Developments in animal husbandry between the Late Roman period and the Early Middle Ages: a comparative study of the evidence from Britain and the Lower Rhineland

by

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A thesis submitted in partial fulfilment of the requirements for the degree of
Doctor of Philosophy

The University of Sheffield
Faculty of Arts and Humanities
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November 2019

To all my friends.

M. R.

Abstract

This study investigates changes in animal husbandry practices between the Late Roman and Early Anglo-Saxon periods in Britain; contemporary assemblages from the Lower Rhineland are used to provide comparative information on the nature and scale of change. All traditional zooarchaeological analyses have been employed; however, the main focus of this study rests on the comparison of biometrical data. Size improvements are a key feature of Roman influence on animal husbandry in western Europe; the nature and reasons behind such improvements highlight important characters of livestock exploitation during the Roman period, and their abandonment or maintenance can be informative of post-Roman husbandry strategies. The results indicate substantial discontinuity in the aims and scale of animal exploitation in Early Anglo-Saxon England. This pattern is enhanced by the continuity and accentuation of 'Romanised' animal husbandry practices into the Late Roman period: such continuity attests to the survival of efficient exploitation of the island's resources beyond the politico-military *crisis of the 3rd century. The need to produce surpluses from agriculture and animal exploitation disappears with the end of the Empire. Zooarchaeological data from Early Anglo-Saxon assemblages reveal more generalised, relaxed animal husbandry strategies typical of self-sufficient communities, with pronounced variability dictated by local needs and environmental constraints. Cattle decrease in size, reflecting the fact that large, robust animals to exploit in intensive agricultural production were no longer needed. On the other hand, the improved sizes of sheep, horse, and chicken fitted well the aims of Early Anglo-Saxon herders, and were largely maintained; this evidence suggest that post-Roman communities did not simply cope with adverse economic conditions, but responded appropriately to the new circumstances.*

Keywords: animal husbandry, biometry, Late Roman, Early Anglo-Saxon, Britain, Merovingian, Lower Rhineland.

Acknowledgements

Several people contributed in different ways to the production of this PhD thesis.

First and foremost, I would like to thank my supervisor Umberto Albarella, for his constant academic and personal support throughout these many years and for the example he provides as a conscientious individual in a changing world. I am also grateful to my second supervisor, Maureen Carroll, for her help and support concerning key parts of this thesis. This project was funded by a Faculty of Arts and Humanities PhD Scholarship Award granted by the University of Sheffield, to which I am profoundly grateful.

My friendship and colleagueship with Veronica Aniceti represented a turning point in my slowly evolving life, and she knows I will never be able to properly express my gratitude to her. Angela Maccarinelli has always been very keen in reminding me I should be working harder to make progress in my work and in my life in general, and I hope she will continue to do so in the future. My friends and housemates Matteo Bormetti and Grazia Sergi have also been very patient and supportive, and they will have to bear with me a bit longer. Angelos Hadjikoumis has provided key moral and material support, helping out with boxes and with useful methodological discussions; he also cheers up the whole lab with his jokes.

All the other past and present members of the Sheffield Zooarchaeology Lab are great friends and colleagues, and we all support each other in our efforts to do research in a collaborative and constructive way. I would like to thank, in order of appearance: Mik Lisowski, Giorgos Kazantzis, Lenny Salvagno, Jane Ford, Lizzie Wright, Hannah Russ, Christina Westhoff, Laura Llorente Rodriguez, Silvia Valenzuela Lamas, Idoia Grau Sologestoa, Chiara Corbino, Angela Trentacoste, Rossana Scavone, Evelyne Browaeys, Lucy Lawrence, Sofia Tecce, Ornella Prato, Miriam Maurizio, Tamsyn Fraser, Ged Poland, Abel Gallego Valle, Helene Benkert, Mahmoud Mardini, Tomos Jones, Dimitris Filioglou, Madeleine Metz, Aiya Raissova, Morgan Windle, Lua Valenzuela Suau, Pablo Castellano, Alex Valenzuela, Moisés Alonso Valladares, Colin Duval, Maaike Groot, Yasha Hourani, Nasia Makarouna, Justin Ayres, Tracy Platts, Jon Whitmore, Chloe Stringer, Ruth Irovec, Benjamin Wimmer, Donna de Groene, Costanza Cassio, Marina Chorro Giner, and Kinga Winnicka. I would also like to thank Bruno, Pietro, Giulia, Phyllis, Gustavo, Ottone, Clotilde, Taco, and Peter. Other former and present Sheffieldians have been supportive friends and valuable colleagues: Giulia Vollono, Sandro Sebastiani, Miguel del Pino, Roberta Mentesana, Valentina Perzolla, Lilli Janotte, Ruben

Tablada, Margarita Dagla, Laura Baiges, and Loo Yeo. I am particularly grateful to Veronica Testolini and Beatrice Triozzi for their friendship and company during several library sessions, and to Marcella Pampaloni, Alessandra Fortini, Valentina Pescini, and Iago for their support during the Tuscanian retreats.

The many archive curators I dealt with in the past few years have been amazing; their support and enthusiasm made data collection much easier and more pleasant. Among the many, I would like to thank Jude Plouviez, Faye Minter, Ben Donnelly-Symes, David Moon, Naomi Bergmans, Pippa Bradley, and Tracy Turner. I am also grateful to the many zooarchaeologists who provided useful information on the relevant material and agreed to share their data: Pam J. Crabtree, with whom I had the chance to collaborate and who provided essential chronological information on the site of West Stow, Maaike Groot, who so kindly shared her data from Late Roman sites from the Netherlands, Sheila Hamilton-Dyer, Lorrain Higbee, Claire Ingrem, Anthony King, Mark Maltby, and Adrienne Powell.

In the Netherlands, I had the pleasure to work with Kinie Esser, an amazing host, colleague, and friend. I am also grateful to Thijs van Kolfschoten, Andre Ramcharan, Stijn Heeren, Femke Lippok, Jasper de Bruin, Jason Laffoon, Witske Prummel, Inge van der Jagt, and Roel Lauwerier. The members of the Leiden Bioarchaeology Lab were great friends and colleagues: I would like to thank Donna, Yuki, Bryan, Carli, Wouter, Ivo, Jan, Alette Anne and many others. My housemates in Leiden were as patient and supportive as Matteo and Grazia (and others): many thanks to Kali, Maciéj, Gracjana, Anthony, Sasha, as well as Marthe, Magali, and Remus.

Helene Benkert, Donna de Groene, Ged Poland, and Evelyne Browaeys worked with me on the analyses of equid and bird remains from West Stow and other sites. Our work provided essential information which are included in this thesis, and I want to thank them for their support and enthusiasm. I would also like to thank Anya Harvey for having let me use her unpublished improved ageing tables for caprines, part of her MSc thesis at Sheffield; Tomos Jones for having provided further support to the use of the diagnostic zones method in the recording of animal remains; Chiara Corbino for having provided her unpublished standard for chicken bone measurements, and for useful discussions and advice; Mik Lisowski for having helped out with the maps included in Chapter 5.

I am sure I have forgotten at least half of the people I would have liked to thank, including very close ones, but if they know me they are aware of my faulty memory and will forgive me.

