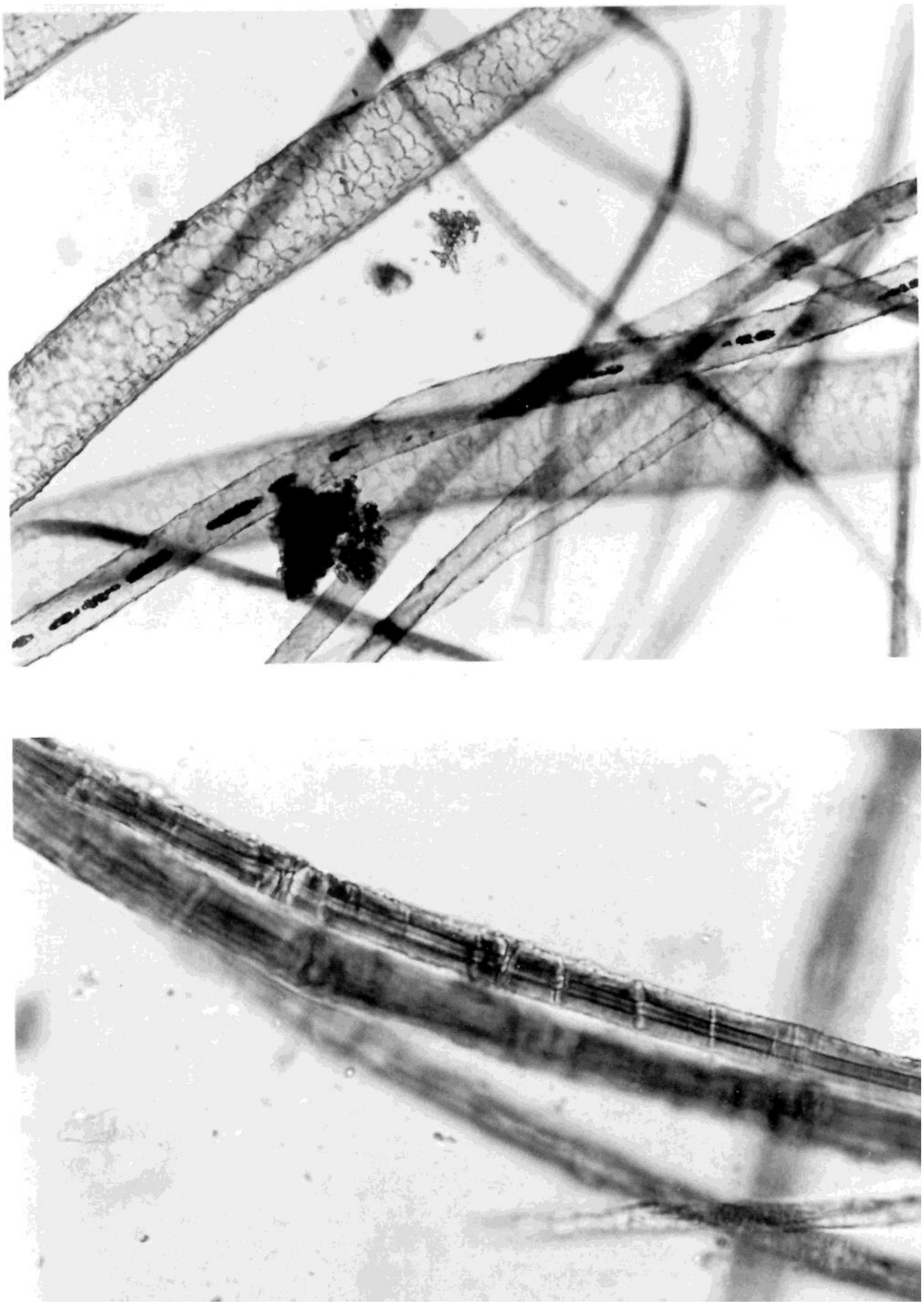


Figure 11: Coppergate 16-22. Samples of woollen fibre (above) and flax fibres (below) viewed under the microscope (© Walton-Rogers and the Anglo-Saxon Laboratory, Walton 1989, pl. XVa and XVb).

4.2 Roman sarcophagus, Spitalfields Market, London, England

In 1998, during the excavation by the Museum of London Archaeological Service of the medieval priory and hospital of St Mary Spital, a Roman cemetery was discovered, which was in use in two different chronological phases, the first at the end of 2nd century AD and the second from the end of the 3rd to the first half of 4th century AD (Burnham *et al.* 2000, 420). The human remains hardly survived in the graves. The cemetery was organised into grave clusters, likely to define different groups (Thomas 1999, 8). A sarcophagus belonged to the second period of use and it was situated in a four high status burial group, placed in an eminent position at right angles to the main ancient road (Thomas 1999, 9). The other three burials were robbed in antiquity, but this one remained untouched. The burial is composed of a limestone sarcophagus, which contained a re ctangular lead coffin. The empty space between the sarcophagus and the lead coffin was filled with soil (Thomas 1999, 9).

The burial was of a woman, twenty years old and despite her short life, she had lived a good quality existence. She was disposed of in straight supine position and her head laid on a support of bay leaves. Textile was found under the bay leaves, which suggests that the bay leaves were the filling of a cushion (Thomas 1999, 9-10). Wet silt was even found under the skeleton. Probably the silt came into the coffin when the water table rose (Thomas 1999, 10). Hence, this burial was a waterlogged environment.

The conservator's lab analyses on this silt allowed the finding of textile remains, which were not visible to the naked eye. Firstly, golden threads were identified near the thigh bones, around the ribs and the wrists of the woman (Thomas 1999, 10). The use of golden threads was extremely rare in Roman Britain, while they were more diffused in contemporary Europe (Gleba 2008, 63). It was deduced by the position where the threads were found, that they might be the decoration of a garment, which dressed the body (Thomas 1999, 10). The examination revealed a spiral thread, which was less than 0.2 mm wide and 0.002 μm thick. It was originally spun around an organic fibre core. There were no more traces of the actual organic thread, but it was assumed that the fibre was silk, because silk fibre has the characteristic to be extremely subtle and strong simultaneously (Thomas 1999, 10). The retrieval of silk evidence in a Roman sarcophagus at Spitalfields, in London, has been possible only by clever observation and accurate conservation (Barham and Lang, 2001; Wild 2012, 17).

The textile discoveries were more than the golden threads. In fact, there was found even a fragment of damask silk and a fragment of wool. It has been suggested that the silk damask and the golden silk might be parts of the same garment (Barham and Lang 2001). The preservation of silk and wool fibres in this burial may be due to the waterlogged environment with silt present. Unfortunately, the original fibre, which was part of the golden thread, did not survive, but the assumption that it was silk, seems reasonable, because the dimension comparisons and the retrieval of other silk fragments in the burial can enforce this hypothesis. However, the identification of preserved fibres in the silt deposit was possible only because of the systematic lab analyses. Conservators used X-radiography, light microscopy, SEM and electron probe microanalysis (Barham and Lang 2001).

5. Dry and arid environments

5.1 Herjolfsnæs, Greenland

Herjolfsnæs is a Viking site placed on south-western Greenland, currently the site is called Ikigaat (Nørlund 1924; Østergård 2004). The Viking cemetery, connected with the local church, was unearthed by proper archaeological missions or occasional digs with different results in 1839, 1860, 1880, 1921; 1997-1999. However, the last two excavations were the most effective in terms of finds. The site is chronologically placed between the 12th to the middle 14th century AD by some historical texts, the *Flatey Book*, *Guđmundar saga biskups Arasonar* and Ivar Baardson personal report, while radiocarbon dates confirm the continuity until the middle 15th century AD (Østergård 2004, 253-254). It has been assumed that the cemetery started in the late 10th century (Østergård 2004, 27).

The importance of the site consists in the good state of preservation of textiles, such as clothing and shrouds, and wooden artefacts. The circumstances shaped the funeral ritual. Wood was a rarity in Greenland and it was mostly driftwood. Hence, the wooden coffins were a sign of prestige, because the wood was employed mostly for buildings. Consequently, burials in shrouds or in garments became an acceptable alternative (Østergård 2004, 24).

The Nørlund excavation investigated around 120 graves and it reported naked-eye observations about those funeral costumes. For example, burial 65 presented fragmentary coarse flax-like textile on the chest of the skeleton. Moreover, the skull of burial 79 still preserved the remains of what has been identified as a hood. However, there are some uncertainties about how to collocate clothing with precise burials, because the report does not provide a precise reconstruction (Nørlund 1924). Overall, there were found 23 complete costumes, 16 hoods, 4 caps and 6 long socks (Østergård 2004).

The preservation of flax, but also of hemp and wool fibres, at Herjolfsnæs, is not easy to understand. The good preservation of textile is in contrast with the human remains, which were almost totally gone. Several causes converged in the preservation of textiles. Sand and gravel compose the soil of Herjolfsnæs churchyard, which promote of free water drainage. Additionally, the extreme low temperature and the permafrost participated in that process of textile preservation (Østergård 2004, 27). The first burials were made in the 10th century AD, when the climate was warmer than today in Greenland (Alley 2000, 5-6 fig. 1.1; Broecker 2001)). Consequently, those burials did not preserve any skeletal remains or clothing.

The drop of temperature, registered during the 13th century AD, produced stable permafrost (Alley 2000, 5-6 fig. 1.1). The graves enclosed in the permafrost layers resulted in the best preserved.

Interestingly, Nørlund (1924) noted that the preservation of textiles might also be influenced by the season in which the burials were made.

5.2 The salt men of Chehr Abad, Iran

In 1994 some human burials were discovered in the salt mine of Chehr Abad Douzlakh, north-western Iran. The find attracted the interest of local and international scholars and scientists because of the exceptional preservation of the bodies. The salt mine is placed in a hilly area between two valleys and the mine is on a slope at 1350 m asl. The area was included in the sedimentary basin of a Miocene lake. The layers were in sequence marl, gypsum and halite, and clay. The mine is in the superficial layer of evaporite sediments of sodium chloride, which are placed under the marls (Aali 2005).

The site was exploited for the salt for a long time span from the 5th century BC. There were found five bodies and their chronology range from 2286±28 (body 5) to 1545±19 (body 2) BP (Pollard *et al.* 2008). Isotopic analyses of the mummies showed that the miners were original from different places (Ramaroli *et al.* 2010). The miners' work was dangerous. In fact, the body numbers 3-5 were buried by natural collapses in the caves (Pollard *et al.* 2008; Aali *et al.* 2012). Those unfortunate events provided the miners bodies with their clothing in excellent condition. Irene Good has studied the clothing textiles as the team member specialist in textiles of the research project. The salt men's clothing were in wool and leather and they were found well-preserved (Pollard *et al.* 2008, 135-136; Aali *et al.* 2012). The fibre structure, the weave and even the colours were kept by the specific salty environment, which had produced an immediate dehydration of all organic tissues, stopping the action of microbiological decay. Some samples of dyed textiles, which were not directly associated with the mummies, were examined by high performance liquid chromatography (Mouri *et al.* 2014). The dyes resulted all derived from plants that grow locally (Mouri *et al.* 2014).

Body 2 was dressed and the analysis of his clothing reveals wool fibres with preserved traces of light brown colour. Additionally, a woven belt, made by strings, was associated with this body, with colour decorations in red, blue, green and white (Aali 2005). Moreover, leather shoes were included as salt man 3 clothing. The body 4 was dressed and his chest area displayed traces of blood loss due to the cave collapse. This body had a woollen and light brown coat and trousers (Aali 2005; Pollard *et al.* 2008, 136).

Two samples of clothing textile from salt men 2 and 5 were provided by Don Brothwell for further analysis. On 17th January 2013, a team composed of Don Brothwell, Annika Burns of the InterArChive project, Megan Stark of Biology and myself, employed the SEM of the Department of Biology of the University of York, to examine the features of the fibres. The samples were scanned with different high levels of magnification. The observations on salt man 2 clothing fibres revealed severe deterioration possibly due to biological damage (fig. 12-14). The cuticle scales are brittle and show material adhering on the surface (fig. 12, 15). The internal structure shows the most damage. The fibres are swelling apart and fungal deterioration is visible (fig. 13, 14). Even the sample of textile from salt man 5 clothing was examined in depth. The analyses have revealed a poor preservation of the fibres, which were still identifiable despite probable microbial attacks (fig. 14). The fibre has been identified as animal hair, possibly wool fibre, according to the previous identifications by Good (Good n.d.) on the clothing of the other salt bodies (fig. 15).

The salt men clothing fibres, analysed by of Irene Good, were described to be in optimal conditions (Good, n.d.), whereas the two samples analysed at York were severely deteriorated. Even if the samples have been kept carefully, the poor preservation of York samples may be attributed to different reasons. One cause might be the exposure to oxygen from the moment of the discovery to the SEM work. In fact, the samples were not stored in airtight containers. Another cause might be the dramatic change of environment, the absence of the extremely salty burial environment, which could have encouraged biological agents of deterioration, such as fungi or bacteria, to start their attack of the woollen fibres.

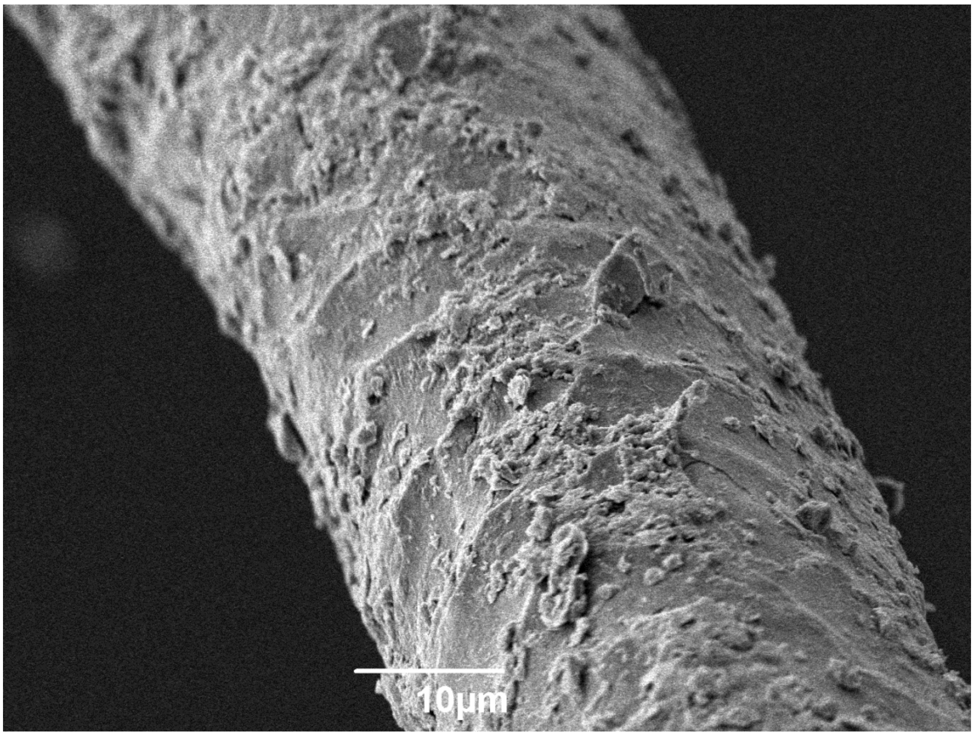


Figure 12: salt man 2, Chehr Abad Douzlakh, Iran. Woollen fibre, SEM photo magnification X 2,000 (author).

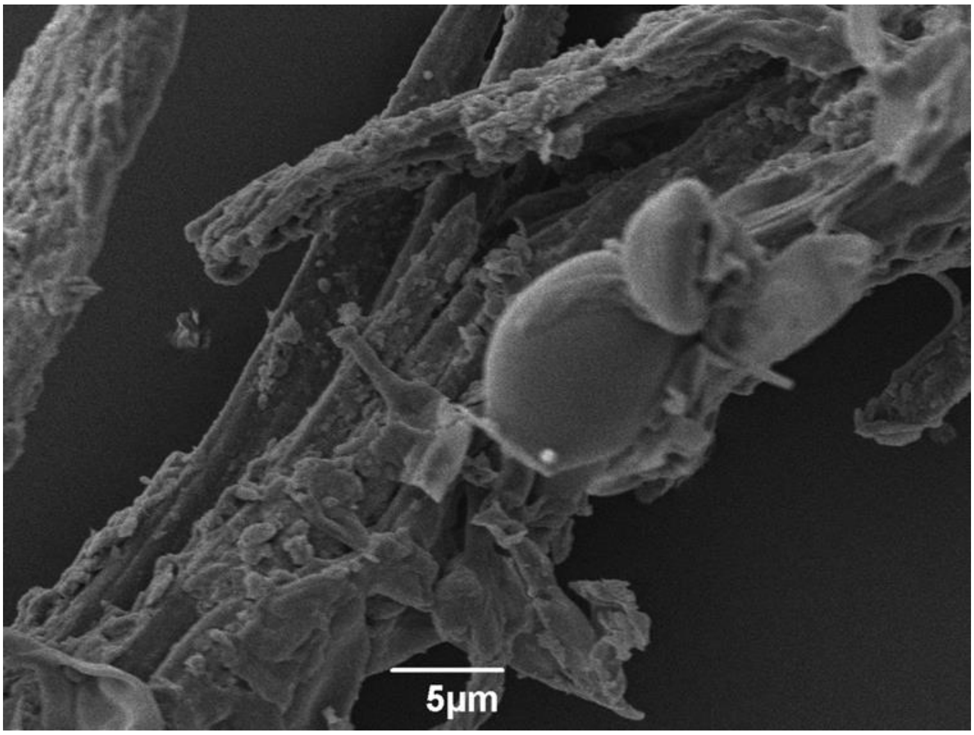


Figure 13: salt man 2, Chehr Abad Douzlakh, Iran. Woollen fibre, SEM photo magnification X 3,000 (author).