Last but not least, voglio ringraziare la mia famiglia estesa per il continuo supporto morale e materiale durante gli ultimi dieci anni. In ordine di apparizione: Maria Teresa Titton e Saverio Rizzetto, per l’educazione ricevuta, i viaggi, il cibo ecc.; Dario Rizzetto, per aver per primo (prima di me) capito quello che volevo fare e per il supporto morale e entusiasmo; Barbara Miraval, per l’amicizia fraterna; Maria Rizzetto, Perla Rizzetto, ed Edoardo Rizzetto, per la gioia che hanno portato nella mia vita; Cester e Taca, per avermi insegnato due modi completamente diversi, ma ugualmente validi, di godersi la vita.

Sheffield, 18th November 2019

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Declaration

I, the author, confirm that the Thesis is my own work. I am aware of the University's Guidance on the Use of Unfair Means (www.sheffield.ac.uk/ssid/unfair-means). This work has not previously been presented for an award at this, or any other, university.

CHAPTER 1

Introduction

At the beginning of the 5th c. AD Britain was still a province of the Roman Empire, and its northernmost outpost. The political, military and economic strives that brought to the gradual fragmentation and final collapse of the Empire, however, had already started decades before. The traditional date marking the end of Roman rule in Britain is AD 410, when the last garrisons left the island. Within a few decades, Britain was overrun by a new invader, the Saxons, namely a composite group of Germanic migrants originating from central-northern Europe (Campbell 1982a; 1982b; Esmonde-Cleary 1989; Higham 1992; Scull 1993; Millett 1995; Faulkner 2000; Hamerow 2012).

The socio-economic and cultural changes that followed these events altered substantially the modes of production and consumption established by the Romans for almost four centuries, although the nature of such developments and the extent to which they affected different regions of the island are still a source of major debates among scholars (§ 2.2, 2.3, 2.4, 2.5, 3.1, and 3.2). Under the Romans, economic activities were closely tied to the needs of the Empire, its army and administration. In particular, the Roman taxation cycle implied the need to produce a surplus; in turn, this brought about economic specialisation, large-scale production and redistribution systems, partly backed by a market economy, and partly driven directly or indirectly by the state. The end of the Empire removed the source of this cause-and-effect structure (Esmonde-Cleary 1989; Evans 1990; Mattingly 2006; Campbell 2017; Maltby 2017).

Food production certainly played a major role within all these developments. Agriculture and animal husbandry, closely intertwined worlds, were key sectors of the Roman economy. Whether taxes were levied in cash or goods, the production of a surplus itself relied largely on the fields. Landscape and agricultural activities were reorganised to fit this purpose. In Britain, as in most of the north-western provinces, animal husbandry focussed on cattle, which ploughed the fields and yielded large amounts of meat. Production became specialised and large-scale, with standardised practices detected at most Romanised sites of the island. Animal management was improved, following a pattern that is widely attested also in other provinces of the Empire (Grant 2004; Groot 2016; Maltby 2016; 2017; Albarella in press).

Since they are a reflection of economy and society, changes in food production practices in the immediate post-Roman period are likely to provide essential information on historical developments, in a period when written sources fall silent and the quantity and quality of other archaeological indicators substantially decrease. Academic research has already contributed essential work to our understanding of post-Roman Britain (e.g. Hodges 1989; Scull 1993; Brookes 2003; Thomas *et al*. 2006; Woolf 2007; Hamerow 2012). This project intends to integrate the many studies on Early Anglo-Saxon food production practices by looking at animal exploitation. In particular, it explores the changing nature of animal husbandry (focussing on cattle, caprines, pig, equids, and chicken) in Late Roman (3rd-4th centuries AD) and Early Anglo-Saxon (5th-7th centuries AD) Britain, by assessing the results of previous zooarchaeological research and complementing them with alternative analytical approaches.

The zooarchaeological techniques of analysis used in the project include the frequency of species, ageing through mandibular wear stages and epiphyseal fusion, butchery evidence and other human-derived alterations on the animal remains, sexing (where possible), and an assessment of pathological conditions; the major focus of the study, however, is on biometry (see Chapter 5: Methods). Size and robustness improvement of the main domesticates is a typical trait of Roman husbandry practices observed in most of western Europe (e.g. Bökönyi 1971; Lepetz 1996; Albarella *et al*. 2008; Colominas and Saña 2009; MacKinnon 2010; Groot 2016; Duval and Clavel 2018). It aimed at larger meat yields per unit and, for cattle, at stronger animals to use in the fields; improvement could be achieved locally and/or by importing larger breeds from other regions (see Chapter 3: Zooarchaeological background). Considering the significance of such developments within the Roman economy, and the different way they could be achieved, any morphometrical changes occurring in Early Anglo-Saxon England must be equally representative of the nature of animal use, informing on key issues of economy and society in both periods. A size reduction of cattle in post-Roman Britain, for example, has been suggested by some studies, but remains a hypothesis to be tested (Crabtree 1991; Holmes 2014b; Duval and Albarella sub.); if such size decrease were revealed to be a general trend, the potential implications would be very informative of early post-Roman economic developments.

The project also looks at the zooarchaeological evidence from the Lower Rhineland, in order to provide a term of comparison to facilitate the interpretation of results from British sites. This region provides a geographically close comparison from the European mainland and has roughly similar environmental conditions to Britain. In addition, the analysis of assemblages from both sides of the Rhine (and of the border – *limes* – that it contributed to reinforce) allows a further comparison between the Romanised part of the Netherlands and the nearby free Germanic territories, which can also contribute to illuminate the dynamics operating in Britain.

1.1 Aims

In sum, the project aims to investigate the following issues:

- how homogeneous were husbandry practices within Late Roman Britain?
- what was the nature and extent of diachronic changes in animal management at the transition between the Late Roman and the Early Anglo-Saxon periods? For example, were there any changes in the size of the main domesticates, and what are the economic implications of such developments?
- did diachronic developments differ in the various regions considered?
- how homogeneous were animal husbandry practices within Early Anglo-Saxon England?
- what are the differences and similarities in the zooarchaeological evidence between Britain and the Lower Rhineland, and how can such differences/similarities enhance our understanding of economic processes in Late Roman Britain and Early Anglo-Saxon England?
- what is the significance of change, when this is integrated with other lines of archaeological evidence, and contextualised within the socio-economic and cultural developments of post-Roman Britain?
- how can the interpretations achieved be integrated within the historical dynamics characterising north-west Europe and the rest of the Continent in the Late Roman period and Early Middle Ages?
- what are the potentials of the application of similar methodologies to other regions of Europe and the Mediterranean?

1.2 Contents

The background and previous studies related to the topic of this research project are in Chapter 2: Historical and archaeological background and Chapter 3: Zooarchaeological background, which provide the basis for the contextualisation of the results. Part of the data analysed in this project was collected by the writer; comparative data were also collected from the literature, to provide a larger dataset. The archaeological sites and contexts that produced the faunal assemblages recorded by the writer are presented in Chapter 4: Sites and material, along with a table listing all the assemblages from the literature that have been integrated in the study. A description of the methodological choices adopted for the recording and analysis of faunal assemblages, as well as for the integration of data from the literature and inter-site comparisons, is provided in Chapter 5: Methods. Chapter 6: Results presents the results by regions (i.e. Suffolk, Cambridgeshire, Oxfordshire, Lower Rhineland); each section is organised by types of analysis. In Chapters 7: Discussion and 8: Conclusions the evidence is interpreted, integrated within other types of archaeological evidence, and summarised in order to highlight what contribution this study has made towards a better understanding of the historical dynamics in Late Roman and post-Roman north-west Europe.

1.3 Complementary studies

During this PhD project, namely between 2015 and 2019, a number of parallel studies which included data used in this work were carried out in collaboration with or independently by other researchers. Such studies complement the results achieved by this PhD project, and will be referred to in Chapter 7: Discussion, or support some methodological approaches adopted and presented in more detail in Chapter 5: Methods.

Cattle lower third molars from Pakenham, Icklingham, and West Stow were sampled for carbon and oxygen stable isotope analysis for a Research Employability Project (a White Rose – College of the Arts & Humanities training programme for doctoral researchers) undertaken by Veronica Aniceti (postdoctoral researcher at the University of Rome Tor Vergata) and the writer, and conducted at VU Amsterdam (The Netherlands) under the supervision of Jason Laffoon (Rizzetto *et al.* in prep.).

A pilot biometrical study on cattle and sheep remains from Roman sites in northern Britain was carried out, in collaboration with Veronica Aniceti, in order to assess the extent and nature of livestock improvement in that region (Aniceti and Rizzetto in prep.).

The large Early Anglo-Saxon faunal assemblage from West Stow provided the opportunity for various MSc thesis projects (MSc Osteoarchaeology 2016-2017, University of Sheffield). Emily Deeb recorded and analysed the pathological evidence on animal remains from the site

(Deeb 2017). Helene Benkert focussed on equid remains, integrating the evidence from West Stow by recording material from other Early Anglo-Saxon and Roman sites, as well as collecting a larger corpus of data from the literature for more comprehensive comparisons (Benkert 2017; Benkert and Rizzetto in prep.). The abundant sheep remains from West Stow allowed Anya Harvey to construct improved mandibular wear stage estimation tables for caprines; such tables have been used to estimate the mandibular wear stage of broken caprine mandibles in this study (Harvey 2019). A selection of material from the same site was recorded by Tomos Jones using both the 'traditional' and the 'diagnostic zone' methods (the latter used in this study); this study highlighted the differences between the two approaches and validated scientifically the advantages brought by selective recording (Jones 2017) (Chapter 5: Methods).

The domestic and wild bird remains from West Stow were studied by Donna de Groene (University of Leiden, The Netherlands) for an Erasmus+ project at the University of Sheffield, while she studied for her MSc Archaeology; Ged Poland and Evelyne Browaeys analysed the biometrical data from ducks and geese and from birds of prey respectively (de Groene *et al*. 2020).

Similarly, the faunal remains from the Late Iron Age and Early Roman phases from the site of Cambourne were studied by Tracy Platts (MSc Osteoarchaeology 2016-2018, University of Sheffield) and integrated with the results from the Mid-Late Roman assemblage analysed for this study (Platts 2018).

CHAPTER 2

Historical and archaeological background

2.1 Introduction

The following sections provide a historical and archaeological background to this study. It was decided to avoid separating the historical and archaeological evidence, as these provide complementary information that can be better understood when presented together. Although references to animal husbandry will be made where appropriate, previous zooarchaeological studies on the subject are presented and discussed separately in Chapter 3.

The chapter is organised into five sections:

- Roman Britain (mid-1st-4th centuries AD);
- The transition (a brief section on the main archaeological and historical issues tackled by studies on the transition between Late Roman Britain and Early Anglo-Saxon England);
- Early Anglo-Saxon England (5th-7th centuries AD);
- The historical and archaeological backgrounds in the British study-areas (a brief section on the evidence from Suffolk, Cambridgeshire, and Oxfordshire, whence most of the British assemblages analysed in this study originate);
- The Roman and Merovingian[1] Lower Rhineland (mid-1st century BC-7th century AD).

The history and archaeology of Early and Middle Roman Britain (mid-1st-2nd centuries AD) provide key information for a better understanding of socio-economic conditions in the Late Roman period (3rd-4th centuries AD), and of the processes behind the changes at the transition. For this reason, the section on Roman Britain starts with the Late Iron Age to Roman transition. Similarly, the changes undergone by Britain in the Early Anglo-Saxon period not only contribute to a better definition of the different aims, scale, and nature of Roman and post-Roman economies, but also constitute a prelude to the political and socio-economic developments of the Middle Anglo-Saxon period, which will be only briefly presented. A similar approach has been adopted for the Lower Rhineland.

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[1] The term 'Merovingian' is used to refer to the period between the mid-5th and mid-8th centuries AD, when the Frankish kingdom(s) expanded over most of Gaul and central-western Germany.

2.2 Roman Britain

The first contacts between Romans and native Britons date back to at least the mid-1st century BC. At this time, Caesar's incursions in the south-eastern part of Britain did not end with a complete and permanent conquest of the island. Nonetheless, the available archaeological evidence, such as Roman pottery found at Iron Age British sites, suggests that the movement of people and goods between southern Britain and the Continent increased considerably (Cunliffe 1994) (Fig. 2.1).

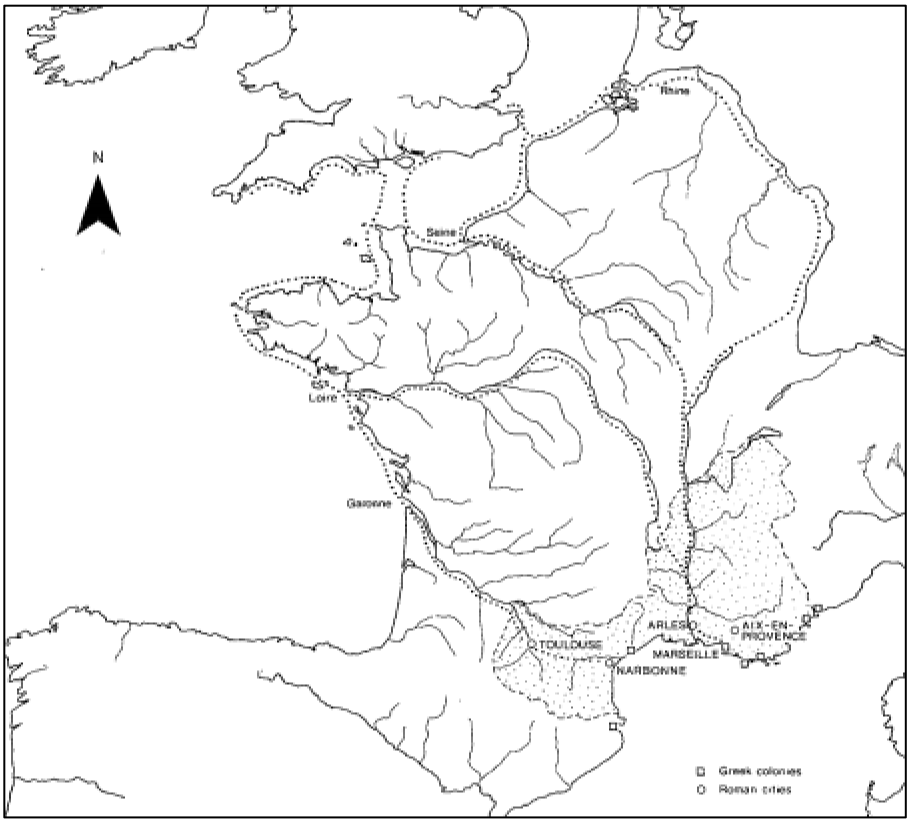


Fig. 2.1 Terrestrial and sea trading routes in the late 1st century BC as described by Strabo; the shaded area shows the extent of Roman territory in Gaul before Caesar's conquest (McGrail 1997, Fig. 10.1.4).