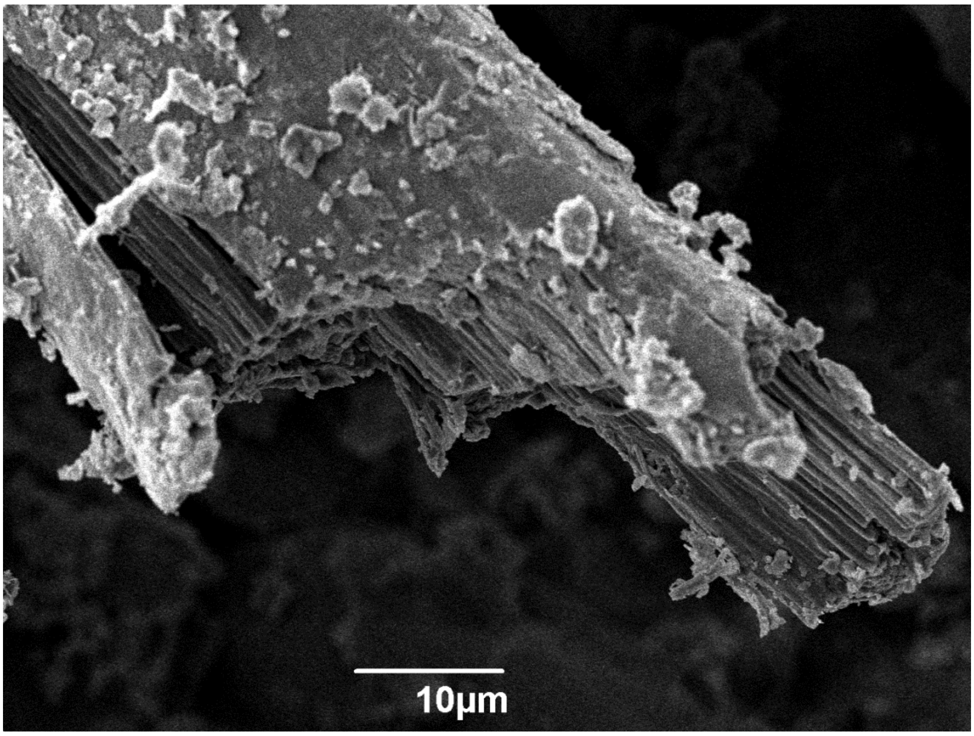


Figure 14: salt man 5, Chehr Abad Douzlakh, Iran. Woollen fibre, SEM photo magnification X 2,000 (author).

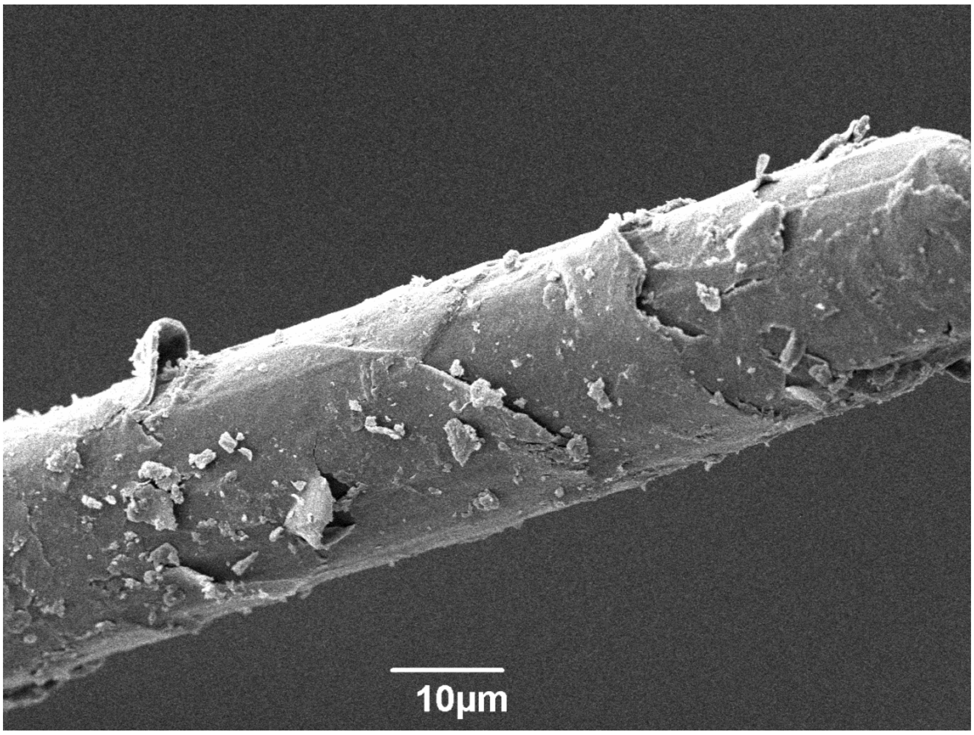


Figure 15: salt man 5, Chehr Abad Douzlakh, Iran. Woollen fibre, SEM photo magnification X 1,500 (author).

Appendix 3: grave objects occurrence and distribution

Tabulations include the object categories described in chapter 3.4.5; the absent categories are not recorded in these tables. Values in the tables are expressed in natural numbers. The numbers between parentheses are graves with no bones left.

1. Eastern Roman cemetery of London

In the Roman Eastern cemetery of London, grave objects do not usually accompany inhumations. Hence, the number of selected cultural traits is relatively low, if it is compared to the high number of inhumations.

Overall, there were found nine cultural traits unevenly distributed among, male, female, immature and indeterminate burials (tab. 1). Indeterminate and female burials contain more grave goods than male and especially immature burials.

Only four brooches were found. Two of them, which were in Germanic style, were in one female grave (**B374**) and the other two were in one male burial (**B538**) and the other in an indeterminate burial (**B329**). The brooches in the male and female burials were likely fastening a cloak or a shroud in the first grave and a cloak or a dress in the latter (Barber and Bowsher 2000, 118).

Buckles and belt fittings are uncommon. Only two graves contained these objects and both are male. **B538** contained an unworn entire belt set, including buckle, plaques and strap end, which were nicely decorated in Germanic style (Barber and Bowsher 2000, 305 and fig. 105).

There are seven pins in total. Some of them might be hairpins while the others could arrange a shroud on the body (Barber and Bowsher 2000, 119). However, no traces of fibre textile were found on them.

Assemblages of hobnails, indicators of original footwear, occur in 34 graves (fig. 1). Most of them were in indeterminate burials, ten with male bones, five with immature remains and four in female inhumations. As reported in the previous subsection, footwear was only preserved in the form of metal hobnails, often extremely corroded. Leathery patches did not survive decay and they were not found (Barber and Bowsher 137-138; tab. 132). However, it has been suggested that the limited presence of footwear is not directly linked to the actual original lack of shoes. It is possible, that shoes or sandals, which did not require metal nails under the sole, were buried especially with remains of women and children.

Figure 1 London Eastern Roman cemetery. Evidence of footwear of B800 (Barber and Bowsher 2000, fig. 99. © MOLA).

Bracelets occur 39 times. Nine are in female burials, one with male remains, eight in immature graves and the rest were with indeterminate burials. Bracelets (Barber and Bowsher 2000, 118) were found worn or unworn and they were in different materials, the most were in copper alloy, but they were also made in jet, shale, iron, silver, glass, ivory and tortoiseshell. The majority of bracelets have been dated 3rd and 4th century.

Two combs were found in the graves of this site, but only one comb was found in a female inhumation (**B374**) (Barber and Bowsher 2000, 133-134; tab. 122). This comb was likely worn and it has been dated to the late AD 4th century. It was made by antler, which is a durable material, and it is interpreted as of Germanic style (Barber and Bowsher 2000, 306). The deposition of this comb was interpreted as a sign of pagan faith.

Four finger rings were discovered, three in indeterminate burials and one was accompanying an adult male. One was worn (grave **B24**) and the others were not. It was noted that the total of recovered finger rings was surprisingly low (Barber and Bowsher 2000, 118).

Keys occur only once (grave **B799**). It is a rare find in Roman cemeteries and in this burial it was found outside the coffin, and it belonged likely to a casket that was not preserved (Barber and Bowsher 2000, 134). Another rare find is ring that was found in just one specimen in a female grave.

Percentages and distributions of the cultural traits are presented in figure 4.3. It appears clear from these low figures that it is difficult to prepare a robust archaeological model of this population. The majority of inhumations were with no grave goods and thus no cultural traits. These figures will be analysed and discussed in the following subsections.

Table 1: Eastern Roman cemetery of London.

Object	Overall	Male	Female	Immature	Indeterminate
Brooch	4	1	2	0	1
Buckle and belt fitting	6	6	0	0	0
Pin	7	0	2	1	4
Hobnail footwear	34	10	4	5	15 (3)
Bracelet	39	1	9	8	21 (6)
Comb	1	0	1	0	0
Finger ring	4	1	0	0	3 (1)
Key and latchlifter	2	0	2	0	0
Other ring	1	0	1	0	0

2. Poundbury

Selected grave goods had low incidence in all grave clusters at Poundbury. The values can be considered as standard average for Roman cemeteries. Overall, there were nine positive categories of grave objects out of fifteen (tab. 2). However, selected objects were not evenly distributed between the cemeteries. More of the selected grave objects were discovered in the main cemetery. Only footwear evidence, namely hobnails, occurred more in the eastern and northern cemeteries.

Generally, there were a slightly higher proportion of grave goods in young female burials (Farwell and Molleson 1993, 151). However, there was not a strong difference in the distribution of selected grave goods between the biological groups. Adult male and female individuals had similar representations, definitely superior to the immature burials.

Brooches are limited to four objects (Farwell and Molleson 1993, 84-88). One brooch was in a Late Iron Age burial, **grave 1403**. The other three brooches belong to Late Roman burials, **grave 567** from site C, **grave 1309** from northern peripheral cemetery and **grave 1407** from eastern peripheral cemetery. No brooch was found in the main cemetery. All brooches were in copper alloy. The report does not describe the presence of textiles or leather traces associated with these brooches.

Pins (Farwell and Molleson 1993, 96 and 105), with faceted head, were found in nine graves. Most of them were made from animal bones and two were forged in metal, silver and iron (**graves 845** and **1194**). The recurrent position of bone pins close to the skull suggested that their function was related to hairdressing (Farwell and Molleson 1993, 105).

Bracelets (Farwell and Molleson 1993, 89-93, 105-108) of some types were mostly found as multiple units. All bracelets were dated around the 4th century AD and were common in Britain. Bracelets occurred both in animal bone and metal alloy. The first were found mostly fragmented, while some of the latter were assembled in multiple units.

Rings (Farwell and Molleson 1993, 93-94) were not numerous and most of them were discovered in early Roman and late Iron Age burials. This occurrence was expected, because finger rings were not a frequent ornament deposited in Late Roman burials. Interpretation of rings was not conclusive, but it is implied they were body ornaments, for hands, ears or feet.

Iron hobnails (Farwell and Molleson 1993, 99) are the most frequent grave objects at Poundbury, and as direct evidence of footwear. The majority of the hobnails were extremely rusted and it was not possible to identify recurrent patterns of diverse footwear styles. However, the position of the hobnails in the burial is often on the foot bones or close to them. They are rarely placed out of the coffin. In one case (**grave 1401**), hobnails were found close to the arms and it was suggested they belonged to arm guards rather than shoes.

Fabric textiles (Farwell and Molleson 1993, 111-113 and microfiche 1 tab. F11-G3) have been discussed in the previous sub-section. Here, it is worth underlining that all textiles, except for the golden thread and the hairband which are not included in the list of selecte d objects (ch. 3.6), are impressions on fragments of gypsum or plaster. Hence, they cannot be considered as direct proof of clothing, while the report suggested they are more likely the remains of shrouds (Crowfoot in Farwell and Molleson 1993, 111).

Combs (Farwell and Molleson 1993, 108-110) occurred seven times, all of them were found in burials of the main cemetery. These combs belonged to the composed and double sided type, which was common in the North western provinces of the Roman Empire.

Generally, the selected artefacts are not numerous and this low incidence may be explained by a preference for shrouded burials rather than clothed bodies. However, the local community during the later phases of the cemeteries showed improved attention to their dead. Archaeologically, hairdressing is the most visible evidence, revealed by the presence of combs, hairpins and preserved hair.

Table 2: Poundbury cemetery.

Main cemetery	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Clasps	1	0	1	0	0
Pin	4	1	2	1	0
Hobnail and Footwear	4	3	0	1	0
Fabric Fibre	22	4	8	8	2
Bracelet	31	0	15	16	0
Comb	7	1	5	0	1
Finger Ring	2	0	1	1	0
Knife	1	0	1	0	0
Other Ring	2	2	0	0	0
Eastern periphery	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Brooch	2	0	1	0	1
Pin	3	1	0	1	1
Hobnail and Footwear	15	7	4	4	0
Bracelet	1	0	0	1	0
Knife	2	0	2	0	0
Northern periphery	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Brooch	1	0	0	1	0
Hobnail and Footwear	16	5	8	2	1
Finger Ring	2	0	0	2	0
Site C	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Pin	1	0	1	0	0
Hobnail and Footwear	5	2	1	2	0
Fabric Fibre	1	1	0	0	0
Bracelet	2	0	0	0	2
Finger Ring	2	2	0	0	0
Knife	1	0	1	0	0
Outlying graves	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Brooch	1	1	0	0	0
Pin	1	0	1	0	0
Hobnail and Footwear	3	1	0	2	0
Fabric Fibre	1	1	0	0	0
Total	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Brooch	4	1	1	1	1
Clasps	1	0	1	0	0
Pin	9	2	4	2	1
Hobnail and Footwear	43	18	13	11	1
Fabric Fibre	24	6	8	8	2
Bracelet	34	0	15	17	2
Comb	7	1	5	0	1
Finger Ring	6	2	1	3	0
Knife	4	0	4	0	0
Other Ring	2	2	0	0	0

3. Alington Avenue

Grave objects were found at Alington Avenue in limited quantities (tab. 3) and they are not equally distributed through the burial groups. Only four object categories were found: brooch, pin, hobnails and fabric fibre fragments. Brooches (**graves 3227** and **3964**) and pin (**grave 2035**) were found in female burials. Footwear and hobnails is the most frequent find and it is present in all burial groups. It seems that the ritual often included footwear in adult burials because adult male (**graves 578**, **767**, **778**, **782**, **1142**, **1941**, **2020**, **3238**, **3240**, **3616**, **3661**, **3872**, **3956**, **4023**, **4329**, **4349** and **4397**) and adult female burials (**graves 751**, **785**, **2621**, **2629**, **2663**, **2666**, **2696**, **3233**, **3281**, **3440**, **3664_b**, **4360**, **4380** and **3227**). Some hobnails were found also in indeterminate graves (**1262**, **2613**, **3609**, **3648**, **3664_a**, **3876**, **3958**, **4318**, **4373** and **4403**). Fragmentary textiles were discovered only in immature burials (**2613** and **4378**).

Table 3: Alington Avenue.

Object	Overall	Male	Female	Immature	Indeterminate
Brooch	3	0	3	0	0
Pin	1	0	1	0	0
Hobnail footwear	39	16	14	2	7
Fabric fibre	4	0	0	4	0

4. Lankhills

Lankhills inhumations may seem particularly rich in grave goods if compared with the other Late Roman cemeteries considered in this work. Overall, there are 53% furnished burials with grave goods, which is a higher portion compared to the usual presence of objects in Roman cemeteries (Booth *et al.* 2010, 484). This subsection analyses and comments on combined data of selected objects found in both Clarke and OA excavations.

Eleven out of the fifteen selected grave goods are represented at Lankhills: namely brooch, buckle and belt fittings, pin, hobnails, fabric fibre, bracelet, comb, finger ring, knife, key and other ring (tab. 4). Generally, most of the objects were found in the burials with indeterminate bones. Among identified burials, buckles, belt fittings, hobnails and knives occurred mostly in adult male inhumations. Bracelets, rings, combs and pins were mostly in immature and female inhumations, with a clear prevalence in immature burials. Footwear appears more in male graves than the other gendered groups. However, these finds were limited to the nailed shoes and boots, while un-nailed shoes made only in leather, were not found. Hence, this presentation suffers from a bias in leather preservation.

Brooches were found in both excavations sixteen in all. Most of them were of the crossbow type and only two belonged to the penannular type (Clarke 1979, 257-263; Booth *et al.* 494-496). Cross-bow brooches are usually associated with special garments, related to social status, rather than specific ethnic origin. In at least five cases, brooches were associated with belt accessories (**grave 745, 1075, 1846, 1925** and **3030**) (Booth *et al.* 2010, 494), implying that this combination was indicative of special clothing. However, not all brooches at Lankhills were found close to the body, so some were likely unworn. Brooches became more common in the last phases of use of the cemetery, burial goods banned in the early stages of traditional Roman funeral ritual.

Buckles and belt fittings occur as distinct artefacts 36 times and are distributed in 21 graves. Hence, some of these fittings were part of an original complicated belt. In some case these grave goods might represent military accessories, which were more elaborate than ordinary belts. Belts and belt related equipment was not a common accessory of Romans in ordinary life. At Lankhills different belt assemblages were recorded, some of them did not include a buckle, or have a buckle and one or two strap-ends (Clarke 1979, 265-269). Their chronology ranges from the second half of the 4^{th} to the 5^{th} century. Usually, this category is associated with adult or sub-adult males, but at least one burial, containing a belt, was reinterpreted as a possible female inhumation by Gowland (2002). Depositional ritual was not consistent, and it seems unlikely that all belts were worn in all burials by the position in the grave.

Both excavations discovered numerous bracelets. These objects varied hugely in typology and material they were made of. Usually, they occurred in combination with more than one in the same grave and often they were not worn. Sometimes, they were buried in a pile close to the bones. Generally, bracelets were associated with remains of adult or immature female individuals. The different occurrence of bracelets seemed to discriminate between different ages. Hence, bracelets might be a symbol of different age status (Cool in Booth *et al.* 2010, 301). Clarke suggested that the presence of bracelets was indicative of foreign origin, but isotope analyses on some Clarke and OA burials with bracelets revealed local origin of those individuals (Cool in Booth *et al.* 2010, 303).

Three types of comb are defined, and a fourth group of fragmentary combs that were not classified (Galloway in Clarke 1979, 246-248). The most common was a composite double-sided bone comb, which was extremely widely diffused from Rome from the 2^{nd} until the 4^{th} century BC. One specimen was a simple double-sided wooden comb, which had counterparts in other Roman sites in Western, Central Europe and Britain. Another type was a composite single-sided triangular bone comb. It was found in only one grave (**265**) and it was likely to be an import from the Rhineland or Low Countries. OA excavation discovered other combs, which were all double sided types and poorly preserved. Analyses of isotopes did not support a Continental origin of the human remains associated with these combs (Cool in Booth *et al.* 2010, 272-274).

Hobnails are the most recurrent evidence of 'clothing' in Lankhills inhumations (Clarke 1979, 322-325; Powell in Booth *et al.* 2010, 311-320), having 262 finds, including discoveries from both excavations. Hobnails give a partial view of the original presence of footwear. Sporadically, the metal nails and plates had preserved fragments of leather because of the corrosion products and sometimes the shape of soles was kept. However, hobnails occurred in different numbers and it was not always possible to detect a scheme for shoes and boot types. A pair of metal spurs with traces of leather was discovered in **grave 1846/2**. It was likely to be part of a leather riding boot (Booth *et al.* 2010, 45). This find shows that a certain number of shoes were buried but left only traces in the archaeological record of this site.