A second Roman invasion of Britain began in AD 43. The reasons and political dynamics behind the invasion have been variably addressed by scholars (e.g. Hanson 1987; Fulford and Allen 2017). Certainly, the conquest and exploitation of new territories was a central feature (and essential requirement) of the centralised military-economic power that was the Early Roman Empire; at the same time, the deployment of troops from eastern Gaul and Germany would have broken up the excessive, and potentially dangerous, concentration of troops in these areas. However, military campaigns and successful expeditions also played an important role in the self-assertion and personal propaganda of political leaders; to this end, the conquest of Britain would have undoubtedly represented an easy target to fulfil the personal political ambitions of the Julio-Claudian dynasty (Hanson 1987; Fulford and Allen 2017).

The first part of Britain to fall under Roman rule was the southeast of the island, the part closest to the Continent. Much of the area was under the control of the Catavellauni, whose expansionist ambitions had given the Romans a *casus belli* for the invasion itself; their defeat and conquest of the south-eastern lowlands by Claudius and his general Aulus Plautius were easily achieved, and a series of client kingdoms was established around the conquered areas. The conquest of the west (especially Wales) and the north (much of it under the Brigantes) proved more demanding. In these regions, tribes were smaller and more numerous, creating a network of small defended *oppida*, and they operated guerrilla-style attacks rather than engaging in open-field battles the Roman army was prepared for. In addition, this was a more difficult terrain for invading military operations than the central-southeastern lowlands, with more mountainous and wooded areas. It took three military campaigns to accomplish the conquest of Wales, while campaigning in the north resulted in a never-ending series of conquests and withdrawals (Faulkner 2000).

After securing Wales in AD 78, Agricola (then the governor of *Britannia*) expanded the province into northern Britain, defeating the tribe of the Brigantes. Moving further north, Agricola launched a series of campaigns, advancing further into modern Scotland, securing the Lowlands till the Forth-Clyde isthmus through a network of forts and roads which linked the region to the south; in AD 84 he pushed the army to the far north-east of Scotland, defeating the local tribes at the battle of Mons Graupius, but then retreating again into the Lowlands (Hanson 1987). Roman occupation in the far north fluctuated since Agricola’s last campaigns, as a result of strategic policies of reorganisation of the conquest and rationalisation of troops, which were often required elsewhere in the Empire; whether deliberately or not, a policy other than complete conquest was adopted and maintained, and for most of the time the border rested at the Tyne-Solway line, where in the 120s Hadrian’s Wall was built (Breeze 1982; Kamm 2004; Mattingly 2006) (Fig. 2.2).

A range of archaeological and historical evidence is now being used to highlight pre-conquest Roman/Continental influences in Britain which, to some extent, would have limited the impact of change (Cunliffe 1994). The image of a wild and belligerent Britain instilled by Roman propaganda to enhance the importance of the conquest masked a situation where, at least in the south-east, the social structure and economy of local tribes had already been influenced by the Empire (e.g. Bird 2017). Nonetheless, since AD 43, Britain's settlement patterns, modes of production, and culture rapidly adapted to radically new political, military and economic conditions. Despite some regionalism, such changes will characterise Roman Britain for almost four centuries; these developments affected animal husbandry among other activities, and therefore represent an inevitable prelude to this study.

Fig. 2.2 Roman Britain (Cornell and Matthews 1982, 135).

The main changes that occurred in Britain from the mid-1st century AD concerned demography, settlement patterns, the scale and types of economic production, trade, and the constant presence of large military units. All these elements are related to each other, and impacted greatly on economic activities (Esmonde-Cleary 1989; de la Bédoyère 1999; Millett 1995; Faulkner 2000; Allen *et al*. 2015).

As a direct result of the Roman conquest, population increased sharply. All estimations are bound to a series of analytical biases, and must therefore be treated with caution. One of the earliest reliable surveys is Millett's (1990, 181-186) who, using modern pre-industrial towns as proxies for urban centres, and generalising the results from archaeological surveys of rural settlements, calculated a population of over 3.5 million for the 4th century AD. Several methodological and practical issues call for further estimations. Regional variability must be taken into account, and cannot be thoroughly investigated; at the same time, chronological changes should distinguish between demographic and settlement dynamics. In other words, differences in the archaeological visibility of settlements does not directly reflect different demographic patterns. At the same time, Roman Britain was certainly not a closed system. Migration to and from the Continent would have played a role, especially considering army allocations and the slave trade; internal migration would have been equally important (Fulford and Allen 2017). Number-wise, it would seem more appropriate to use a wide estimation range which, using data from different studies, Bird (2017) calculates to be between 2 and 5-6 million people. Concerning demography, however, two issues might more importantly (and reliably) be discussed: relative fluctuations, and the reasons behind population increase.

A detailed geographical and chronological distribution of rural settlements has recently been produced by the Roman Rural Settlement project (Allen *et al*. 2015). In the southeastern and central-eastern parts of Britain, farms and villas increase dramatically after the conquest, peaking in the early 2nd century AD. The number of occupied sites remains stable or very slowly declines thereafter; in general, such decline reaches its lowest levels in the mid-4th century AD. However, considerable regional variations exist. The peak and lowest levels are dated differently in different regions; also, in some areas the decline is less intense, while in others the number of occupied sites in the 4th century goes below pre-Roman estimates (Fig. 2.3). Although relative fluctuations of archaeologically visible occupied sites must not be directly related to demographic changes, they remain the closest less biased proxy for such estimations.