Knives were found in both excavations. Seven knives were discovered by Clarke and another seven by the OA excavation, one of which was not examined because of its poor preservation (Cool in Booth *et al.* 2010, 276-277). All the knives consisted of a blade and handle, which was in wood or bone. Clarke classified the knives he found into three types (Clarke 1979, 249-251), and most of the knives belong to Clarke Type B. Some of the knives found by the OA team belong to other typologies (Cool in Booth *et al.* 2010, 276-277). The knives started to be buried from the second half of the 4th century and only male burials contained this category of object. It has been stated that the presence of knives and their distribution in this site, is uncommon for Romano-British cemetery standards. Typological comparisons revealed similarities with these knives and some areas of the Continent. Some types were in use mostly in North eastern Gaul and Rhineland (Clarke 1979, 250).

Recorded pins were 19 overall in both excavations. They were mostly found in immature burials, likely young female individuals. These grave objects were often found close to the skull, suggesting an original function as hairdressing pins. Usually they were poorly preserved so that sometimes it was problematic to distinguish them from coffin nails (Clarke 1979, 249). They were made mostly in metal, but a few cases of bone pins occurred as well (Both *et al.* 2010, 303-304).

Finger rings and other rings were recorded under the same category by Clarke (1979, 318-320); even if Cool (in Booth *et al.* 2010, 304-305) indicated that some of the rings may have a different purpose, like earrings. Some of these rings were worn, while others were not close to the hands, suggesting a different use.

The distribution of selected objects suggests a common funeral costume with a limited presence of metal fasteners and a preference for shrouding bodies and providing shoes. The barbaric tradition of weapon burials was not in Lankhills. It is interesting to note the chronology of furnished burials, which dated mostly from the second half of the 4th century AD. Distribution patterns may imply an initial change in funeral tradition with the rise of clothed inhumations in the Roman funeral tradition. Lankhills may represent a starting point of transformation before the migration of Anglo-Saxon people into Britain. Male burials are more numerous, as it is normally in British Roman cemeteries. On the other hand, clothing fasteners and personal ornaments appear in a kind of innovation, or maybe a return to the funeral tradition.

Table 4: Lankhills.

Object	Overall	Male	Female	Immature	Indeterminate
Brooch	16	1	1	2	12
Buckle and belt fitting	36	8	0	0	28
Pin	19	0	1	11	7
Hobnail footwear	262	63	41	47	111
Fabric fibre	1	0	0	1	0
Bracelet	228	0	16	133	79
Comb	26	3	5	6	12
Finger ring	39	2	3	19	15
Knife	14	7	0	1	6
Key latchlifter	1	0	0	1	0
Other ring	8	2	0	5	1

5. West Heslerton

The object types represented are 12 out of 15 of the list of selected objects (ch. 3.4.5.1). The categories of objects found are boss shield, brooch, buckle and belt fitting, clasp, pin, girdle hanger, fabric, finger ring, knife, spearhead, shield boss, latchlifter and other ring. There is any evidence of footwear, comb and bracelet. The total of selected objects is 488 finds. The occurrence and distribution of the object categories by the groups of cemetery population is summarised in numbers (tab. 5).

According with the catalogue (Haughton and Powlesland 1999a), brooches are the most frequent artefact, which are 139 finds overall. They are distributed between female graves (**78, 84, 88, 89, 101, 107, 110, 113, 114, 120, 123, 124, 139, 165** and **177**), not identified adult graves (**8, 14, 22, 23, 25, 27, 28, 32, 36, 45, 47, 55, 56, 60, 62, 68, 76, 83, 86, 95, 111, 119, 127, 140, 141, 143, 147, 152, 160, 163, 167 173, 175** and **180**), immature graves (**5, 10, 97, 100, 108, 118, 122, 132,** and **154**) and graves without human remains (**12, 29, 39, 40, 41, 43, 54** and **168**). Several types are frequently represented: cruciform brooch, square-headed brooch, small-long brooch and annular brooch. Penannular brooch, equal armed brooch, openwork brooch and bow brooch are still present, but with minimal frequency. The disposal on skeletal remains of brooches suggests their use in fastening gowns and garments. The brooches are mostly assembled in couples, while sometimes they occur as singular brooch (**graves 14, 25, 28, 32, 54, 101, 108, 111, 120, 122, 160, 165** and **168**) or in set of three brooches (**graves 10, 12, 29, 36, 40, 62, 86, 95, 97, 123, 143, 173** and **177**). Rarely they are found in set of four (**graves 78, 83** and **147**). The brooches are usually placed in the upper part of skeletal remains. Either, if there are single or in assemblage, they fix to the shoulders gowns.

Brooch is the artefact, which keeps more evidence for textile fibres and also more variety of textile fibres. In the majority of cases fibres found on brooches were unidentified (**graves 12, 13, 19, 21, 27, 28, 29, 30, 32, 39, 42, 45, 47, 52, 59, 73, 74, 77, 93, 95, 127, 130, 136, 143, 150, 151, 167, 173, 175, 181, 182** and **185**). However, there were interesting fibre identifications in West Heslerton brooches. Flax evidence was found on 17 brooches (**graves 14, 28, 47, 62, 78, 97, 100, 101, 107, 113, 122, 152, 154** and **163**). Hemp fibres were attached to a brooch (808AA) in **grave 140**. Not better identified plant fibres were stuck to four brooches (**14, 36, 113** and **177**). There were found 29 woollen fragments (**23, 29, 62, 86, 95, 107, 108, 113, 119, 124, 139, 140, 141, 143, 147, 152, 160, 163, 173** and **180**).Eight leathery finds were also present on brooches (**graves 78, 88, 101, 132, 139, 141** and **180**).

The buckle and belt fittings category is represented by 65 items, but more than half of their bulk is concentrated in indeterminate adult graves (37), which it may be added the number of items found in graves without human remains (5). The distribution in sexed and immature burials is balanced, nine buckles in female burials (**89, 101, 123, 144, 164** and **184**) and seven male burials (**31, 103, 109, 115, 126, 176** and **179**) and eight in the immature graves (**10, 33, 71, 108, 121, 128, 132** and **137**). Buckles occur also in indeterminate graves (**12, 13, 19, 21, 27, 28, 29, 30, 32, 39, 42, 45, 47, 52, 59, 73, 74, 77, 93, 95, 127, 130, 136, 143, 150, 151, 167, 173, 175, 181, 182** and **185**) There are both copper alloy and iron buckles, with a predominance of the latter on the first material. The shapes are simple: D-shaped, ovoid, sub-circular. However, any pattern of distribution has been recognised in relation with material and shape of buckles. Buckles and other belt fittings have often kept fibre textiles and leather. Overall, 22 leather fragments were found (**graves 12, 27, 30, 45, 59, 71, 77, 93, 95, 101, 108, 121, 127, 128, 136, 143, 167, 179, 181** and **184**). Flax fibres were on two buckles (**graves 95** and **103**) and wool was found on five buckles (**graves 33, 130, 137, 143** and **173**). Animal fibres not better identified were on a buckle from **grave 181** (95AD). Nevertheless, the majority of textile finds on buckles were unidentified (**graves 10, 13, 45, 71, 74, 77, 89, 93, 95, 108, 109, 121, 123, 126, 128, 132, 137, 144, 173, 175, 176, 179** and **185**).

All the clasps belong to the B type of Hines classification. The majority of clasps, which are the fourth object in terms presence, have been found in indeterminate adult graves (**26, 27, 36, 45, 47, 55, 60, 62, 76, 86, 95, 119, 127, 143, 147, 152, 173** and **180**) and a minimal part in female (**graves 89** and

177). Three graves without human remains (**12, 39** and **40**) and two immature graves (**66** and **97**) have clasps; any evidence of those was discovered in male burials. Their presence implies the use of long sleeves in female costumes. There were found association between clasps and fibre textiles. Woollen fibres were in six clasps (**graves 47, 119, 143, 147** and **180**). Clasps found in **grave 60** had flax fibre, while leathery traces were on the clasps of **grave 152**. Unidentified fibres were on 16 clasps (**40, 45, 47, 62, 62, 86, 86, 86, 97, 143, 152, 152, 173, 177, 177** and **180**). Not all clasps were combined in pairs. This evidence may suggest the use of old clothing in burials.

Pin category occurs 21 times. Two pins were in graves of female group (**grave 123** and **124**), 13 in the indeterminate graves (**8, 27, 45, 55, 60, 76, 79, 111, 119, 141, 167** and **175**), three in immature graves (**5, 100** and **102**) and two in graves without human remains (**graves 12** and **43**). Usually they have been found in the upper part of the body, especially on the central thorax. In those cases, it is assumed that they need to tie cloaks or other external garment. Ten pins had unidentified fibres attached on their surface (**5, 8, 12, 27, 102, 111, 119, 124, 167** and **167**), while flax was on the pin found in **grave 100**.

Girdle hangers are limited to seven finds, which are concentrated in two female burials (**graves 113** and **139**) and one indeterminate burial (**grave 152**). Even if, the latter is suspected to be a female burial because its grave good assemblage suggests this gender orientation. The girdle hangers are usually in pair and the group found in **grave 152** is associated with numerous pieces of fabric, as it will be explained below (fig. 5.5-7). The girdle hangers found in **grave 152** had leather attached on their surface. All three hangers of **grave 113** preserved fibre textiles, two were wool (BH and BI) and one was unidentified (BG).

There are 13 evidences of fabrics. A single evidence of piece of fabric, which has not been directly attached to other object, has been found in an immature grave (**132**) fig. 5. The fabric was recovered in a soil block, which contained also other objects: a walnut amulet, two latchlifters, two lace tags, a copper alloy ring and a buckle. All this assemblage has been interpreted as a purse group (Haughton and Powlesland 1999 tab. 9; Haughton and Powlesland 1999a, 223). The fibre was in poor conditions of preservation and the identification was not possible.

All the other fibrous fabric textiles were found in indeterminate burials (**55, 86, 132, 141** and **152**). 8 of the other 12 pieces of fabric come from a female a soil block of a female grave (**152**) (fig. 4 and 5). This case, like the previous one, has been interpreted as a purse group. The block contained also two girdle hangers, three latchlifters, one knife, three lace tags and a purse ring. The eight piece of fabric were not preserved similarly. Four fragments are woollen fibres, while the other four are unidentified (Haughton and Powlesland 1999, tab. 9; Haughton and Powlesland 1999a, 264-9). **Grave 141** contains other two fragments, one of those is flax fibre and the other unidentified. One woollen fabric fragment was in **grave 86**, while the fabric found in **grave 55** is unidentified.

There is not numerous evidence of personal ornament at West Heslerton. Bracelets are absent and finger rings are a limited presence. There was found only one finger ring in an indeterminate adult grave (**127**). It is in copper alloy and it is accompanied by other grave goods, which have been interpreted as an assemblage for a female burial.

Knife is the second most recurring object, which is equally almost distributed in female graves (**34, 88, 105, 107, 120, 123, 124, 144, 164** and **184**) and male graves (**16, 72, 103, 112, 115, 126, 155, 158, 176** and **179**). Then, the immature graves have eight knives (**71, 90, 98, 100, 118, 122, 138** and **157**). The majority of knives was kept within indeterminate burials (**8, 13, 19, 21, 22, 23, 25, 26, 27, 28, 30, 32, 36, 39, 40, 43, 45, 47, 48, 51, 55, 59, 60, 61, 64, 73, 74, 75, 77, 83, 86, 93, 94, 95, 119, 127, 130, 136, 141, 150, 151, 152, 160, 163, 173, 180, 181, 182, 183** and **185**). Knives are frequently place at the right side of the pelvis, where they were likely hanged on the belt. Knives are associated with preserved leather in 49 cases (**graves 28, 30, 34, 39, 45, 48, 51, 59, 64, 71, 77, 83, 88, 90, 93, 94, 95, 98, 103, 105, 107, 112, 118, 119, 120, 122, 123, 124, 126, 130, 130, 136, 138, 141, 150, 152, 157, 160, 163, 173, 179, 180, 181, 182, 183, 184** and **185**). Numerous blades held evidence for unidentified fibres (**13, 22, 23, 27, 28, 34, 72, 73, 98, 105, 107, 123, 130, 136, 141, 157, 160, 180, 181, 184** and **185**). The knives found in **graves 124 and 164** had woollen fibres on its surface, while animal fibres were on the knife of **grave 151**. Evidence of flax was on the knife found in **grave 60**.

The spearhead and shield boss categories show an interesting frequency, which contrasts with usual gender assumption. In fact, some boss shields and spearheads have been found in graves of female sex. Overall, there are 27 spearheads and eight shield bosses at West Heslerton. The 53% of spearheads belongs to indeterminate adult graves. This percentage reaches 57% (**2, 19, 48, 52, 73, 74, 75, 85, 130, 136, 151, 183** and **185**), if it is added also spearhead from **grave 185**, which does not have human remains. Seven spearheads were found in male graves (**72, 87, 115, 155, 158, 176** and **179**), while three spearheads were in female graves (**graves 144**, **164** and **184**) and one occurred in an immature grave (**98**). Leather was discovered on the surface of three spearheads (**75, 136** and **151**). Traces of wool were on the spearhead of **grave 183** and animal fibres were on the spearhead of **grave 164**. Other spearheads presented unidentified textile residues (**2, 176** and **184**).

Furthermore, four shield bosses were uncovered in indeterminate adult burials (**19, 73, 74** and **183**), three in male burials (**72, 158** and **179**) and one was in a female burial (**grave 184**). Seven bosses had remains of preserved leather (**graves 19, 73, 74, 158, 179, 183** and **184**). Moreover, unidentified textile fibres were on the shield boss found in **grave 183** and wool was discovered in the shield boss of **grave 179**.

The category of key and latchlifter, it is represented only by 45 finds; all of them are described as latchlifters. 14 latchlifters were in female burials (**107, 113, 120** and **139**). Four were found in one immature grave (**132**). 27 were contained within graves with indeterminate remains or any bones (**8, 13, 39, 43, 45, 86, 119, 143, 152, 167** and **173**). Traces of textile fibres and leather were found on some latchlifter. Most of the textiles had a damaged structure, and identification was not possible. Three graves contained latchlifters associated with woollen fibres (**119, 139** and **143**), while animal fibre was identified on one of those latchlifter in **grave 113** (BF). Four latchlifters had traces of leather (**graves 13** and **173**).

Other rings are 27 and are disseminated in female graves (**88, 96, 107, 110, 113, 123, 124** and **139**) and indeterminate inhumations (**42, 43, 45, 47, 55, 119, 127, 141, 143, 152, 163, 167** and **173**). Only two finds were in immature graves (**132** and **172**) and any evidence comes from male graves. This category may include ring use in purse assemblage or for belt loop. In the majority of cases, their presence seems to imply the presence of a purse or other object that was tied to the belt. Some rings preserved traces of organic textiles; most of them were unidentified (**88, 96, 110, 123, 124, 127, 141, 163** and **167**). The ring in **grave 119** preserved fragments of flax, while woollen fibres were attached to the ring of **grave 124** and **132**.

Table 5: West Heslerton.

Object	Overall	Female	Male	Immature	Indeterminate	No bones
Brooch	139	32	0	18	72	17
Buckle and belt fitting	65	9	8	7	33	8
Clasp	50	4	0	3	37	6
Pin	20	2	0	3	13	2
Girdle hanger	7	5	0	0	2	0
Fabric fibre	10	0	0	1	9	0
Finger ring	1	0	0	0	1	0
Knife	86	11	12	8	48	7
Spearhead	27	3	7	1	14	2
Shield boss	8	1	3	0	4	0
Key and latchlifter	45	14	0	4	23	4
Other ring	27	9	0	2	14	2

6. Alton

Of the 15 selected grave good types, nine were present. In fact, this cemetery includes: brooch, buckle and belt fitting, pin, girdle hanger, knife, spearhead, shield boss, key latchlifter and other rings (tab. 6).

The brooch category occurs 14 times, mostly in female burials (**14, 23, 35, 43** and **47**). All graves contain two brooches each. Two brooches are also in male (**grave 12**) and in immature (**grave 37**) burials. Eight brooches kept fibrous traces, seven of them were mineralised (**graves 12, 23, 35** and **47**). One of the two brooches found in **grave 37** (1) had flax attached.

There are buckles and belt fittings 19 occurrences and most of them are in male burials (**2, 7, 16, 30, 34, 39, 40, 42** and **44**), with a double record in **grave 16**. Five are buried with female remains (**graves 11, 23, 33** and **47**). **Grave 23** contained two buckles. The remaining buckles were in immature burials (**24, 27, 37** and **41**). Buckles and belt fittings are associated with textile fibres in seven cases. Six of them are unidentified fibres (2, 11, 24, 27, 37 and 41), while flax fibres are attached to a buckle (3) from **grave 7**.

Pins are almost equally distributed between female (**11, 14, 23, 35** and **47**) and immature graves (**27,** and **41**). One pin was found in the **grave 12**, which is a male. Unidentified fibres are attached to pins from **graves 11** and **14**.

Only one girdle hanger is retrieved in **grave 23**, which contained the remains of an adult woman. This object shows presence of mineralised textile. Knives occur 31 times. Female graves (**6, 11, 14, 21, 23, 33, 35** and **47**) have eight objects. 12 are contained in male burials (**1, 7, 12, 16, 30, 34, 36, 39, 40, 42, 44** and **49_2**) and the remaining are in immature graves (**3, 9, 17, 19, 24, 26, 27, 29, 37** and **41**). Threads are attached to four knives (**9, 12, 14** and **29**) in a mineralised state.

A spearhead is an accompanying object for 11 male graves (**1, 2, 6, 7 16, 34, 36, 40, 42, 44, 45** and **49 2**). Three spearheads are distributed in immature **grave 3** and female **grave 6**. Remains of unidentified fibres are attached to three spearheads from **graves 36, 40** and **49 2**.

Alton graves contained seven shield bosses. All of them were in adult male burials (**1, 2, 4, 16, 42, 45** and **49 2**). The boss contained in **grave 45** was associated with unidentified fibres. Male (**grave 12**) and immature graves (**27** and **41**) share four keys found at Alton cemetery. Those found in **grave 12** have mineralised threads still attached.

The other ring category occurs unevenly. Immature graves contain eight rings (**9, 17, 27, 41** and **41**); female graves three of them (**graves 23** and **47**) and male graves have two rings (**12** and **30**). Traces of mineralised textile are on three rings from **graves 9** and **27**.

Table 6: Alton.

Object	Overall	Male	Female	Immature
Brooch	14	2	10	2
Buckle and belt fitting	19	10	5	4
Pin	11	1	6	4
Girdle hanger	1	0	1	0
Knife	31	12	8	11
Spearhead	17	14	1	2
Shield boss	7	7	0	0
Key latchlifter	4	2	0	2
Other ring	13	2	3	8

7. Beckford cemetery A

Of the 15 selected cultural traits (ch. 3.6) eight were found in this cemetery: brooch, buckle and belt fitting, pin, knife, spearhead, shield boss, key and latchlifter and other ring (tab. 7).

Brooches are 16 in total, distributed unequally in eight adult female graves (**7**, **9**, **11**, **12**, **16**, **18**, **20** and **23**) and one in an immature grave (**3**). **Graves 7**, **9**, **16**, **20** and **23** contained two brooches, while **grave 11** contained three. Brooches display fibrous fragments in six cases (**graves 11**, **16**, **18**, **20** and **23**). The majority of these finds were unidentifiable under microscopic examination, but in two cases the fibre was recognised as plant material comparable with flax (graves **18** and **20**). Brooch 1 from **grave 18** preserves fragments of flax threads and another mineralised fibre (Evison and Hill 1996, 78, tab. 32). Moreover, traces of flax were identified on a bronze metal tube in the same grave. **Grave 20** provided two brooches and one of them displayed flax fibres and the other one evidence of mineralised fibre.

Buckles and belt fittings are 13. Six buckles were in five adult male graves (**1**, **8**, **13**, **14** and **22**), six in five adult female burials (**2**, **12**, **16**, **18** and **23**) and one in an immature burial (**5**). Traces of organic fibre were revealed in seven cases. Mineralised fibres were in five buckles (graves **1**, **2**, **13**, **16** and **18**), while traces of leather were known in graves **18** and **12**. Interestingly, grave **18** gave evidence of leather and unidentified fibre from a buckle and evidence of flax from a brooch (Evison and Hill 1996, 78, tab. 32), as it has been underlined above.

Pins are eight and they are distributed in six adult female burials (**7**, **9**, **12**, **16**, **20** and **23**), while **graves 12** and **23** have two pins. Any pin was associated with textile remains. Sixteen knives were found buried in sixteen graves. Four were in adult female burials (**graves 7**, **12**, **16** and **18**), ten were buried with adult males (**graves 1**, **4**, **6**, **8**, **13**, **21**, **22**, **24**, **25** and **27**) and two were in immature graves (**5** and **15**). Organic fibres were attached to three knives (**graves 1**, **13** and **25**). The material identification was possible only for the knife from **grave 25**, which was clearly leather.

Spearheads are 11. Apart from one female burial (**2**), all of them were found in seven adult male graves (**4**, **6**, **8**, **13**, **14**, **22** and **25**). Two spearheads were buried together in **graves 4**, **6** and **14**. Traces of mineralised fibres were found on the spearheads from **grave 4** and **grave 22**. Seven shield bosses were counted in cemetery A. Six of them belonged to adult male graves (**6**, **13**, **14**, **22**, **25** and **26**), while one accompanied an adult female (**grave 2**). Three bosses kept traces of leather (**graves 2**, **14** and **25**). It is to be noted that **grave 2**, provided a spear and a shield for a woman. This case shows contrasting associations between biological traits and gender.

Keys and latchlifters were in **graves 9** and **12**, both of them dedicated to adult women. A patch of mineralised fibre was on the key from **grave 12**. Female graves possessed 15 other rings (**graves 7**, **9**, **11**, **12** and **16**). **Grave 12** had six rings, **grave 16** five of them and two were in **grave 9**. The latter rings showed leather on them (6 and 7) and mineralised fibres were found on three rings of **grave 16** (9 a, b and d). The rings from **graves 9** and **16** with organic traces may imply the original presence of a purse as accompaniment for the deceased.

In the majority of the burials, grave goods are related to the sex of the deceased. However, two cases show a discrepancy. A female skeleton in **grave 2** has a spearhead, a shield boss and a belt buckle, which are considered to be male grave goods. **Grave 16** contains male remains associated with two brooches, a belt buckle, a pin, a knife and several rings.

Table 7: Beckford cemetery A.

Object	Overall	Male	Female	Immature
Brooch	16	2	13	1
Buckle and belt fitting	13	7	5	1
Pin	8	1	7	0
Knife	16	11	5	2
Spearhead	11	10	1	0
Shield boss	7	6	1	0
Key and latchlifter	2	0	2	0
Other ring	15	5	10	0

8. Beckford cemetery B

Of 15 selected cultural traits (ch. 3.6), nine were found in this cemetery: brooch, buckle and belt fitting, pin, finger ring, knife, spearhead, shield boss, key and latchlifter, and other ring (tab. 8).

55 brooches were found distributed in 45 adult female graves (**6**, **8**, **16**, **24**, **26**, **31**, **34**, **36**, **38**, **39**, **45**, **48**, **55**, **57**, **61**, **62**, **65**, **66**, **67**, **70**, **73**, **74**, **80**, **83**, **89**, **97** and **98**) and the remaining ten were in

immature burials (**29**, **46**, **58**, **68** and **82**). Graves **31**, **34**, **48**, **57**, **62**, **65**, **73**, **and 80** and contained a single brooch. Three brooches were discovered in **grave 74**. All the other graves had two brooches. Nine brooches (**graves 6**, **26**, **29**, **45**, **46**, **57**, **61**, **67** and **97**) displayed traces of unidentified fibres, mostly mineralised. Only one brooch (**grave 6**) held identifiable threads of flax, which were associated with other mineralised fibres.

Buckle and belt fittings occurred 26 times. 16 were in adult female burials (**1**, **6**, **10**, **16**, **17**, **34**, **48**, **57**, **61**, **74**, **89**, **101**, and **102**), four accompanied adult males (**18**, **84** and **94**) and six sub-adult burials were equipped with them (**graves 29**, **33 1**, **68** and **69**). The majority of buckles were buried singly, but graves **6**, **18**, **74**, and **101** included two buckles and grave **29** held three of them. The belt fittings found in graves **6**, **18**, **57**, **89** and **102** kept traces of unidentified fibres. Remarkably, both buckles of grave **101** showed the presence of fibre. Leather was recognised on buckles from graves **1**, **29** and **33 1**. Five buckles were associated with leather and unidentified textil e materials (**18**, **61**, **68**, **84** and **94**).

11 pins were discovered. Nine were distributed in female graves (**8**, **16**, **36**, **41**, **48**, **62** and **89**) and two in immature burials (**29** and **58**). Graves **41** and **48** contained two pins. Most of the pins are of iron and they preserved mineralised fibres in three objects (**graves 48** and **89**). Finger rings were found in three graves. Two were adult female (**graves 39** and **74**) and one was a juvenile burial (**29**).

The knife category is better represented. There are 26 knives in total. 14 were in adult female graves (**3**, **6**, **16**, **28**, **34**, **36**, **39**, **48**, **5**3, **55**, **57**, **61**, **74** and **80**). Seven were in adult male graves (**5**, **18**, **20**, **25**, **51**, **81** and **92**). Five were in immature burials (**19**, **32**, **85**, **99** and **106**). Only one knife (**grave 39**) preserved traces of unidentified fibres.

Spearheads were found 28 times. 21 were buried with male deceased (**graves 5, 7, 11, 20, 35, 47, 51, 60, 64, 72, 77, 81, 91, 92, 94, 95, 96, 104** and **105**). Six were in immature burials, possibly male adolescents, (**40, 56, 79, 85, 99** and **106**). One was buried in **grave 93**, which contained adult female remains. **Graves 72** and **81** contained two spearheads. The spearheads found in **graves 85** and **95**, preserved traces of mineralised textile.

13 shield bosses were distributed in 12 male graves (5**, 7, 20, 27, 35, 47, 51, 64, 77, 92, 94** and **95**) and one was an immature **grave 32**. The shield bosses found in **graves 5** and **27** held leather traces and the shield boss discovered in **grave 35** kept unidentified textile remains.

Keys and latchlifters were seven in number and were found in three female graves (**39, 67** and **71**). **Graves 67** and **71** contained three keys. Any key had traces of organic fibre. The other ring category occurred 22 times. 12 rings were in adult female burials (**16, 39, 67, 71, 74, 83** and **101**). The remaining rings were in immature burials (**29** and **68**). Rings are often grouped in one grave. Four rings of **grave 68** had leather and other unidentified fibre attached to their surface. These rings were found attached with a buckle loop - here already recorded – and a bronze Roman coin. They were stuck together close to the pelvis (Evison and Hill 1996, 87). Other unidentified fibres were attached to rings from **graves 16, 39** and **71**.

Cemetery B has some burials with discrepancies between sexual traits and gender identity of grave goods. **Grave 5** is a female burial with a spearhead and a shield boss. Another adult female was buried with a spearhead in **grave 93**. **Graves 55**, **70**, **73** and **75** are male burials with feminine grave goods. **Graves 55** and **70** include a pair of brooches each, while **grave 73** had only one brooch and several beads. **Grave 75** included one amber bead and two perforated bronze coins.

Table 8: Beckford cemetery B.

Object	Overall	Male	Female	Immature
Brooch	55	5	40	10
Buckle and belt fitting	26	4	16	6
Pin	11	0	9	2
Finger ring	3	0	2	1
Knife	26	8	13	5
Spearhead	28	22	2	6
Shield boss	13	11	1	1
Key and latchlifter	7	0	7	0
Other ring	22	0	12	10

9. Butler's Field, Lechlade

The object types represented are 12 out of 15 of the list of selected objects (ch. 3.6). The categories of objects found are brooch, buckle and belt fitting, clasps, pin, girdle hanger, comb, finger ring, knife, spearhead, shield boss, key and latchlifter and other ring. There is no evidence of footwear, fabric fibre and bracelet. The total of selected cultural objects is 445. The occurrence and distribution of the objects in the cemetery population is summarised in numbers (appendix 3) and in percentages (fig. 5.25). The preserved textile fibres are presented in graph 30 and the association between objects and clothing is compared in graph 31.

This cemetery provides evidence of preserved textile fibres and leather. Mineralisation is the main process of textile preservation. It occurs because of the original close association of textile with metal objects. 87 graves showed the presence of textile. However, there are also cases of preserved textile fibres due by reactions different to mineral replacement. Textile of Butler's Field cemetery have been analysed by specialists, who could distinguish different weaves and rebuild costumes, especially female ones. However, the identification of fibres has been difficult and not very productive, because of high metal replacement (Boyle *et al.* 2011, 93-104).

Brooch is the most recurrent cultural trait, with 85 finds over 445 selected objects. Female graves contained most of brooches (**10, 18, 19, 25, 33 2, 41, 45, 47, 56, 59, 77, 78, 81 1, 81 4, 86, 90, 101, 111, 123, 130, 133, 136, 144, 152, 159, 160, 163, 167 2 169, 174, 180, 184** and **185**). 21 brooches were in immature burials (**1 1, 11, 13, 17, 50, 81 3, 97, 128, 134, 142, 146** and **164**). Two brooches were included in one indeterminate grave (**80 1**) and in one male grave (**176**).

Brooches mostly occur in couple in the same burial (**1, 10, 11, 33 2, 41, 45, 47, 50, 77, 78, 80 1, 81 1, 81 3, 81 4, 96, 90, 97, 111, 123, 128, 130, 133, 136, 142, 144, 146, 152, 159, 163, 164, 167 2, 169, 176** and **184**) and more rarely single, whereas, they occur in three of them only in two inhumations (**18** and **56**). Not surprisingly, 62 brooches out of 85 preserved fragments of textile fibres, but all of them are unidentified (**inhumations 1 1 10, 11, 13, 18, 19, 33 2, 41, 45, 47, 50 56 77 78, 80 1, 81 1, 81 3, 81 4, 86, 90, 97, 101, 111, 123, 128, 130, 133, 136, 142, 144, 146, 152, 159, 160, 163, 164, 169, 174, 180** and **184**).

Belt buckles and other belt fittings are represented by 62 finds. Female inhumations were accompanied by 35 buckles (**10 18, 20, 25 41, 42, 47, 59, 71, 81 1, 81 4, 86, 111, 127, 130, 133, 152, 159, 165, 174, 180** and **184**). 20 buckles were part of male skeleton assemblages (**inhumations 8, 16, 58 1, 65, 69, 89 1, 104 112, 143, 154, 155, 172 1, 183** and **192**) and seven were with immature skeletal remains (**inhumations 48, 88, 92, 140** and **171**).

11 Buckles kept traces of leather on their surface, mostly for mineralisation (**inhumations 16, 18, 47, 47, 65, 69, 88, 92, 140** and **155**) and other traces of unidentified textiles were found on buckles from several graves (**inhumations 10, 18, 41, 42, 58 1, 59, 65, 69, 81 1, 86, 88, 89 1, 104, 130, 154, 159, 165, 171, 180** and **184**).

Only one clasp was found in a female burial (**145 2**) and it did not have any textile preserved. Pins occur more frequently than clasps (graph 8). Most of them were in female burials (**inhumations 10, 18, 25, 33 2, 42, 45, 47, 54, 56, 59, 62, 77, 81 1, 85, 86, 90, 123, 130, 138, 144, 145 2, 150, 159, 160, 163, 169, 174, 179, 180, 184** and **186**). 13 pins were contained in immature graves (**13, 33 3, 43, 81 3, 97, 128, 134, 135, 140, 142, 164** and **166**) and 4 were found in male graves (**125, 155, 176** and **181**). Evidence of unidentified fibre textiles were preserved on 14 pins (**inhumations 18, 33 3, 45, 54, 77, 81 1, 86, 90, 97, 164, 166, 169, 176** and **186**).

Only one girdle hanger was found and it was buried with a female skeleton (**inhumation 25**). It preserved traces of textile but they were unidentified. Five combs were discovered at Butler's Field cemetery. Three combs accompanied female skeletons (**18, 62** and **81 4**) and two combs were in one immature grave (**inhumation 14**). Plant fibres were preserved on the surface of the two combs from **inhumation 14**. Overall, 11 finger rings were buried at Butler's Field. Female inhumations had nine of them (**18, 78, 130, 144, 152, 169** and **180**) and the other two were in immature graves (**14** and **52**).

Knife is the second category best represented at Butler's Field cemetery. More than half of knives were deposited in female burials (**3, 15, 18, 22, 25, 33 2, 41, 42, 45, 47, 54, 55, 60, 62, 70, 76, 78, 81 1, 81 4, 111, 123, 127, 133, 136, 138, 145 2, 147, 152, 159, 160, 163, 174, 184, 185, 187, 191** and **197**). Male inhumations were accompanied by 31 knives (**inhumations 2, 8, 16, 35, 40, 44, 57, 64, 65, 69, 72, 75, 89 1, 91, 102, 104, 106, 112, 115, 116, 121, 143, 143, 154, 155, 155, 172 1, 178, 181** and **183**) and nine were with immature skeletal remains (**1 1, 36 2, 58 2, 82, 88, 92, 140, 164** and **170**).

Leathery fragments were preserved on 11 knives (**inhumations 41, 47, 57, 69, 82, 89 1, 92, 145 2, 160, 163** and **183**). Unidentified fibres were on four knives (**inhumations 112, 136, 174** and **181**). More successful fibre identifications were on knives from **inhumations 2** and **65**, where woollen fibres were found, and from **inhumation 36 2**, which kept plant fibre evidence on its surface.

27 spearheads were discovered in total. The majority of them were in adult male burials (**21, 35, 40, 49, 65, 102, 104, 106, 112, 115, 121, 154, 155, 172 1, 181** and **182**). Two spearheads accompanied adult female remains (**inhumations 95 1** and **191**) and seven were with immature skeletons (**inhumations 39, 88, 92, 92, 105, 168** and **196**). Spearheads preserved fragments of textiles, but all of them were unidentified (**inhumations 35, 105, 115, 154, 155, 172 1, 181** and **182**).

Shield boss is represented by 11 finds. All of them were in adult male burials (**40, 58 1, 64, 65, 102, 106, 112, 115, 116** and **192**), except one, which it was in an immature grave (**92**). Almost all shield bosses kept fragments of textiles. Leather is the most recurrent (**inhumations 58 1, 64, 65, 92, 102, 106, 116** and **192**), but there are two identification cases of wool (**64** and **115**) and four unidentified textile fibres (**inhumations 40, 58 1, 92** and **116**).

Keys and latchlifters are 29 in total. More than two thirds were within female burials (**10, 56, 62, 76, 78, 81 1, 103, 130, 136, 145 2, 179** and **184**) and the rest was buried with immature skeletons (**14, 33 3,** and **97**). Numerous keys preserved textile fibres, which were unidentifiable (**inhumations 10, 33 3, 56, 76, 78, 81 1, 97, 103, 130, 136** and **184**), but one key kept plant fibre preserved (**inhumation 179**).

Other ring category is well-represented. Most of the rings were part of female funerary assemblages (**inhumations 18, 56, 76, 78, 81 1, 130, 138, 144, 145 2, 159, 163, 167 2, 169, 179, 185** and **187**). 27

rings accompanied immature graves (**1 1, 14, 17, 43, 48, 100, 148, 164, 172 2** and **177**) and two rings were in male burials (**155** and **178**). 16 rings preserved fragments of unidentified fibres (**inhumations 18, 48, 56, 78, 138, 148, 185** and **187**).

Table 9: Butler's Field.

Object	Overall	Male	Female	Immature	Indeterminate
Brooch	85	2	60	21	2
Buckle and belt fitting	62	20	35	7	0
Clasps	1	0	1	0	0
Pin	53	4	36	13	0
Girdle hanger	1	0	1	0	0
Comb	5	0	3	2	0
Finger ring	11	0	9	2	0
Knife	82	31	42	9	0
Spearhead	27	18	2	7	0
Shield boss	11	10	0	1	0
Key and latchlifter	29	0	21	8	0
Other ring	78	2	49	27	0

10. Empingham II

Over 15 cultural traits, 12 were found at Empingham II, brooch, buckle and belt fitting, clasps, pin, girdle hanger, comb, finger ring, knife, spearhead, shield boss, key and latchlifter and other ring (tab. 10). Brooch is a recurrent object, there were found 100 brooches distributed in female, male, immature and unsexed burials. Adult female burials have the majority of them (**4 a, 6, 17, 22, 27, 37, 39, 40, 42, 48, 49 a, 50, 61, 62, 63, 64, 67 a, 69, 73, 79 a, 80, 81, 83, 85 a, 89, 90, 91, 95, 107, 109, 115, 127, 130** and **131**). Eight brooches were in male graves (**16 a, 23, 26 c, 46, 98 b, 119 c** and **129**). Immature burials contained 12 brooches (**graves 24, 52, 68, 72, 85 b, 105, 120** and **126**). Remaining seven brooches were in unsexed adult graves (**15, 33, 94,** and **100**). Numerous graves contained more than one brooch. Assemblages with two brooches were found on **graves 6, 16 a, 22, 24, 27, 39, 40, 42, 48, 50, 61, 67 a, 69, 81, 90, 91, 94, 98 b, 107, 109, 115, 130** and **131**. Three brooches together were discovered in **graves 4 a, 17, 37, 49 a, 73, 83, 95, 100** and **105**. Four brooches were associated to burial **80** and five were with burial **85 b**. Unidentified textiles were found associated with brooches in 17 cases and one brooch (**grave 98 b,** 2) preserved degraded textile fibres and possible human skin (Timby 1996, 122).