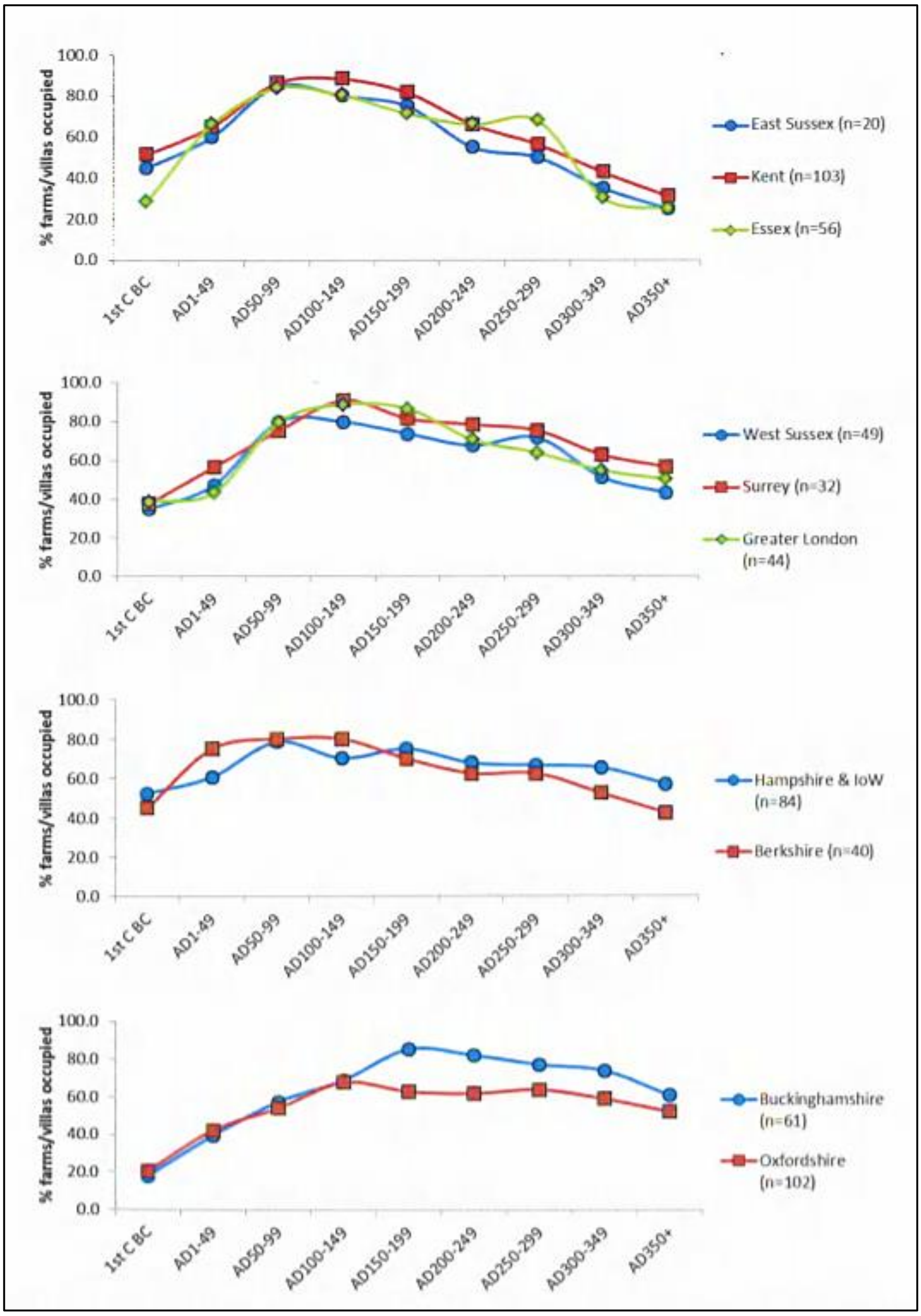


Fig. 2.3 Occupation of rural settlements in south-eastern Britain between the 1st century BC and the 4th century AD (Fulford and Allen 2017, 3, Fig. 1.1).

The main phenomenon affecting population displacement (and certainly its increase), however, was urbanisation, with the development of a settlement hierarchy and related infrastructures; these were functional to the Empire's administration, as well as to its production and distribution strategies (Matthews 1986; Millett 1995; Mattingly 2006). The nature of the economic system underpinning these changes in settlement patterns has been widely debated, although it is now accepted by most scholars that the state's requirements would have impacted greatly on such developments (Hopkins 1980; Millett 1995; Bang 2008). Indeed, the demand for money taxes fuelled a cycle of production and redistribution which generated the need for net-production sites, required to produce a surplus in the form of agricultural and animal products (Mattingly 2006; Campbell 2017; Maltby 2017). Such surplus was then brought to the market, usually in the nearest town, to be sold, the cash acquired being used to pay taxes; the need to pay rents would have contributed to the process in a similar way (Hopkins 1980). In turn, these (and agricultural produce) allowed the maintenance of the huge army stationed along the borders, Britain included (Millett 1995) (Fig. 2.4). Private initiatives, including many craft productions, trade, and services related to it, would have developed, usually on a limited scale, as a side effect of the taxation cycle (Hopkins 1980; cf. Temin 2001; Bowman and Wilson 2009). The importance of towns as centres of economic mediation is supported by the fact that, after the politico-economic crisis of the 3rd century AD and the increasing reliance on the more direct taxation in goods, most towns, along with their trade, declined and shrank, their role being reduced to that of administrative centres (de la Bédoyère 1999; see below).

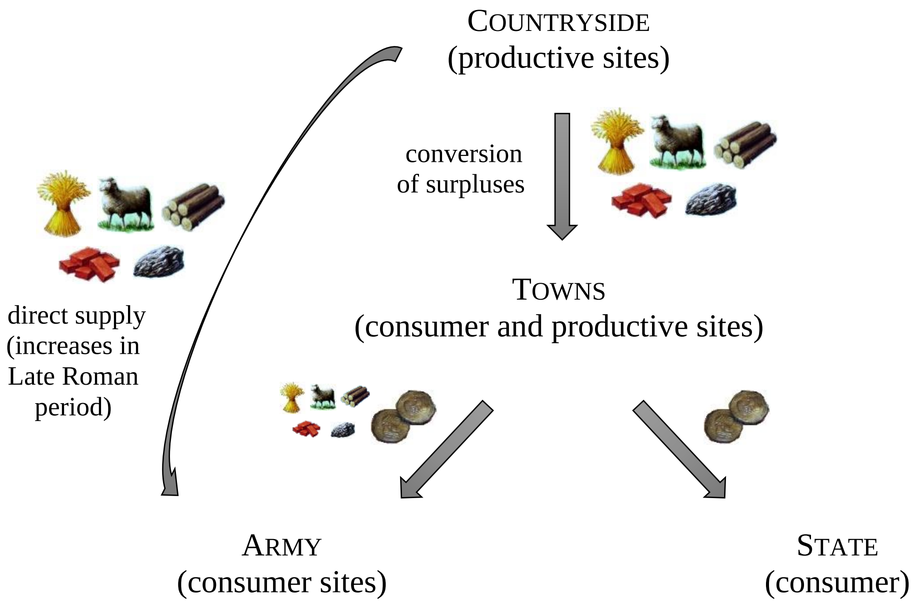


Fig. 2.4 Main dynamics for the flow, conversion, and redistribution of goods and money in the Roman economic system of exploitation. The system remained in place, with fluctuating success, until the end of the Roman Empire, and implied the creation or reinforcement of a functional settlement hierarchy.

However, the role of Early and Middle Roman towns was not limited to administration and the conversion of surpluses; they also acted as centres of Romanisation, a phenomenon which implies the spread and adoption/adaptation of ‘Roman’ cultural models (Millett 1990, 69-91, 104-117; Webster 2001). The concept and implications of the Romanisation process have been widely debated, moving from an 'imperialistic' view of imposition of 'superior' Roman practices and cultural models onto submitted populations (Haverfield 1905), to 'post-colonialist' views which take into consideration an active interaction between Romans and locals (e.g. Millett 1990; Webster 1996; 2001; Woolf 1997; 2014; Hingley 2005; Mattingly 2006; Pitts 2008; Gardner 2013). Even within this more recent approach, different views exist: some scholars highlight the major role of elites in mediating change (Millett 1990; Hingley 2005); others suggest a 'resistant adaptation' of the lower classes as the main drive behind change, and terms such as 'creolisation', borrowed from American colonial archaeological theory, have been introduced to replace the term 'Romanisation' (Webster 2001). These more recent approaches, which largely ground their arguments on modern post-colonialism and globalisation theories, have attempted the construction of alternative models where a 'colonialist' one-way imposition of traditions and rules is replaced by a more equal mediation of cultural values; often, however, these revisions have proved more informative on the development of modern scholarly thought than on the actual socio-economic conditions of Roman provinces, and ended up "sanitizing discredited brands" by repeating "the same old narrative with the moral valencies reversed" (Woolf 2014, 47; Albarella 2007). Roman influence on the society and economy of dominated territories, and the consequent development of different cultural models and production processes, remain a fact, and are important exploring further in the context of the present study. Three issues in particular are worth considering, as they impacted greatly on practices and traditions of agricultural production and animal management.