Buckles and other belt fittings occur in 73 finds. 27 were in female burials (**4 a, 6, 17, 22, 27, 34, 40, 48, 50, 67 a, 69, 73, 81, 83, 89, 90, 95** and **127**). 27 were also in male burials (**3, 23, 26 c, 29, 31 b, 32, 36, 43, 45, 53, 59, 74, 77, 86, 92, 97, 98 b, 111, 112** and **119 c**). Immature burials contained 16 belt fittings (**graves 16 b, 18, 24, 26 b, 68, 75, 85 b, 96 c, 104 a, 108, 114, 120** and **122**) and five were in unsexed adult graves (**7, 13, 15, 51** and **100**). 17 buckles and belt fittings have a positive association with preserved textiles and 16 cases of leather survival attached to buckles are present.

Overall, there were discovered 69 clasps. 48 of them were in female inhumations **(4 a, 6, 17, 34, 37, 39, 40, 42, 48, 49 a, 50, 61, 67 a, 69, 73, 79 a, 81, 83, 85 a, 89, 95, 107, 115, 127** and **134**). Eight clasps were distributed in male burials (**16 a, 46, 98 b** and **129**) and in unsexed adults burials (**7, 8, 20, 33, 94** and **100**). Five clasps were in immature graves (**24, 68, 85 b** and **120**).

Nine pins were a part of some burials at Empingham II, all pins found were made in copper alloy, which is less common material in comparison with the other Anglo-Saxon cemeteries here analysed. Usually, iron is the favourite metal for pins. Six were in female burials (**6, 22, 27, 48** and **89**). Three pins were in immature graves (**24, 85 b** and **126**).

The category of girdle hanger results in nine finds. Five hangers were with female remains (**22, 40** and **83**). Two girdle hangers were in male (**98 b**) and immature (**85 b**) graves. Three combs were found in total. Two were in female burials (**67 a** and **115**). One comb accompanied male skeletal remains (**grave 45**). Finger ring (graph 11) category is represented by four finds. Three rings were in female graves (**6, 39** and **67 a**) and one was in a male grave (**46**).

70 knives were found at Empingham II inhumations. Female burials contained 27 knives (graves **6, 17, 22, 27, 37, 39, 42, 48, 50, 58, 61, 63, 64, 73, 79 a, 80, 81, 90, 91, 107, 109, 115, 127** and **131**). The male burials have the same quantity of blades as the women (**3, 10, 26 c, 29, 30, 31 a, 31 b, 32, 43, 45, 53, 59, 74, 77, 84, 86, 92, 93, 97, 98 b, 104 b, 110, 111, 112** and **119 a**). 12 knives were in immature graves (**14, 24, 60, 66, 75, 85 b, 96 a, 96 b, 99, 101, 104 a** and **120**). Unsexed adult remains were associated with four knives (**33, 41** and **100**). Knife held fibrous traces in three cases. Leathery remains on knife blades occur 43 times, which is the likely presence of a sheath in the majority of these knives.

Spearheads occur 38 times. They are mostly in male burials (**3, 21, 26 c, 26 c, 29, 31 a, 31 b, 32, 35, 36, 45, 56, 59, 74, 77, 84, 86, 92, 97, 98 a, 104 b, 110, 111, 112, 119 b** and **119 c**). Eight spearhead were buried with immature remains (**26 b, 66, 75, 96 a, 96 c, 104 a, 106** and **125**). One spearhead was associated with unsexed adult bones (**grave 51**), while another one was found in a burial without any bone left (**grave 132**).

Shield boss category had 21 finds and all of them were in adult male graves (**3, 4 b, 26 c, 29, 30, 31 a, 31 b, 32, 35, 36, 43, 45, 56, 59, 74, 92, 98 a, 112, 119 a, 119 b** and **123**). Overall bosses keep leather pieces in 13 cases and one boss has even traces of fibre textiles.

Keys and latchlifter were six. Four were associated with adult female remains (**graves 73** and **107**). One was in an adult male burial (**grave 46**) and another one in a juvenile burial (**grave 76**). Three keys were associated with traces of textile fibres.

The category of other rings includes 44 finds. 26 were distributed in burials of women (**6, 11 a, 22, 27, 34, 40, 42, 50, 69, 73, 83, 89, 91, 115, 127, 131** and **134**). Six rings were in male graves (**16 a, 31 c, 46,** and **98 b**). Immature burials contained seven rings (**5, 68, 85 b, 120** and **201**). Rings were found in four unsexed burials (**20, 41, 94** and **100**). This category has evidence of preserved textile and leather evidence. Three rings are associated with leather remains and four rings keep fibre traces.

Table 10: Empingham II.

Object	Overall	Male	Female	Immature	Indeterminate
Brooch	100	9	72	12	7
Buckle and belt fitting	73	27	27	14	5
Clasps	69	8	48	5	8
Pin	9	0	6	3	0
Girdle hanger	9	2	5	2	0
Comb	3	1	2	0	0
Finger ring	4	1	3	0	0
Knife	70	27	27	12	4
Spearhead	38	28	0	8	2
Shield boss	21	21	0	0	0
Key and latchlifter	6	1	4	0	1
Other ring	44	7	26	7	4

11. Norton on Tees

Grave objects amount to 13 out of 15 of the list of selected objects for analysis (ch. 3.6). The categories of object found are brooch, buckle and belt fitting, clasp, pin, girdle hanger, fabric fibre, bracelet, comb, knife spearhead, boss shield, key and latch lifter and other ring. There is no evidence of footwear or finger ring. The total of selected objects is 310 (tab. 11).

According to the report (Sherlock and Welch 1992), the brooch is the commonest grave object, with 78 finds overall. Female inhumations have the majority of the brooches (**graves 1, 2 1, 9, 19 1, 22, 23, 28, 29, 30, 35, 40, 41 1, 49, 52, 56, 65, 84, 85, 94, 96 105** and **112**). Brooches are also in male graves (**4, 7, 57, 63, 86, 90, 98, 107 and 113 1**) and in immature burials (**5, 11, 44, 45, 66** and **72**). Indeterminate burials and graves with no bones contain brooches as well (**graves 21, 61, 70, 77, 80, 102** and **103**). Often brooches lay more than one in the same burial. **Graves 4, 11, 19 1, 22, 23, 28, 29, 35, 41 1, 61, 63, 66, 77, 84, 86, 90** and **107** have two brooches, three brooches are in graves **30, 40, 94, 96** and **112** and four brooches occur in **graves 9** and **102**. The majority of fibrous finds were found attached to brooches. 47 textiles were unidentified. Two brooches kept flax fibres (**grave 1**, 5; **grave 22**, 5) and one had woollen fibres on its surface (**grave 63**, 5). Leather fragments were found on three brooches from **graves 94** and **96**.

Buckle and belt fittings are represented by 28 finds. The majority have been found in female burials (**2 1, 22, 23, 35, 38, 40, 48, 49, 52, 56, 85** and **94**). The male (**graves 12, 13, 34 1, 64, 69, 78** and **113 1**) and immature inhumations (**11, 27, 44** and **54**) have minor occurrences of belt fittings. Three buckles were contained in indeterminate burials (**21, 70** and **100**). Nine buckles were associated with fragments of unidentified fibres and one had leathery remains with unidentified textile (**grave 38**, 2).

Overall, 43 clasps were found at Norton burials. 23 clasps were buried in female burials (**1, 9, 22, 29, 35, 40, 52, 56, 68, 68, 84, 94** and **96**) and 12 clasps accompanied male remains (**graves 4, 4, 4, 4, 7, 7, 7, 7, 57, 57, 59** and **63**). Only one clasp was found in an immature grave (45) and seven were in indeterminate graves (**21, 70, 77** and **102**). There are three associations of unidentified textile remains with clasps (**graves 9**, 9; **70**, 12 and **84**, 7).

Pin category is present by 16 finds. An half of them was distributed in female graves (**28, 29, 30, 35, 41 1, 49, 105** and **106**). Five pins were in male inhumations (**4, 7** and **86**) and three were in indeterminate burials (**70, 82** and **103**). Only one pin had textile remains on its surface (**grave 49**, 3).

Three girdle hangers were found at Norton. Two hangers were in adult female burials (**1** and **29**) and one was within an indeterminate burial (**grave 21**). The latter girdle hanger preserved fragments of unidentified textile (2).

Grave 86 is the only one, which preserved a piece of textile fabric fibre not associated to any object. The burial contained adult male skeletal remains. The fibrous remains were mineralised and they laid onto a shoulder bone (Sherlock and Welch 1992, 179).

Three bracelets were deposited within three graves of Norton cemetery. Two were in one adult female burial (**grave 40**) and one was in a juvenile burial (**grave 44**). There are three bone combs. They are distributed in two adult female graves (**graves 29** and **99**) and one immature grave (**grave 11**). Bracelets and combs did not preserved textile traces.

The knife category is present with 50 objects. 21 are distributed in female graves (**9, 19 1, 22, 23, 28, 29, 35, 38, 40, 41 1, 49, 52, 56, 65, 68, 84, 85, 87, 94** and **96**). 16 knives were in male graves (**7, 13, 17, 24, 34 1, 59, 63, 64, 76, 78, 79, 86, 90, 113 1** and **120**). Eight immature graves contained knives (**graves 11, 16, 26, 43, 45, 54, 89** and **110**). The remaining knives were in indeterminate graves (**70,**

74, 82, 102 and **111**). Few knives preserved fragments of leather (**graves 38**, 1; **41 1**, 1 and **49**, 1). The knife found in **grave 49** held also traces of unidentified fibres on its blade.

There were ten spearheads and all of them accompanied adult male inhumations (**12, 24, 25, 34_1, 42, 55, 60, 64, 69** and **120**). The spearhead 2 of **grave 60** preserved textile fragments, while a patch of possible leather adhered to spearhead 3 of **grave 64**.

Five shield bosses were scattered in five male inhumations (**34 1, 42, 55, 60** and **64**). Evidence of unidentified textile was on the shield boss 1 of **grave 60**.

Keys and latchlifter amounted to 36 finds. Female graves contained the majority of keys (**19 1, 22, 28, 35, 40, 52, 68** and **85**). Two keys were in male burials (**63** and **86**) and in indeterminate graves (**70** and **82**). Eight keys were included in immature burials (**11** and **54**). Unidentified fibres were attached to five keys from graves **19 1, 40, 52, 52, 84** and **85**.

There were found 34 rings. 23 were included in female burials (**19 1, 29, 35, 40, 41 1, 52, 84, 85, 87** and **105**). Five rings laid within indeterminate inhumations (**70** and **102**). Four male graves contained rings (**36 1, 59, 63** and **90**) and two rings were in two immature graves (**39** and **54**). Preserved textile fragments were found six rings from **graves 19 1**, 4; **40**, 2; **52**, 6 and 14; **84**, 2 and **85**, 4.

Table 11: Norton on Tees.

Object	Overall	Male	Female	Immature	Indeterminate adult (no human remains)
Brooch	78	14	44	8	12 (6)
Buckle and belt fitting	28	7	14	4	3
Clasp	43	12	23	1	7 (1)
Pin	16	5	8	0	3
Girdle hanger	3	0	2	0	1
Fabric fibre	1	1	0	0	0
Bracelet	3	0	2	1	0
Comb	3	0	2	1	0
Knife	50	16	21	8	5 (1)
Spearhead	10	10	0	0	0
Shield boss	5	5	0	0	0
Key latchlifter	36	2	24	8	2
Other ring	34	2	23	2	5 (1)

12. Sewerby

This section illustrates occurrence and distribution of grave objects included in the list of cultural traits in chapter 3. Over 15 cultural traits, Sewerby cemetery have 11 types: brooch, buckle and belt fitting, clasps, pin, girdle hanger, bracelet, knife, spearhead, shield boss, key and latchlifter and other ring (tab. 12).

Overall, brooch is the object that occurs more often with 45 finds. 18 brooches were scattered into female burials (**8, 12, 23 24, 35, 41** and **49**). Usually, brooches take part to an assemblage, which includes three of them (**graves 8, 35** and **49**) or two (**graves 23** and **41**). **Grave 12** has been already cited because it contains four brooches, which is rare combination. **Grave 24** had only one brooch. Even burials with male skeletal remains keep brooches (**19**, **31** and **38**). **Grave 19** and **38** contain respectively three and two brooches. Graves with adult indeterminate adult remains have ten brooches (**graves 15, 50, 54** and **57**), two brooches were in **graves 50** and **54**, while three brooches were in **graves 15** and **57**. The immature graves have 11 brooches (**17, 28, 29, 42** and **51**). The presence of multiple brooches is confirmed even in subadult assemblages. **Graves 17** and **28** had three brooches each and **graves 29** and **51** had two brooches each. Over 45 textile finds, 26 were attached to brooches. 23 of these fibres are not identified because of the deep mineralisation. Three brooches provide evidence for woollen fibres (**grave 19** 4; **grave 57** 4 and 5). Brooch 4 from **grave 19** contains even flax and another unidentified fibre. Brooch 1 from **grave 42** has attached organic material, likely leather, which may be the only leather finds on selected object at Sewerby. Three different fibre types were on brooch 1 in **grave 8**, two of them were unidentifiable, but one has a structure defined as fibrous animal material. Two not better identified plant fibres were on brooch 7 in **grave 15** and brooch 5 in **grave 35**.

Buckle and other belt fittings have 18 occurrences and are balanced distributed between adult graves, while only few were found in immature graves. Female burials contain five buckles (**graves 23, 34, 35** and **41**). Four buckles were in male graves (**10, 19** and **48**). Other seven buckles were distributed in adult burials without sexual identification and buri als with no bones left (**graves 15, 54, 55, 56** and **57**). Three unidentified fibres were associated to buckles 5 and 6 in **grave 19**, buckle plate 28 in **grave 54**. Buckle 5 found in **grave 56** held pieces of mineralised and unidentified textile and it laid over an organic stain. This may be interpreted as traces of an organic case or bag tied to the belt (Hirst 1985, 51 tab. III, 166, fig. 79).

There are 20 clasps. Six are in female graves (**35** and **49**), two are in **grave 38**, which is a male one. Ten of them were found into indeterminate adult burials (**15, 16_1, 50, 54** and **57**) and two were in the juvenile **grave 42**. Seven textile finds were associated to clasps, only clasp 7 in **grave 57** returns identified woollen fibre and all the other were unidentified.

Pins are not numerous, only three of them were discovered (**35, 49** and **54**), two were in adult female burials **35** and **49**, while one was in **grave 54**, which is an adult burial with no sex identification.

Girdle hanger category is represented by six objects, distributed in four burials (**15, 35, 38** and **49**). Three hangers were in female burials (**35** and **49**), two in a male burial (**38**) and one was in an indeterminate burial (**15**). **Grave 57** keeps the unique bracelet found in Sewerby cemetery. Four unidentified fibres are attached to girdle hangers. Two of them were on hangers 10 and 11 of **grave 49**. One was on hanger 9 of **grave 35** and the last was on hangers 7 of **grave 38**.

Knives occur 28 times **(graves 5, 8, 10, 11, 12, 23, 25, 27, 34, 35, 37, 38, 39, 40, 41, 42, 45, 48, 49, 52, 54, 55** and **56**). They are distributed in eight female graves (**8, 12, 23, 25, 34, 35, 41** and **49**), nine are male accompaniments (**graves 10, 11, 27, 37, 37, 38, 45** and **48**). Indeterminate burials and graves without bones returned eight knives (**graves 5, 52, 54, 55** and **56**). Three knives were buried with subadult human remains (**graves 39, 40** and **42**).

Spearheads were found all in male graves (**10, 11, 37** and **45**) apart for one (**55**), which was buried in a grave without bones. Shield bosses were one in a male grave (**45**) and one in an immature grave (**55**). The only key was found in the male **grave 38** and it presents traces of unidentified fibrous material.

Other rings were in five graves (**12, 15, 35, 38** and **54**). Two were in adult female (**15** and **35**) and indeterminate burials (**15** and **54**). One bronze ring was found in male **grave 38** with unidentified fibre attached on its surface. Unidentified textile was found even on iron ring 17 of **grave 15**.

Table 12: Sewerby.

Object	Overall	Male	Female	Immature	Indeterminate
Brooch	45	6	18	11	10
Buckle and belt fitting	18	4	5	2	7
Clasps	20	2	6	2	10
Pin	3	0	2	0	1
Girdle hanger	6	2	3	0	1
Bracelet	1	0	0	0	1
Knife	28	9	8	3	8
Spearhead	5	4	0	0	1
Shield boss	2	1	0	0	1
Key and latchlifter	1	1	0	0	0
Other ring	5	1	2	0	2

13. Spong Hill

Over 15 selected grave good types, ten were present. In fact, this cemetery includes: brooch, buckle and belt fitting, clasps, pin, girdle hanger, knife, spearhead, shield boss, key latchlifter and other rings and there were included 166 finds in total (tab. 13).

Overall, there are 54 brooches at Spong Hill inhumations. 36 were in female graves (**inhumations 2, 5, 14, 19, 22, 26, 29, 37, 38, 39, 42, 44, 56,** and **57**). Only one brooch was in an immature grave (**inhumation 3**). Remaining brooches were distributed in empty graves and burials with no sex identification (**inhumations 11, 12, 18, 24, 45, 46,** and **58**). One single brooch found only in graves **3** and **11**, the other brooches are part of an assemblage. Two brooches were in graves **5, 18, 19, 26, 29, 37, 42, 44, 56** and **58**. Three brooches were combined in graves **12, 14, 22, 24, 38, 39, 45, 46** and **57**. Brooch category preserves the most of fibres. Unidentified fibres occur with 38 brooches. Wool and other animal fibres were found attached to six brooches as well as flax and other plant fibres were associated with six brooches. Only one brooch kept leather evidence.

Buckles and belt fittings are 20 finds. Five were found in female graves (**22, 38** and **39**). Three were in male burials (**23 1** and **31 1**). Two immature graves had buckles (**6** and **16**). Ten buckles were in graves with no good bone identification (**24, 27, 28, 32, 41, 46, 49, 51** and **54**). Fragments of leather were attached to six buckles and belt fittings. Moreover, unidentified fibre textile was associated with ten buckles.