First, although most western provinces underwent radical socio-economic and cultural changes, these were not introduced as a standard, identical Romanisation 'package' radiating from the core of the Empire. Indeed, while some elements were exported consistently, many others were functionally adapted: Romanisation is increasingly seen by scholars as a complex and geographically varied process whereby Roman models were adopted and adapted, and continuously negotiated, by local populations to express themselves and live compatibly with the new political and socio-economic conditions of the Empire they were part of (Webster 2001; Hingley 2005). Changes could also stem from traditions and practices characterising other regions within or without the Empire, differing much from patterns seen in Italy and Rome itself. Some food production practices and manufacture in Roman Britain, for example, are the result of influences from eastern Gaul and Roman Germany, whence most of the soldiers employed in the island originated (Innes 2007). At the same time, native practices were not completely abandoned and influenced post-conquest developments (Webster 2001); other features are explained in terms of pressure on food production for feeding both the army and the taxation cycle imposed by the state (see Chapter 3).

Second, Romanisation did not affect all provinces homogenously, and was much less successful in marginal areas (usually mountainous and/or peripheral regions, where urbanisation would have been less feasible and functional, and native settlement and practices were largely maintained), such as Wales, northern England and southern Scotland. Roman Britain is indeed a clear example of such differences. Despite having been permanently conquered by the army, the west and north of Roman Britain never fully assumed the characters of Romanisation, which were more substantially acquired by the centre-southeast of the province (Evans 1990; Millett 1995; Innes 2007). Romanisation and the exploitation of resources it accompanied worked more efficiently in relatively densely populated regions of long agricultural tradition, which could assure a regular flow of surpluses to feed the taxation cycle imposed by the state. The west and north were mountainous, mainly pastoral regions, with few and poor-quality arable areas and a scattered population inhabiting small settlements. Conquest, Romanisation and exploitation inevitably worked less well, with obvious implications when it comes to developments in agricultural and animal husbandry practices (these considerations also affected the selection of sites analysed in this study; see Chapters 3 and 4). At the same time, constant military presence had to be maintained in these regions too, making the balance of Roman occupation (costs *vs* tax revenues) barely viable (Faulkner 2000).

The third and last element to consider is the extent to which Romanisation followed spontaneously the conquest of a region, or was deliberately conceived by the Roman administration as an instrument to control and better exploit its provinces; as was often the case in the Empire, both cases apply. While some changes were the natural consequence of new political and economic structures, towns were often enriched with typically Roman buildings, such as temples, baths, and amphitheatres (de la Bédoyère 1999). That this was deliberately done to increase control and acquiescence of the native population is further supported in a famous passage of Tacitus' *Agricola* (late 1st century AD); although the propagandistic nature of the text invites caution in its interpretation, it does suggest some sort of a deliberate political strategy behind the assimilation of the local population:

“His object was to accustom them to a life of peace and quiet by the provision of amenities. He therefore gave official assistance to the building of temples, public squares and good houses. He educated the sons of the chiefs in the liberal arts, and expressed a preference for British ability as compared to the trained skills of the Gauls. The result was that instead of loathing the Latin language they became eager to speak it effectively. In the same way, our national dress came into favour and the toga was everywhere to be seen. And so the population was gradually led into the demoralizing temptation of arcades, baths and sumptuous banquets. The unsuspecting Britons spoke of such novelties as ‘civilization’, when in fact they were only a feature of their enslavement.” (Tacitus, *Agricola*, Chapter 21. Translation from Mattingly 1948)

Britain was established as a Roman province and flourished in the 1st and 2nd centuries AD. The main features of its Romanisation are to be found in the birth and development of towns, conceived as political, cultural, administrative and economic centres; in the standardisation and larger scale of productions and their distribution; in the rapid spread and adoption of ‘Roman’ (or, better, ‘non-British’) cultural preferences and social structures. The events that followed this ‘golden age’ of Roman Britain compromised, either temporarily or permanently, some of these characters (Esmonde-Cleary 1989; Millett 1995; de la Bédoyère 1999; Faulkner 2000).

In Britain, the troubles of the early 3rd century started earlier than elsewhere in the Empire. The army stationed in the island mutinied more than once in the 180s and 190s. In the civil war for the succession of Commodus, British officers supported the ‘wrong’ candidate, Clodius Albinus, against Septimius Severus. When the latter won, he set out to Britain to cleanse it of his enemy’s supporters; in addition, as the army stationed in Britain was one of the largest under a single province, and rebellions in the island had already proven rather dangerous, Septimius Severus decided to split it into two administrative units: one province for the populous and ‘Romanised’ south (*Britannia Superior*), and another for the more ‘Barbaric’ and militarised north (*Britannia Inferior*). The accession of Septimius Severus had temporarily stabilised the politico-military situation in the northern provinces; however, problems with resource distribution broke up again in the early 3rd century, culminating with the murder of Severus Alexander, the last of his dynasty. At this point, the north-western army elevated Maximinus Thrax, the first of many emperors/usurpers (over twenty in fifty years) who tried to take control of the Empire during the 3rd century (Millett 1995; de la Bédoyère 1999; Mattingly 2006). The civil wars, rebellions, and malfunctioning of the fiscal system impacted greatly on military control of the frontiers. In the north-west, migrations from eastern Europe and central Asia had forced Germanic tribes to cross the Rhine; in the south-east, the Sassanids of Persia had replaced a declining Parthian Empire, and represented a major threat for the provinces of the Levant (Faulkner 2000). The peak of the crisis came in the third quarter of the 3rd century: the Alamanni crossed the Rhine twice in 258 and 260, devastating parts of Gaul, and leading the local Roman elite to elevate their own emperors until Aurelian took back control of the region in 274 (Drinkwater 2007) (see below); in the east, the co-emperor Valerian was defeated and captured by the Sassanids in 260; Zenobia, a member of the Palmyrene aristocracy (Syria), established an independent Empire, conquering many of the eastern provinces before being stopped in 273. To counteract disaster, pressure on taxation increased; with time, this caused rebellions and inflation, bringing the Empire very close to collapse (Chadwick 1986; Faulkner 2000).

In the end, the localised, temporary disorders prompted by the provincial aristocrats and the peasantry were overcome and the established order restored. In 284 Diocletian, a military commander of low-status origin from Dalmatia, became sole emperor, and initiated a series of administrative reforms that put an end to the politico-military crisis of the 3rd century. In 286 he initiated what came to be known as the ‘Tetrarchy’ (‘rule of the four’): the Empire was organised in two macro-regions, with the eastern half ruled by Diocletian and the western half assigned to Maximian. In 293 both Diocletian and Maximian (who acquired the title of *Augusti*), appointed a junior emperor: Galerius for the east, and Constantius for the west (with the title of *Caesares*), further subdividing the Empire in four regions, or prefectures. The plan was to create a system of controlled successions whereby the senior emperors would have been replaced by their juniors, who in turn elected two other *Caesares*. In 305, respecting the plans of the Tetrarchy, Diocletian and Maximian retired and were replaced by Galerius and Constantius. However, just one year later, Constantius died in York; a series of claims to the title of *Augustus* in the west led to a period of civil war, which ended with Constantine (Constantius’ son) becoming sole ruler of the Empire in 324 (Corcoran 2000) (Fig. 2.5). Although the Tetrarchy system did not to last for long, it was one of several reforms aimed at ensuring long-term political stabilisation and closer control over the vast territories of the Empire. Two other reforms that are important in the context of the present study did survive, almost unchanged, throughout all the period leading to the end of the Roman State.

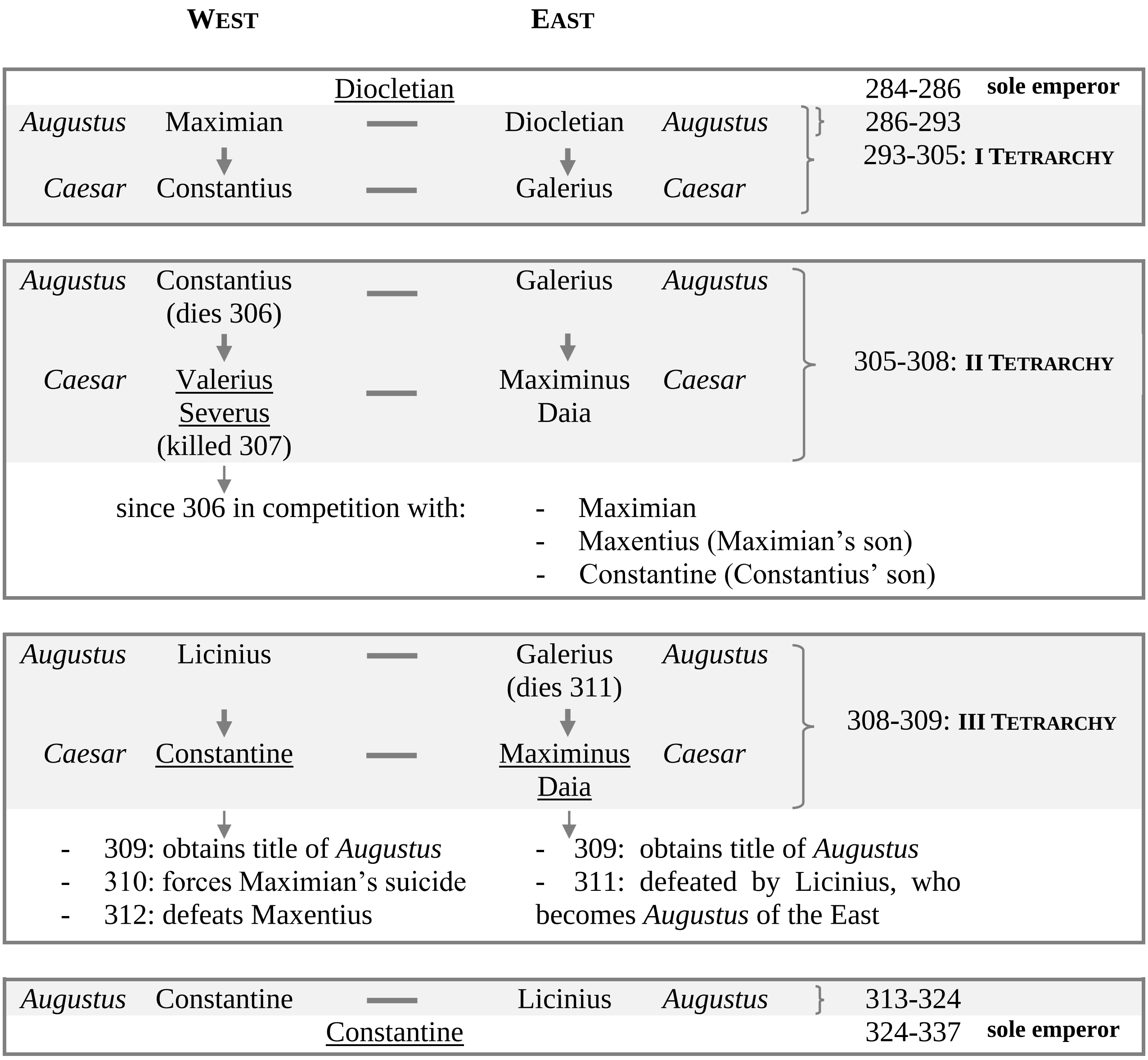


Fig. 2.5 Developments of the Tetrarchy organisation of power in the late 3rd-early 4th centuries AD, from Diocletian to Constantine as sole emperors (constructed from Corcoran 2000; Faulkner 2000).

The reform of the provinces, conceived by Diocletian, implied the subdivision of the Empire into much smaller administrative units, each with its own capital and a bureaucratically complex hierarchy of authorities; these latter included three finance officials in charge of the collection and distribution of taxes. Such more complex state bureaucracy brought Roman authorities closer to the source of exploitation, ensuring a more direct control and more efficient use of what was raised from the countryside and towns (Esmonde-Cleary 1989). Despite the troubles of the 3rd-century crisis (and of the following century), therefore, the taxation cycle imposed by the state did not collapse, nor even relax, but was rather reformed and reinforced. Production itself had not declined in the course of the 3rd century, but the politico-military turmoil had made Rome lose its grip on the exploitation of whole regions; once power was regained, the new administrative system was made to work along with the different economic and political conditions of the late 3rd-century Empire (Drinkwater 1983). Parallel to these developments, Roman rulers had to face the overexploitation of the fiscal and monetary system, which had resulted in economic recession and monetary inflation. A new currency with increased contents of precious metals was issued, but failed to maintain its value and was soon debased. As a debased currency would have affected tax revenues, the solution was to increase the amount of taxes raised in kind (Esmonde-Cleary 1989; Millett 1995). A standard amount of goods to deliver to the provincial officers was calculated for the whole Empire, regardless of local environmental and economic conditions or specific circumstances. These calculations reflected the state's need for goods, and through time were adapted accordingly; the events of the Late Empire implied that these adjustments always resulted in increased taxation. In sum, the need for the countryside to produce a surplus, in terms of agricultural and animal products, was not only maintained, but probably increased in the Late Roman period (Hopkins 1980). The reform of the army, reinforced and refined by Constantine, reflected the needs of its times and also fitted well with the administrative and fiscal developments outlined above. While in the past the control of the borders was in the hands of mainly stationery large army units (most notably the legions), a neat distinction was now made between lower grade, permanent posts along the borders (the so-called *limitanei*), and small, mobile, well-trained and equipped field troops (*comitatenses*), who campaigned through the Empire to deal with sudden, localised invasions, rebellions etc. (Esmonde-Cleary 1989). Although a shift towards a more mobile army had already started with Gallienus (253-268), Constantine institutionalised the change, whereby the offensive war of expansion of the Early Empire gave way to a more defensive approach led by mobile troops. In addition, Constantine separated and professionalised two careers that had traditionally been bound together: the civil-service/political career, and the military one. The former was obviously functional to the latter, but its power declined in favour of the army. Army commanders became competitive professionals climbing up the military hierarchy, often challenging the 'established order' and at times proclaiming themselves rulers of a region of the Empire (Faulkner 2000).