Over 15 clasps finds, 13 were mostly present in adult female burials (**5, 29, 37, 38, 42,** and **57**) and other two were in indeterminate graves (**46** and **48**). Two clasps preserved unidentified fibres and one kept evidence for animal fibre. Pin category occurs only two times in indeterminate graves (**27** and **36**). Four girdle hangers were buried at Spong Hill. Two of them were in female burial **38** and other two in indeterminate grave **24**. Only one girdle from the latter grave was found with evidence for unidentified fibre.

Twenty-nine knives were found distributed by six female graves (**2, 17, 22, 26, 38** and **44**), five male burials (**13, 23 1, 30, 31 1** and **50**), 15 indeterminate burials (**8, 24, 27, 28, 32, 36, 41, 45, 46, 48, 49, 51, 55** and **58**) and one juvenile burial (**16**). 15 knives preserved traces of leather on their surface. Other fibre textiles were found on seven knives, but only it was identified as woollen fibre textile.

Spearhead category is represented by 11 finds. Most of them were in indeterminate burials (**27, 28, 32, 36, 40, 41, 49** and **54**) and three were in adult male burials (**13, 31 1** and **50**). Three spearhead had on their surface preserved unidentified textile. Seven shield bosses were found in Spong Hill inhumations. Only one was found in an identified male inhumation (**31 1**), while the others were associated with unidentified human remains (**inhumations 36** and **51**) or burials without bones (**inhumations 27, 40, 41** and **49**). All shield bosses preserved evidence for leather and four of them had also traces of unidentified textile.

Key and latchlifter category occurs five times. Three keys were in female burial **22**, while the other two keys were in indeterminate inhumations (**24** and **45**). Four keys were found with traces of unidentified textile. 19 other rings were in Spong Hills inhumations. 11 of them were in adult female graves (**2, 5, 14, 29, 38** and **44**). Eight rings were distributed in indeterminate or graves without bones (**24, 41, 41, 45, 45, 46, 46** and **58**). **Inhumations 38, 41, 44, 45** and **46** contain more than one ring, implying they might be part to bags or purses. Unidentified textile was found on four rings and leather was on one.

The weaves analyses confirm that they are types diffused in Anglo-Saxon graves. Tabby weaves, four-shed twills, three-shed twills and tablet weaves are present in the finds from Spong Hill inhumations.

The funeral female costumes were successfully reconstructed by the study of metal fasteners and textile fragments associated. The brooches are often three, two small ones at shoulders and a bigger one in the middle of the chest. Likely women dressed light long sleeved undergarment, covered by a heavier over garment, the two brooches at shoulders fastened them. A cloak or blanket was kept by central brooch. A veil likely covered the head. It is suggested by fragmentary tabby weaves preserved in the brooches. Male and immature burials did not show enough evidence to allow costume reconstructions.

Table 13: Spong Hill.

Object	**Overall**	**Male**	**Female**	**Immature**	**Indeterminate**
Brooch	54	0	36	1	17
Buckle and belt fitting	20	3	5	2	10
Clasps	15	0	13	0	2
Pin	2	0	0	0	2
Girdle hanger	4	0	2	0	2
Knife	29	7	6	1	15
Spearhead	11	3	0	0	8
Shield boss	7	1	0	0	6
Key latchlifter	5	0	3	0	2
Other ring	19	0	11	0	8

Some grave objects are selected in this research because they are suggestive of clothing and they may preserve evidence of textiles, mostly mineralised. The selected objects are fifteen (ch. 3.4.5), and here there are more detailed descriptions of the five objects, which are considered the closest to personal clothing.

14. Brooches

14.1 Roman brooches

The brooch or *fibula*, in Latin, is a fastener of wide use in antiquity, which is a good archaeological, cultural and chronological signal. They are quite identifiable in the field and solid enough to resist decay. Generally, brooches are composed of three main parts, technically defined as the body, pin and a spring or a hinge. Any solid material can make brooches, but only metals are documented to be used for brooches. The commonest material found are copper alloys, which better resist corrosion and commonly survive. The iron brooches are widely documented, even if huge corrosion affects iron buried in the ground, so iron brooches may be under represented. More rarely gold and silver were used to produce brooches (Strong and Brown 1976). Changes in the technological process of production also occurred. For instance, during the late period Roman crossbow brooches were made from gilded sheet bronze, while previously they were made by solid casting (Swift 2000, 13).

Roman brooches have firstly a practical function to fasten clothes together, such as a cloak, a tunic or a vest. Consequently, some types of brooches were gender addressed. For instance, soldiers wore a coat which was usually fastened by one brooch of big dimension, while female tunics were often composed of two piece of cloth fastened by two or four brooches, one or two for the shoulder. Secondarily, brooches could be more evident or covered other clothes. In the latter case, we might expect brooches without decorations. In other cases, brooches could acquire also a differentiating and symbolic function. For example, specific types of brooch could be chosen by a military unit, such as the *aucissas* brooch privileged by the XIV legio Gemina at Wroxeter (Webster 2002). Consequently, the position of brooches on an undisturbed inhumation may suggest gender hints. Additionally, some types may indicate regional or tribal patterns of distribution, especially during the late Iron and the first phases of the Roman conquest of Britain (Mackreth 2011, 234-240).

Brooch types are classified with different systems, which usually consider shape and dimension of the different parts. There are several systems of classification for brooches. Those taxonomies have main differences in terms of rationality and nomenclature. For instance, Roman brooches found in Britain have been classified by four principal classification systems (Collingwood 1930; Simpson, Hawkes and Hull 1979; Hull and Hawkes 1987; Hattatt 1982; 1985; 1987 and 1989; Swift 2003; Mackreth 2011).

14.2 Anglo-Saxon brooches

Anglo-Saxon brooches were used to fasten clothes and they are made in metal as well the Roman types. However, the two categories differ in several aspects. For example, brooches are usually found in female burials, while are occasional finds in male burials, so it appears to be an object related to gender. Additionally the majority of types differ in style and decoration, if they occur, from the Roman brooches.

The Anglo-Saxon types of brooches has been categorised by specialized studies. Nevertheless, recurrent updates occur and revise what has been established previously (Åberg 1926; Leeds 1945; Avent 1975; Evison 1977; Evison, V. 1978; Dickinson 1979 Avent and Evison 1982; Dickinson 1982; Hines 1984; Leigh 1984; Dickinson 1993; Ager 1985; Hirst 1985, 55-57; Mortimer 1990; Dodd 1995, 81-82; Boyle *et al.* 1995, 82; Pinder 1995; Evison and Hill 1996, 10; Geake 1997, 54-55; Hines 1997; Parfitt and Brugmann 1997, 31-124; Chadwick Hawkes 2000; Carver, Hills and Scheschkewitz 2009; Brugmann 2012). For instance, Walton-Rogers has classified fourteen main types and then numerous sub-types of Anglo-Saxon brooches (2007, 113-122). Early inhumations contained the majority of Anglo-Saxon brooches. The number reduced dramatically from the second half of 6th century. This indicates significant cultural change for archaeologists.

15. Buckles and belt fittings

Belt is a flexible band, usually in leather or cloth, which is worn around the waist to support clothing, bear tools or weapons or it is worn as decoration. However, in late Roman inhumations, belts are regularly placed at the feet of the deceased rather than been worn (Swift 2003, 41). Less commonly, belts were worn in another part of the body, such as legs, or from the back to the chest. The best clues, which reveal the presence of a belt in a grave, are the buckle and the strap-end, which sometimes may also preserve mineralised remains of the organic band. Buckles might occur as joined to a metal plate, or not. In the first case, there are more chances to find preserved organic material. In fact, usually the recovered belt fittings are made in metal or metallic alloy. Belt fittings are good indicators of clothing, but not always they provide complete information. For example, some Roman inhumations had buckle deposited close to the feet, suggesting that belt was not worn. Additionally, belts could be produce also without metal buckle. For instance, the Tollund man was found with a tied leather belt without any buckle or other metal fitting (Brothwell 1986).

Late Roman belt buckles and fittings have been classified and studied in their different features and geographical distribution (Bullinger 1969; Simpson 1976; Sommer 1984; Bayley and Butcher 2004). Belts were largely used by soldiers as a functional accessory to carry weapons and as a symbol to indicate rank within the army (Swift 2000 and 2003, 41). Belts might have numerous decorations, such as hooks and rings to fasten other objects. However, not necessarily all types of Roman belt buckles have been found in soldier graves (Hawkes 1974, 390; Lehay 1984). In the late Roman period, the distribution of belt finds changed and they were buried also in civilian graves. This suggests wider diffusion of belts among social strata, possibly linked to fashion, but this phenomenon requires further analyses for a full understanding (Swift 2000, 2).

Buckles, more than other belt fittings, are good indicators of chronology and geographical origin (Chadwick Hawkes and Dunning 1961; Simpson 1976; Marzinzik 2003). For example, the annular shape was typical of third century AD buckles, while D-shaped buckles were common during the fourth and fifth centuries, and rectangular buckles were the local type from Pannonia and other eastern provinces.

Some decorative techniques for buckles are documented in late Roman Britain. They are zoomorphic ornaments, chip-carving, niello, openwork, engraving and punched work. The zoomorphic technique consists in animal representations, often these images were extremely stylised and so it could be arduous to recognise the actual animal.

Chip-carving consists in carving with sharp tools, such as chisels, to remove small chips of the metal from a flat surface in a single piece. Chip-carving buckles are poorly-documented in Roman Britain, while numerous finds have been made in continental provinces, especially Germany. This decorative technique tends to cover all surfaces of buckles and plates. The representations are geometric and repetitive motifs.

Niello is an inlay coloured dark metal in plates and buckles, usually in precious materials, to produce a chromatic contrast. The subjects represented in those plates are the most variable, such as mythological scenes, animals, gods and goddesses.

Openwork buckles were common both to the early and late Roman Empire, but during the later period the favourite outlines were geometric. Additionally, also without the above described techniques, belts could be superbly and variously decorated with engraving and punched works.

Buckles were also common in Anglo-Saxon male clothing accessories because of fastened waist or other types of belts. Buckles have been found in male as well as female Anglo-Saxon graves (Chadwick Hawkes and Dunning 1961). Obviously, this occurrence suggests that the belt was not simply related to sex, but it has some more articulated patterns to be explained. Some types of buckles, such as the Type II.1 and II.2 (Marzinzik 2003), show continuity with the Roman style. These buckles are elaborate and usually were worn by men. However, during the Migration period several female graves included similar buckles of Roman tradition. Generally, Anglo-Saxon women wore plain buckles because it is likely that other garments (Walton-Rogers 2007, 124, 219-221) covered their belts.

Iron and copper alloys were the more common materials for Anglo-Saxon buckles. Silver, gilded silver and animal bone were occasional materials and there is found one example of a buckle made from boar's tusk at Castledyke South grave 91 (Drinkall and Foreman 1998 61-62, 272, 357, fig. 81). Walton-Rogers (2007, 123) divides the Anglo-Saxon buckles into two main classes. Firstly, one with the strap passing through the buckle loops and stitched back itself. Then, one with the end of the strap inserted between metal plates. Hence, the classification distinguishes two main classes: class I without plate and class II with plate. They have then been grouped into 38 types (Marzinzik 2003).

Strap-ends are occasional components of Anglo-Saxon belts. Generally, strap-ends were composed of two copper alloy plates kept together by rivets at the end of the strap and designed as a tongue. Additionally, there are examples of strap-ends cast in one single piece, in Scandinavian and Continental tradition (Marzinzik 2003).

16. Clasps

Clasps are dress-fasteners characterized by knob-head from the back of which a loop or a sort of nail protrudes. The majority of recovered clasps are in metal, even if there are a few examples made in other hard materials, such as bone. Their function is to keep together two pieces of clothing of any materials, leather or fabric fibres. Roman clasps occurred only in cloaks or mantles (Wild 1970, 145). Clasps were not popular during Roman times, but they became common starting from the barbarian migrations within the boundaries of the Roman Empire, as in the case of Croatian retrievals (Ilkic and Curkovic 2008.). Classification of clasps in Britain has been done by Wild (1970) after the study by Gillam of pre-Roman clasps in Britain (1958).

Anglo-Saxons wore clothes with long sleeves, which required clasps to fix cuffs. Anglo-Saxon clasps were usually composed of two parts, a hook and an eye because they join each other. They needed to fasten sleeves usually in the wrist area. They have been grouped into three classes A, B and C (Hines 1984; 1993). Class A clasps are similar to hook-and-eye closure made in copper-alloy or silver wire. Class B may be roundels, plates or bars of copper alloy, riveted or sewed to the costume. Class C clasps are cast and ornate. Class B is the most diffused in England and Anglia is the region with more occurrences. This accessory mostly occurred in female garments at wrists in England. In contrast, class B clasps were commonly worn by men and women in Scandinavia (Walton-Rogers 2007, 123).

17. Pins

Pins were used as hair dress accessory, to fasten veils, bonnets and other headdress to the hair. However, pins found in graves are not always necessarily garment accessories, but they can also be fasteners for textiles different from clothing. For instance, it was observed an interesting association between pins and knives at Buckland cemetery, Dover (Evison 1987), so these pins are likely related to the wrapping of cutlery or other objects with a blade. In the absence of textile remains attached to the pins, their position on the body may provide important clues about function.

Romans produced pins made from several materials, like copper alloys, animal bones and jet, while glass pins were rarer. Roman pins are classified by numerous types and they are distinguished by shape and decoration, while the same type was made in different materials. Pins can vary from simple shape, such as conic end, to elaborate carved figure decorations (Crummy 1983, 19-20; Cool 1992; Johns 1996). The simplest types are defined 'conical head' and 'conical' or 'rounded head' with beads-and-reel decoration were common during the 4th century AD. The type with a spherical head started from the 2nd century forwards and the 'faceted head' type was produced from the late 3rd century forwards. Regional differences disappeared in the later period (Swift 2003, 40).

The Anglo Saxons produced numerous typologies of pins. Currently, 58 types have been listed from the 5th to the 7th century AD (Ross 1991). The pins introduced by the Anglo-Saxons were generally with a length between 70 and 150 mm. they were predominantly made in iron in southern England, with the head shaped as a loop, crook or coil. In contrast, copper alloy and iron pins had the same frequency in the North, where they often have pierced heads, some of which were threaded as with a wire ring. Metal plates or spangles could also decorate pins. Occasionally, other materials than metals were used. For instance, grave Li1 G137 at Castledyke includes one early case of pins made in pig bone and it is dated to the middle 6th century (Drinkall and Foreman 1998, 270), while this kind of pin became more popular in the following centuries. The pins also became smaller in the following centuries, having a general length of between 35 and 60 mm. Generally, they still kept traditional shapes and decorations and introduced new ornaments, such as garnets, filigree and gold foil. The more common materials were copper alloys, silver and turned bone. At the end of the 7th century AD, the type of pairs of pins jointed by a chain started (Ross 1991). Pins are more frequent in female graves. It has been noted that they occur more commonly in the upper chest area of the body, even if sometimes they can sink down to the waist (Walton-Rogers 2007, 126).

18. Footwear

Roman footwear is well documented by archaeological finds, literary sources and artistic representations (Goldman 1994, 101 and 105-126). The archaeological retrievals span from the northern limits of the Roman Empire to the South. Different types of shoes, boots and sandals in leather have been found in the provinces of Britannia and Germania Inferior and Superior. In dry regions, such as Egypt and Near East, fibre and leather Roman sandals are preserved. Hence, the archaeological record informs us that Romans used numerous materials to produce shoes: leather, wood, cork and also metal for functional or decorative utility. Shoes could be made also with a combination of various materials together. For example, one pair of carbonised sandal soles has been discovered at Bisenzio, Italy, and currently is curated at Villa Giulia Museum, Rome. They are made in wood and outlined in bronze, while the hinges, now missing, were in leather (Goldman 1994, 101). However, the most common evidence for boots or shoes in late Roman cemeteries are metal fasteners and iron hobnails. The latter were fixed to the sole to provide a better grip to the soil and more resistance. Additionally, two other aspects are extremely important regarding Roman footwear. Firstly, Romans might also walk with bare feet, for different reasons, such as ritual or poverty. Secondly, it is hard to create a chronology based on shoe style because several models were worn in different periods of the long history of Rome.

Romans also wore socks in order to cover their feet. One of the best finds is a sock from Vindolanda (Goldman 1994, 125). It is still well preserved, is an extremely rare case, and it is a size suitable for a child. The shape resembles a foot with fabric fibre distinguishing the big toe. In addition, some written documents provide information about the use of socks at Vindolanda. One of the tablets, number 346, found there, mentions explicitly that the writer sent a pair of socks and also underwear and sandals (Bowman and Thomas 1983, 11-13; 379-388).

Conversely, Anglo-Saxon graves of the early period do not have archaeological evidence for footwear. The literary sources are not indicative and the artistic representations are poor. However, it has been suggested that Anglo-Saxons wore shoes and occasionally they went barefoot (Owen-Crocker 1986, 81). Archaeological evidence started from the end of the 6th century AD. However, Walton-Rogers (2007, 221) suggested that some comparisons with Iron Age and early Middle Age shoes found in Germany and Denmark provide a plausible example for shoes of early Anglo-Saxon migrants. During this phase, footwear was likely made in skin or hide, without metallic fasteners which are documented from the end of the 6th and the beginning of 7th centuries (Mould, Carlisle and Cameron 2003, 3256, 3268-3350; Walton-Rogers 2007, 221). It has also been implied that shoes, as well as other leatherworking, were made from cured or oil-dressed skins (Walton-Rogers 2007, 221), because vegetable tanning was probably introduced during the later Anglo-Saxon phases (Cameron 2000, 70-3).

Appendix 4: soil formation factors and soil biota

1. Soil formation factors

Five factors participate in the formation of soil, which is also called pedogenesis. They are parent material, topography, climate, biological activity and time. Their combination transforms and produces changes in the soil.

Parent material

Soil is primarily composed of so-called parent material, which is its basic mineral constituent. Parent material might be already present at the site or be transported from other locations to the current site. Hence, it is called sedimentary or residual soil which derives from parent material originally off the site. Furthermore, it is called saprolite, the stony and massive material derived from bedrock weathering in the lower layers of soil; the physical and chemical weathering results in a larger concentration of saprolite compared to the lower bedrock. Therefore, the material may be dug easily, while the texture and original rock structure remain. The chemical weathering changes primary minerals into secondary minerals and the particles are reordered vertically. The development of soil is done by addition and removal of material. Obviously residual soil maintains numerous features from the lower bedrock. Saprolite may provide the upper soil with some characteristics, such as soil texture, mineralogy and pH. Moreover, it may occur that some phenomena, such as erosion, move material from the original site to new locations where it becomes parent material for new soil. However, sometimes, before the movement to new sites, the material may be subjected to weathering. As a consequence, these cases show only a small number of characteristics in common with parent material. An existing soil may also be buried by transported material. The processes of soil formation begin immediately after any depositional episode. The transportation of parent material occurs because of the action of ice, gravity, water and wind, and sometimes these agents can operate in combination (Retallack 2001; Wilson 2006).

Ice

When ice advances, it creates at its front and sides glacial deposits. Since ice melts from lower layers, this affects also material deposited under glaciers. Moreover, water from melted ice can accumulate material as outwash. The composition of soils formed from glacial deposits is variable, because it is influenced by the rock type over which the glacier moved. The complexity of composition and the depositional environment of the parent material are also subjected to all advances and retreats of glaciers through time. Interestingly, the mode and distance of transport and the type of rock weathered are mirrored by the texture of soil formed in glacial deposits. Generally, clay and silt sized material are produced by shale and limestone scouring, whereas sandy soils are produced by igneous and metamorphic rocks. Additionally, materials deposited under the ice are typically finer textured and denser, whereas outwash and front and side deposits are coarser.

Gravity

Gravity produces colluvium or hillslope sediments. There are several causes for these deposits. They can be created by catastrophic events, such as mudslides and avalanches. Otherwise, it is by slow and persistent events, such as slope wash or surface creep. It is observable that sediments and clay content intensify on the downslope.

Water

Streams in floodplains or deltas create alluvial deposits. Streams can reach great speed, so it can collect debris. For instance, fast rivers undercut outer banks, while it flows more slowly around the inner banks, because of its loss of energy. Hence, a barrier is formed by the deposition of coarse material over the inner bank. When floods happen, the water level increases and the overflowing river tends to occupy the floodplain. As a result of flood, there are alluvial deposits, which are typical of the decline in energy during deposition. Floods usually create embankments where they leave traces of their different levels of energy. The silty material is deposited on the far side of the embankment, where sufficient energy is available. Conversely, clay settles on the floodplain, because of the low energy. Embankments require sufficient energy to be created (Brown 1997, 96-100).

The texture of the ground and the thickness of the deposit are related to the distance to the channel. Both of them become finer as the distance increases. A sudden decrease in slope generates alluvial fans in the water channel, which are carrying sediments downhill. The material is deposited because of the abrupt reduction of stream energy. The same event happens where a narrow valley widens into a broad plain. Fans tend to enlarge downhill, having a cone shape. The sediments of fan deposits are constantly re-worked. Furthermore, their texture becomes finer the more distant from the apex of the fan. Usually fans of humid regions are different from those of arid regions. The first are less steep and occupy wider areas than the second. Inland seas and lakes are environments at low-energy, which create specific deposits. Usually their sediments are coarse near the shore and finer toward the middle of the lake or sea. Generally shoreline deposits form soils with coarse texture and occupy high landscape positions. The peats are formed in bog landscapes where sediments are dominated by organic substances.

Wind

There are two principal deposits created by wind: aeolian sands and loess. Although wind transports this material, it cannot erode it, because of its characteristic clay-sized particle dimension, which is at least < 0.002 mm. Aeolian sands have a typical range of diameter between 0.05 mm to 2 mm. The movement of aeolian sands is called saltation and it is generally a series of small distance jumps. However, aeolian sands can cover distances in the order of kilometres by numerous saltations. During these movements, other clay material may adhere to aeolian sands. This material has a narrow texture and usually is deposited on the protected side of valleys and waterbodies. Loess is characterised by smaller dimensions in comparison with aeolian sand. It is silt-sized with a diameter of between 0.002 to 0.05 mm and it can be transported by the wind for several hundred kilometres before it is deposited. The texture of loess does not show variation in a vertical direction, while it becomes thinner in relation to the distance from the original source. Windblown material and water-transported material have different shapes. The first has sharp edges, a conchoidal shape and surface etching. The second has rounded edges and polished surfaces.

Living organisms

Biota or living organisms participate actively in the transformation and decomposition of soil (appendix 4.1). The term biota includes fauna, flora, fungi and microorganisms. Several categories of animals work the earth: large and small mammals including human beings, birds, reptiles, amphibians, insects, bacteria and actinomycetes, which mix the soil with their activities. Plants, such as trees and grasses, also contribute, absorbing mineral nutrients from the subsoil by the roots and then they return the mineral in the form of leaf litter. Moreover, roots have a mechanical role in soil transformation, because they create passages through soil where water moves clay and organic matter. Among the numerous living beings which affect soil, the microscopic saprotrophs are the most effective (Adl 2003; Buscot and Varma 2005). They release organic acid in order to take their nourishment from the remains of plants and animals. Oxidation/reduction and other chemical reactions of soil begin from the activity of these microorganisms. Distribution of organic matter can change in relation to the environment. For instance, the forest concentrates organic matter on the surface of soil and it rapidly reduces with depth, but in contrast, organic matter is accumulated to great depth in grassland. Remarkably, humus leaves a dark stain which endures also in buried soils. Hence, the colour of soil is a reliable clue for archaeologists to recognise buried soil. Forest and grassland soils show different patterns also in the distribution of iron and aluminium. In fact, heavy rainfalls drain clay and organics in forest soil, as a result, minerals, such as iron and aluminium, are left in the B horizon in higher concentration than in grassland.

2. Biota and their activity in soil.

Table 1: Principal biota and their potential impacts on soil (Courchesne 2006, tab. 12.1).

Vegetation formations	Contrasts in horizon sequence, profile depth, pH, clay mineralogy, cation exchange capacity, organic matter and sesquioxides contents, colour and nutrient distribution in profiles at forest-praire bounduary, or under coniferous versus deciduous forests
Tree stands	Pits and mounds micromorphology resulting from windthrow with increased water flow and organic matter accumulation in pits
Three canopy	Increased input of matter and water in throughfall, canopy drip (coniferous species), stemflow (*Fagus grandfolia*) or litterfall (*Betulla alleghaniensis*, *Agathis australis*) compared with open areas; concentration of elements in surface horizons through biocycling; umbrella effect and soil protection against the impact of rain drops
Tree roots	Accumulation of organic matter, acidification/alkalinisation, oxidation/reduction, CO_2 release and increased mineral weathering in the rhizosphere; preferential hydrologic flow and leaching along root channels; creation and stabilization of soil aggregates and protection of soil surface against erosion
Grasses	Secretion of secondary soil minerals (e.g. phytolithis)
Lichens and mosses	Role in physical disintegration and chemical weathering of minerals and rocks at early stages of pedogenesis complexation of metals by excreted organic acids; trapping of atmospheric dusts and accumulation of fines on barren surfaces
Fungi	Decomposition of organic residues, litter materials and woody debris; chelation of dissolved metals and accelerated dissolution of soil minerals by exudates; stabilization of soil aggregates
Algae, diatoms	Nitrogen fixation; disintegration of rocks and minerals; addition of solid phases in the form of Si-rich cell walls (organic soils)
Large Mammals (large e.g. bears, cattle)	Excavation of the soil surface; compaction by herds of migrating ungulates or by grazing animals with consequences on accelerated erosion by surface run-off

Table 1: Principal biota and their potential impacts on soil (Courchesne 2006, tab. 12.1).

Mammals (small e.g. moles, rodents)	Digging of large burrows in soil with impacts on water infiltration, on the establishment of preferential hydrologic flows, on the formation of *krotovina* (tunnels of rodents back-filled with soil) and on increased mass-wasting; selective transport of soil materials to the surface; disturbance and reworking of surface horizons
Birds (e.g. penguins)	Cycling of carbon, nitrogen and phosphorus to the soil surface in faeces, egg shells and bone fragments; disturbance of surface horizons by nests; soil acidification by droppings
Reptiles, amphibians	Disturbance and reworking of surface horizons while digging nests; effect of tunnel networks on water infiltration
Insects (e.g. ants, termites)	Mixing and disturbance of horizons; creation of extended porous networks and increased hydraulic conductivity; increased nutrient (Ca, Mg, K, N, P) content in mounds; cementation of soil material; incorporation of organic matter; fragmentation of litter materials; sorting and size-dependent segregation of soil particles ; selective transport of soil material in the surface; creation of microreliefs
Insects (e.g. beetles, spiders)	Fragmentation of litter; formation of poorly connected burrows and channels resulting in voids in soils
Earthworms	Improvement of soil structure and of ped formation; mixing of soil materials and formation of A horizons; creation of biopores for infiltration of water and aeration; increased nutrient and fine particle contents in casts; decomposition of fresh litter and integration of organic substances; release of calcareous nodules; selective transport of soil material to the surface; nitrogen mineralization
Bacteria, Actinomycetes	Decomposition of organic debris and litter materials; weathering of soil materials; oxidation and reduction of metals; cycling and transformations of macronutrients (C, N, S, P)

Appendix 5: human body facts

The human body participates actively in the process of organic decomposition that happens in burial environment. Hence, it seems significant provide information about the body compositions. Below, tables show data of a human body in its different tissues (tab. 2), cell content (tab. 3), chemical elements (tab. 4) and compared with other big mammals (tab. 5).

Notes

The following tabulations refer to different studies. However, these data are specific to those examinations and are presented here as example. Some variations in values may be possible in other studies. For instance, Moulton (1923) discovered alterations in the chemical composition of some mammals, from birth until a specific period of maturity, and it consists mainly in the simultaneous increase of nitrogen and decrease of water. These physical changes happen also in a human body during its development. Several examinations have been carried on the human body composition and they can be distinguished between "traditional" and "new methods" (Lukaski 1987). Traditional methods have been addressed to calculate total body water by isotopes of hydrogen, deuterium and tritium, even if they are not free from contraindications (Lukaski 1987, 537). Among the pioneer studies, the experiment of Forbes, Cooper and Mitchell (1953) provides the following results. They analysed a corpse of an adult white male individual, 168.5 cm tall and 53.8 kg in weight. The result is 55.74 per cent of the whole body is composed of water, 19.66 per cent ether extract, 18.82 per cent protein, 5.49 per cent is described with the generic term "ash", 1.9 per cent calcium and 0.9 per cent phosphorus. The new methods are possible by the progress of *in vivo* total-body neutron activation analyses. It is possible to measure all somatic components of a living human being, without any loss of data. There are several *in vivo* techniques of body analysis: densitometry, dilution, bioelectrical impedance and conductance, whole body counting, neutron activation, X-ray absorptiometry, computed tomography and magnetic resonance imaging. Even if it has been stated that the most efficient and precise are immersion and plethysmography (Lukaski 1987, 551 tab. 1), the best results are got by the combination of all methods (Ellis 2000).

Table 1: Percentage values of adult human body chemical composition; after the Forbes, Cooper and Mitchell experiment (1953, 361 tab. I).

* Chemical composition assumed

† congested with blood

	Total body	Water	Ether extract	Crude protein (N x 6.25)	Ash	Ca	P
Skin	6.33	57.71	14.23	27.33	0.62	0.0034	0.070
Skeleton	17.58	28.17	25.04	19.71	26.62	10.68	4.61
Teeth	0.08	5.00*		23.00*	67.95	25.05	12.09
Striated muscle	39.76	70.09	6.60	21.94	1.01	0.0066	0.156
Brain, spinal cord, nerve trunks	2.99	75.09	12.35	11.50	1.37	0.0147	0.299
Liver	2.34	71.58	3.11	22.24	1.35	0.0133	0.303
Heart	0.52	62.95	16.58	17.48	0.61	0.0058	0.144
Lungs †	3.30	77.28	1.32	19.20	1.03	0.0090	0.132
Spleen*	0.11	78.69	1.19	17.81	1.13	0.0089	0.217
Kidneys	0.51	70.58	7.18	19.28	0.87	0.0057	0.188
Pancreas*	0.14	73.08	13.08	12.69	0.93	0.0143	0.155
Alimentary tract	1.80	77.40	9.17	12.77	0.53	0.0140	0.098
Adipose tissue	11.37	23.02	71.57	5.85	0.20	0.0078	0.031
Remaining tissue solid	11.43	59.29	22.47	17.28	0.85	0.0257	0.088
Remaining tissue liquid	0.59	81.45	2.55	13.58	0.82	0.0044	0.104
Bile, content of bladder and alimentary tract	0.99						
Hair and nails	0.10						
Average (weighted) all tissues	98.91	55.74	19.66	18.82	5.49	1.928	0.936
Total composition whole body weighting 53.80 kilos	100.00	55.13	19.44	18.62	5.43	1.907	0.925
Composition fat-free body		69.38		23.43	6.83	2.400	1.164

Table 2: human body chemical components (Lide 2007, 7-18).

Element	Amount (g)	Percentage of body mass
Oxygen	43000	61
Carbon	16000	23
Hydrogen	7000	10
Nitrogen	1800	2.6
Calcium	1000	1.4
Phosphorus	780	1.1
Sulphur	140	0.20
Potassium	140	0.20
Sodium	100	0.14
Chlorine	95	0.12
Magnesium	19	0.027
Silicon	18	0.026
Iron	4.2	0.006
Fluorine	2.6	0.0037
Zinc	2.3	0.0033
Rubidium	0.32	0.00046
Strontium	0.32	0.00046
Bromine	0.20	0.00029
Lead	0.12	0.00017
Copper	0.072	0.00010
Aluminium	0.061	0.00009
Cadmium	0.050	0.00007
Boron	< 0.048	0.00007
Barium	0.022	0.00003
Tin	< 0.017	0.00002
Iodine	0.013	0.00002
Manganese	0.012	0.00002
Nickel	0.010	0.00001
Gold	< 0.010	0.00001
Molybdenum	< 0.0093	0.00001
Chromium	< 0.0018	0.000003
Caesium	0.0015	0.000002
Cobalt	0.0015	0.000002
Uranium	0.00009	0.0000001
Beryllium	0.000036	-
Radium	3.1×10^{-11}	-

Table 3: human cell composition: molecular mass (Freitas 1999, 71 tab. 3.2). A dalton is the standard unit, which is applied to indicate mass on an atomic or molecular scale (atomic mass).

Molecule	Mass percentage	MW (daltons)	Number of molecules	Molecule percentage	Number of Molecular types
Water	65	18	1.74×10^{14}	98.73	1
Other Inorganic	1.5	55	1.31×10^{12}	0.74	20
Lipid	12	700	8.4×10^{11}	0.475	50
Other Organic	0.4	250	7.7×10^{10}	0.044	~200
Protein	20	50,000	1.9×10^{10}	0.011	~5,000
RNA	1.0	1×10^{6}	5×10^{7}	3×10^{-5}	—
DNA	0.1	1×10^{11}	46	3×10^{-11}	—
TOTALS	100%	—	1.76×10^{14}	100%	—

Table 4: Body composition comparisons of some mammals (Carter and Tibett 2008, 32 tab. 2.1).

Organic Resource	H_2O (%)	C:N ratio	N (g kg^{-1})	P (g kg^{-1})	K (g kg^{-1})	Ca (g kg^{-1})	Mg (g kg^{-1})	References
Human (Homo sapiens) age adult	60	5.8	32	10	4.0	15	1.0	Tortora and Grabowski (2000)
Pig (Sus scrofa) age: 56 days	80	7.7	26	6.5	2.9	10	0.4	Spray and Widdowson (1950); DeSutter and Ham (2005)
Pig (Sus scrofa) age: 28 days	78	_	29	7.4	2.7	10	0.4	Manners and McCrea (1963)
Rabbit age: 70 days	78	29	7.0	3.2	12	_	_	Spray and Widdowson (1950)
Rat (Rattus rattus) age: 70 days	75	_	3.2	6.5	3.5	12	0.5	Spray and Widdowson (1950)

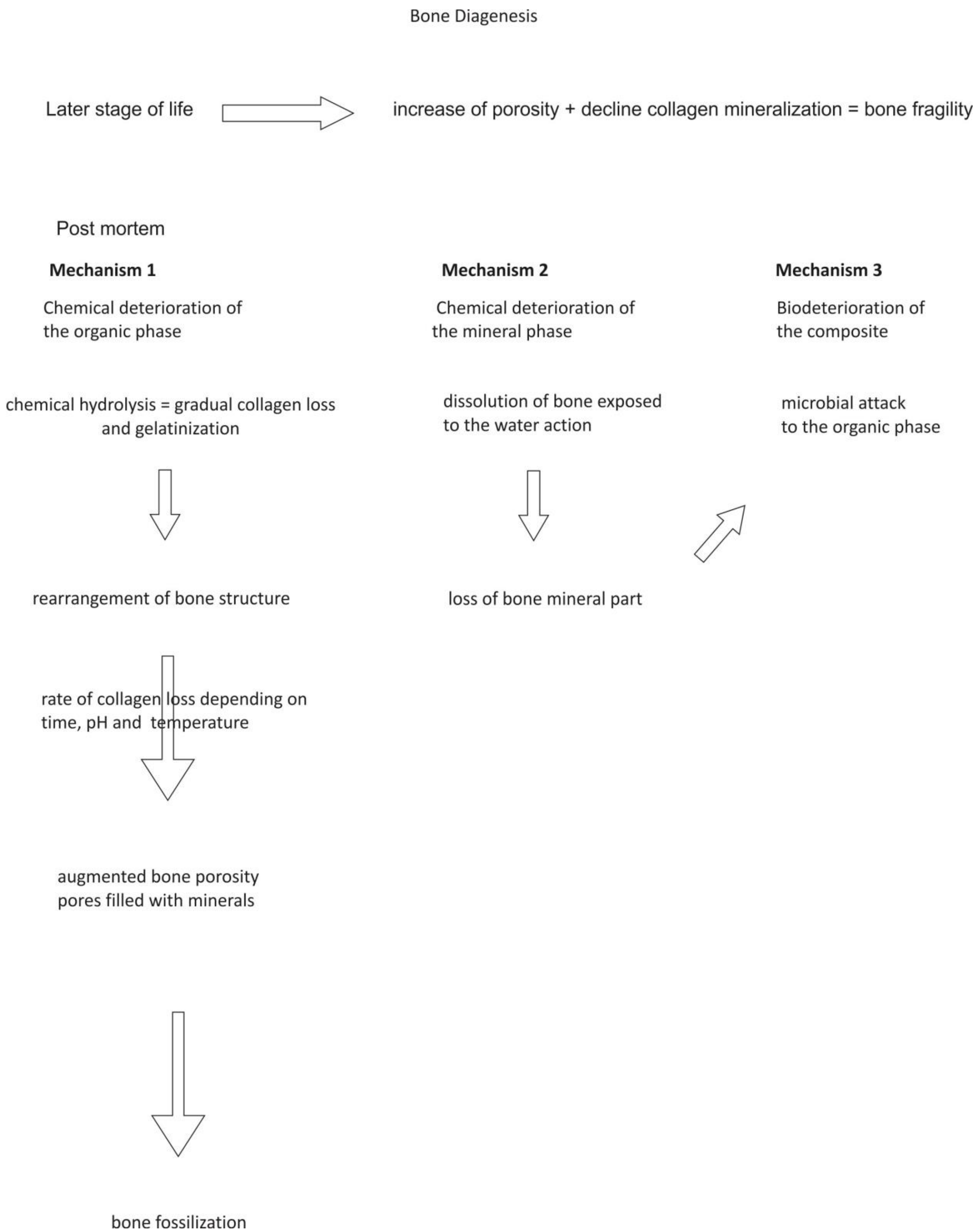


Figure 1: Three mechanisms of bone diagenesis (diagram of the author based on Collins *et al.* 2002).

Appendix 6: bog bodies

An explanatory, but not complete, list of bog bodies and their associated clothing is provided below in order to the organic material that survives in bog environment (tab. 1).

Table 1: some examples of clothes and artefacts associated with bog bodies.

Name	Clothing	Other objects	Gender	Provenance	Chronology	Reference
Bentstreek Foot	Leather shoe, textile	None	Unknown	Lengener Moor, Landkreis Wittmund, Germany	AD 80 -135 / 160 – 170 / 195 – 210 cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Bernuthsfeld Man	Two woollen cloaks, leg wrappings, a sleeved tunic of 45 patched out piece of cloth out of 20 different fabrics in 9 different weaving patterns, two leather belts	A stick, a leather knife sheath	Male	Hogehahn Moor, Aurich, Germany	AD 680–775 cal ^{14}C (Van Der Plicht *et al.* 2004)	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Brammer Man	Branches, twigs	Stones	Male	Kreepen, Landkreis, Verden, Germany	AD 1440-1520 or 1585-1625 cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Bunsoh	Woollen "necklace"	Posts	Unknown	Bunsoh, Landkreis Dithmarschen, Germany	AD 560 – 620 cal ^{14}C	Dieck 1965; Van Der Plicht *et al.* 2004

Table 1: some examples of clothes and artefacts associated with bog bodies.

Name	Clothing	Other objects	Gender	Provenance	Chronology	Reference
Dägten	A woollen cloak, a pair of woollen knee length breeches, remains of a woollen tunic, other garments and accessories	None	Unknown	Grossen Moor, Landkreis Rendsburg-Eckernförde, Germany	AD 345 – 535 cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Dägten Man	X	Woollen thread, crooks	Male	Grosses Moor, Landkreis Rendsburg-Eckernförde, Germany	AD 135 – 385 cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Damendorf Man	Woollen cloak, a pair of woollen breeches, two woollen leg wrappings, two leather belts, a pair of leather shoes	None	Male	Seemoor, Landkreis Rendsburg-Eckernförde, Germany	AD 135-335 cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Damendorf Girl	Short woollen skirt, fur cape,	Leather bowl, crooks, stones	Female	Ruchmoor, Landkreis Rendsburg-Eckernförde, Germany	895 – 810 BC cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Elling Woman	Two fur capes, a woollen belt and a leather halter	None	Female	Bjaeldskovdal, Viborg, Denmark	355 205 BC ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004

Table 1: some examples of clothes and artefacts associated with bog bodies.

Name	Clothing	Other objects	Gender	Provenance	Chronology	Reference
Emmer-Erfscheidenveen Man	Fragments of woollen undergarment, deerskin shoe, sheepskin cap, calfskin cape	Branches	Male (?)	Emmen, Netherlands	(less precise) Bronze Age 1370-1365 / 1315 – 1260 / 1265 - 1215 B.C. ^{14}C cal (Van Der Plicht *et al.* 2004)	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Huldremose Woman	Checked woollen skirt and scarf and two skin capes	A bone comb, leather and a headband wrapped in a bladder	Female	Ramten, Denmark	Iron Age/Roman 160 BC – AD 340 ^{14}C (Van Der Plicht *et al.* 2004)	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Hunteburg Foot	(Left) shoe, leather	Post	Unknown	Grossen Moor, Landkreis, Diepholz, Germany	AD 1215 – 1300 ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Hunteburg Men (I and II)	Two woollen cloaks	A small bunch of flowering heather	Male	Grossen Moor, Landkreis, Diepholz, Germany	AD 245 – 415 ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Hunteburg III	Piece of animal, likely a deer (?)	None	Unknown	Grossen Moor, Landkreis, Diepholz, Germany	40 BC – AD 75 ^{14}C cal	Van der Sanden 1996; Van Der Plicht *et al.* 2004
Johann Spieker	Woollen jacket, buttons	Coins, remains of a prayer book,	Male	Goldenstedter Moor, Landkreis Vechta	185 ± 25 BP ^{14}C cal	Van Der Plicht *et al.* 2004
Jührdenerfeld Man	Wollen cloak, fur cape	Posts	Male	Jührdenerfeld, Landkreis, Freiskand, Germany	90-80 BC or 55 BC – AD 25 ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004

Table 1: some examples of clothes and artefacts associated with bog bodies.

Name	Clothing	Other objects	Gender	Provenance	Chronology	Reference
Kayhausen boy	Fur cape; textile	None	Male	Kayhausermoor, Landkreis, Ammerland, Germany	Inaccurate results around 330-115 BC ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Lindow II	A fox-fur armband, a thong of leather	An iron rod	Male	Chesire, England	Iron Age/Roman - ^{14}C 1910-1965 B.P.	Gowlett *et al.* 1989
Marx-Etzel	A sleeveless woollen tunic, a pair of woollen knee-length breeches, remains of a third woollen garment and a leather shoe	Pots	Unknown	Hilgenmoor, Landkreis Wittmund, Germany	AD 140–395 ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Marx-Stapelstein	Remains of several woollen garments	None	Unknown	Hilgenmoor, Landkreis Wittmund, Germany	AD 135–385 ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Neu-Versen Man/Roter Franz	Woollen thread and woollen cloak (?)	None	Male	Kreepen, Landkreis Verden, Germany	AD 135–385 ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Oberaltendorf Man	A woollen cloak, a tunic, a pair of breeches, leg wrappings, shoes	Two silver *Kapselberlocks* (ornaments)	Male	Kehdinger Moor, Germany	AD 260–380 ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004

Table 1: some examples of clothes and artefacts associated with bog bodies.

Name	Clothing	Other objects	Gender	Provenance	Chronology	Reference
Osterby Man	Fur cape	None	Male	Köhlmoor, Landkreis Rendsburg-Eckernförde, Germany	AD 75 – 130 ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Rendswühren Man	A piece of leather bound with leather thongs at left leg; rectangular woollen cloth and a cape made of pieces of skin sewed together	None	Male	Kiel, Germany	AD 135 – 255 / 305 – 315 cal ^{14}C (Van Der Plicht *et al.* 2004)	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Röst Girl	Woollen cloak	None	Female	Röster Moor, Landkreis Dithmarschen, Germany	200 – 95 BC cal ^{14}C	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Tollund Man	A fur cap of sheepskin, cow hide pieces sewed together and a leather belt	A noose	Male	Bjældskovdal, Denmark	Iron Age/Roman 760 BC – AD 260 Calibrated ^{14}C	Dieck 1965; Glob 1969; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Tumbeagh	None	Wood	Unknown	Tumbeagh bog, Offaly county, Ireland	430 ± 60 BP cal ^{14}C	Van Der Plicht *et al.* 2004
Yde Girl	A woollen "sprang" band and a woollen cloak	None	Female	Tynaarlo, Netherlands	40 BC – AD 50 ^{14}C (Van Der Plicht *et al.* 2004)	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Windeby I	A woollen blindfold tied across the eye	None	Male	Windeby, Germany	AD 41-118 ^{14}C (Van Der Plicht *et al.* 2004)	Van Der Plicht *et al.* 2004

Table 1: some examples of clothes and artefacts associated with bog bodies.

Name	Clothing	Other objects	Gender	Provenance	Chronology	Reference
Windeby Girl	Woollen band, fur cape	Pottery sherds, a stone, a branch, several twigs	Female	Domlandmoor, Landkreis Rendsburg-Eckernförde, Germany	150 – 135 / 115 – 0 BC ^{14}C cal	Dieck 1965; Van der Sanden 1996; Van Der Plicht *et al.* 2004
Wijster Four (burial group of four individuals)	Branches, a sleeved red woollen jacket, a pair of woollen breeches, a leather jacket, a leather strap	16 coins and a bronze cauldron	All males	Drenthe, Netherlands	AD 1435-1625 ^{14}C (Van Der Plicht *et al.* 2004)	Dieck 1965; Van Der Plicht *et al.* 2004

Appendix 7: PCA further biplots

Another version of PCA biplots (ch. 3.6) are presented here. These biplots are more readable because they lack the vectors, but their values are identical to those presented in ch. 3.6.

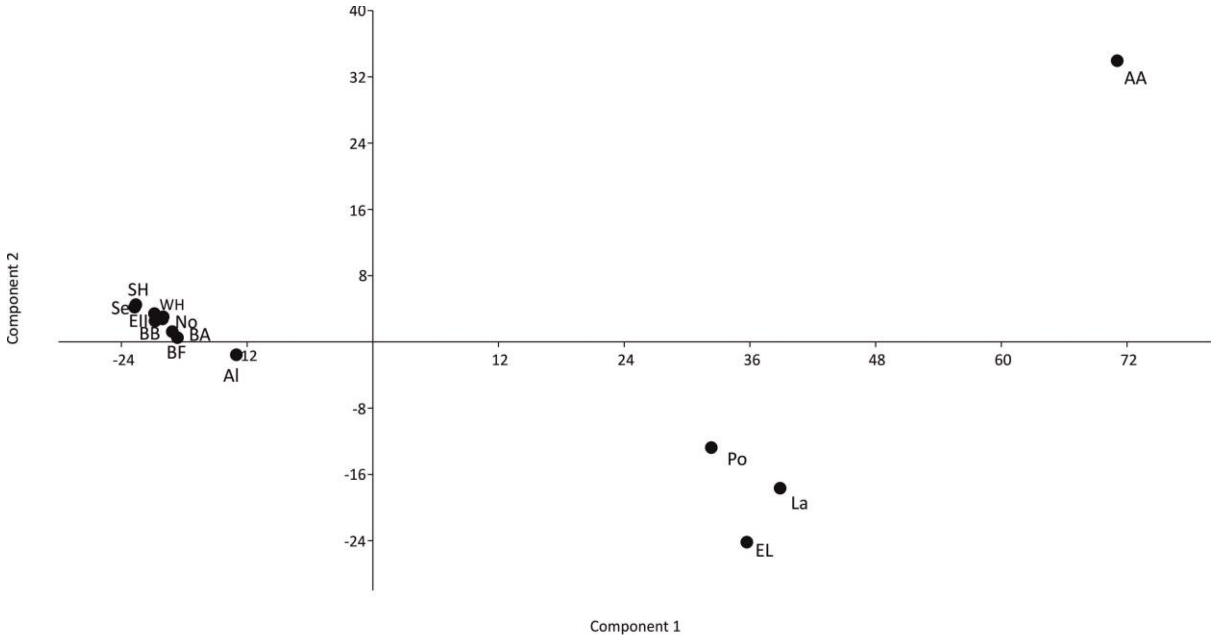


Figure 1: PCA biplot including all graves of all cemeteries.

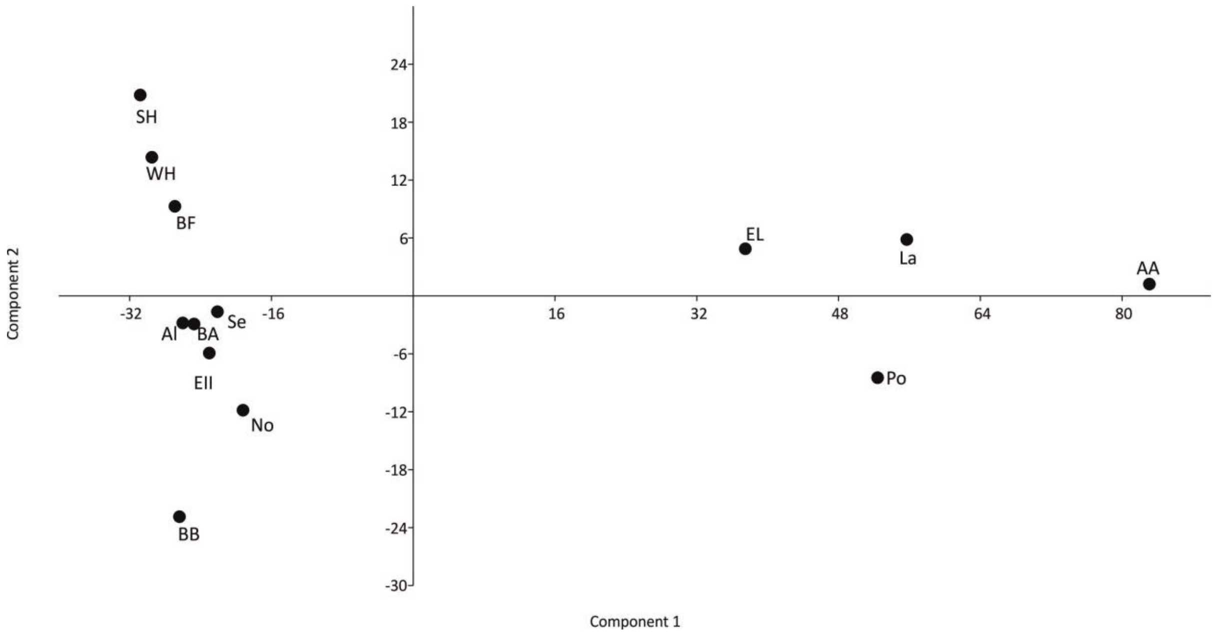


Figure 2: PCA biplot including male graves of all cemeteries.

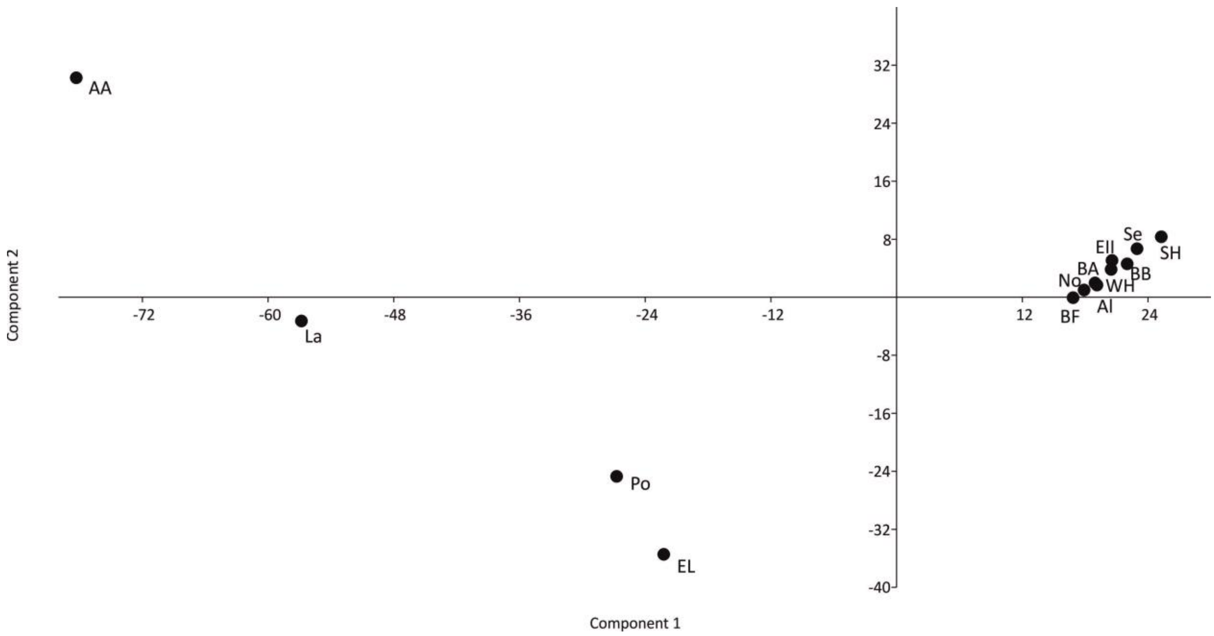


Figure 3: PCA biplot including female graves of all cemeteries.

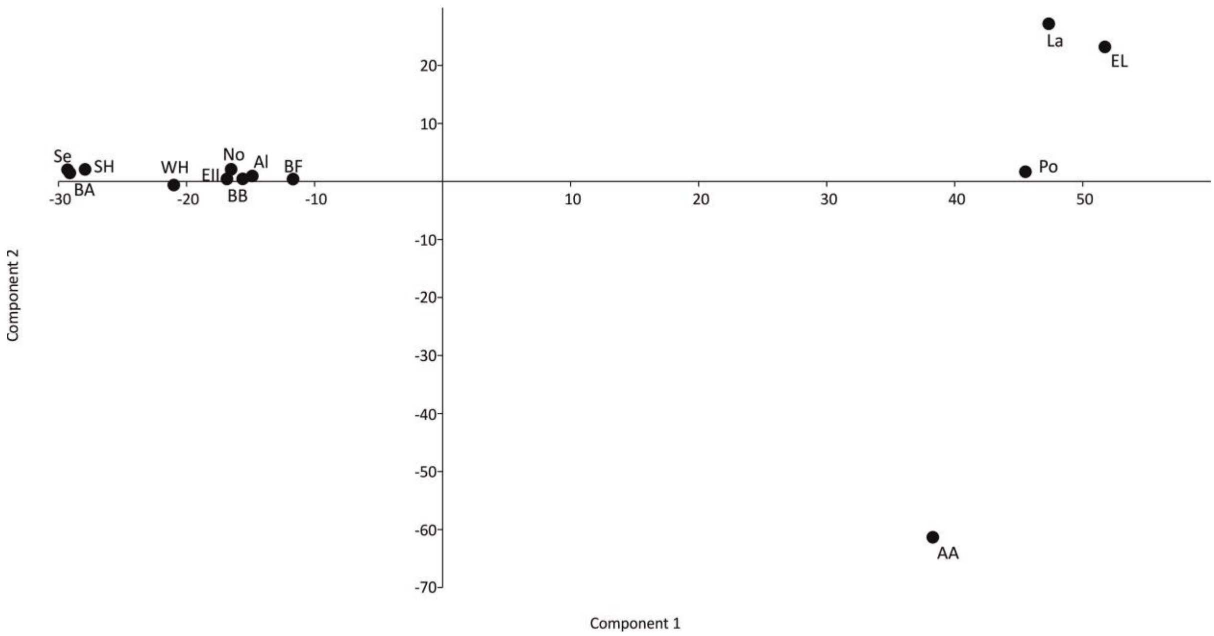


Figure 4: PCA biplot including immature graves of all cemeteries.

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