Roman Britain was directly influenced by the events and developments of the late 3rd-early 4th centuries. In 286 Carausius proclaimed himself emperor of Britain and northern Gaul; his military and economic strategies kept him, and his successor Allectus, in power for ten years (de la Bédoyère 1999). The army is thought to have been employed in Britain until the late

310s to settle down rebellions and restore power and defensive structures. The fortifications of Hadrian's Wall were reinforced, as were the watching posts built by Carausius along the eastern coast (the so-called 'Saxon Shore') to prevent Saxon raids from the sea (Breeze 1982). Towns were walled, or their existing walls reinforced. A network of small towns was built or renewed; they did not bear any resemblance of Romanisation, nor any administrative function. They existed as industrial centres or small markets, replacing the centralised role previously played by larger towns (Burnham and Wacher 1990). At the same time, some of the features characterising British towns in the Early Roman period were lost: new public and private buildings or repairs on old ones are almost invisible, and trade seems to have decreased further. Late Roman British towns seem less 'urbanised' and 'Romanised' in comparison to the previous centuries and to contemporary towns in the Continent. The countryside stopped relying on towns as administrative and economic centres where surplus products could be exchanged with money to feed the taxation cycle; the landscape now gravitated around rural villas, which become more common in this period (de la Bédoyère 1999; Speed 2014).

The change was so palpable that some authors argued for the end of 'Classical' Roman Britain, and the beginning of a period of transition that will lead the island into the Early Middle Ages (e.g. Reece 1980). Although it is important to stress the many differences between pre- and post-3rd century Britain, it is equally true that the Roman State did survive, its military presence reinforced, and the administrative and fiscal systems refined.

One last feature, though not the least important, came to characterise the Late Empire. The adoption of Christianity as state religion, endowed by Constantine, probably contributed to the preservation of the established order (Faulkner 2000); at the same time, some scholars have been considering the emergence of the Church as a parallel and competitive organisation to that of the Empire, which contributed, at least in part, to its decline (e.g. Chadwick 1986). The former approach (the adoption of Christianity as a planned imperial strategy) highlights the instrumentalisation of the basic principles of this 'new' monotheistic religion: it promoted uniformity, self-sacrifice for a better after-life, and was backed by a highly organised hierarchy. By becoming the official religion of the Empire, this latter identifying itself with the Church, Christians would have granted loyalty and obedience to both. As N. Faulkner stated:

> "The Church, in short, could counteract men's alienation from the state, mask the power and greed of the imperial grandees, and endow the war effort with the aura of a crusade. As ever, religion mystified reality so that men could continue to obey the orders of their masters." (Faulkner 2000, 116)

Following the Edict of Milan (313), which accorded the toleration of Christianity, and even more importantly that of Thessalonica (380), which recognised Christianity as the official religion of the Empire, the Church was granted estates and subsidies, and its officials (mainly the bishops) entered and commingled in the imperial apparatus. In Britain, churches or supposed Christian buildings have been identified at some archaeological sites. However, these were mainly limited to towns and some military sites (e.g. at Canterbury, St Albans, and Silchester); only centuries later, in Anglo-Saxon England, Christianity spread widely into the countryside establishing churches and monasteries, thus achieving ever greater control on economic activities and its revenues (Millett 1995).

The period of relative peace imposed by Diocletian and Constantine was short-lived. In the early 350s Constantius II (one of Constantine's son among which the Empire had been divided) had to deal with Magnentius, a usurper who had risen to power in the west. A few years later, Julian, elevated to *Caesar* of the west by his cousin Constantius, campaigned successfully in the Rhineland against the local Germanic tribes. To meet the demands of such war, he ordered 600 ships of grain from Britain to be delivered to the mainland; such demand argues for the viability of British agricultural production in the 4th century, as well as for the importance of the province as a supplier of products from the countryside. Driven by success, he was elevated as *Augustus* by the army, and replaced Constantius in the east. From here, he initiated a demanding campaign against the Sassanids, draining further men and resources from the rest of the Empire (Faulkner 2000). Britain, deployed of troops and supplies, became the target of what historians have later defined the 'Barbarian conspiracy': during the 360s (with a peak in 367), Roman Britain was under attack from all sides. Tribes from the Scottish Highlands and the Attacotti from the Western Isles invaded from the north; the Scotti raided the western coast from Ireland; and the Saxons, squeezed in their Continental homeland by incoming people from the east, and by raising sea levels in the north, raided the British eastern coast (Pearson 2005; Mattingly 2006). All these groups were what can be defined 'clan-societies'; they were characterised by a lack of social stratification and political organisation. With no large-scale, permanent military organisation, they could only attempt raids into the territory of an Empire which, however weakened, was still able to react. Within a few years, Valentinian I had Britain cleared of the invaders, its towns and military infrastructures restored and reinforced. Pro-Roman chiefdoms north of Hadrian's Wall created a buffer zone between the Empire and the rest of Scotland; the Wall itself and its forts were restored. In light of the invaders' ability to penetrate deep in Roman Britain, new forts were established south of the Wall, and the towns of the whole province had again defensive walls built or restored. To prevent further raiding from the north, the east, and the Irish Sea, the Saxon Shore and western coast forts were re-established. Once again, Britain was made safe; the period of relative calm which followed was, however, very short (Mattingly 2006).

In 378, the eastern Roman emperor Valens and his army were defeated at the Battle of Adrianople. The defeat set in motion a series of events with important consequences on Roman Britain. Theodosius, the new eastern emperor, facing the loss of most of his army, officially adopted a recruitment policy that directly involved groups of Barbarians settled within the Empire, the so-called *foederati*. Military policies in the east as in the west kept draining men and resources from the periphery of the Empire. At unease with this trend, the British army rebelled against the western emperor Gratian, and in 383 elevated Magnus Maximus to the throne. He moved most of the units to the Continent, chased and defeated Gratian, drove his successor Valentinian II out of Italy, just to be defeated by Theodosius in 388 (Faulkner 2000). To make things worse, Valentinian II was succeeded by Eugenius, a puppet emperor controlled by the Frankish general Arbogast. Theodosius, aiming at full control of the Empire, adopted a policy of military expenditure and endorsement of Christianism that drained the resources of the state even further. In 394 he defeated Eugenius and, four months before his death, became the last sole Roman emperor (Elton 1996a).

The British troops brought to the Continent by Magnus Maximus were not replaced. The process of decline could not be reverted, as from now on emperors would have been too occupied in the Continent to deal with problems in Britain. At this time many forts were abandoned and garrisons (and their salary and supplies) greatly reduced, the taxation system was compromised; as a result, villas and towns were gradually abandoned as well, and typical Romano-British products (e.g. pottery) declined or disappeared (Evans 1990; Millett 1995). Although Roman Britain never recovered, it remained within the Empire for two more decades after the defeat of Magnus Maximus. In 395 the Empire was, for the last time, split into two, with Arcadius in the east and Honorius in the west; in the west, however, actual power was held by Stilicho, a Roman general of Vandal origin. Having to face a chronic lack of resources, and abandoned by the richer eastern half of the Empire, Stilicho further drained the peripheries, including Britain, of troops and resources, and entertained an ambiguous relationship of alliance and war with various Barbarian groups (Heather 1991). Although in 396-399 the army campaigned in Britain against external attacks, in 401 Stilicho withdrew the last troops from the island to face the Goths of Alaric, who in 410 would have sacked Rome itself (Heather

1991). In winter 406 the Rhine froze, and groups of Alans, Suebi, and Vandals crossed it, plundering through Gaul and Spain. Cut off from the rest of the Empire, in 407 British officers chose their own emperors: Marcus and Gratian were elevated and killed within a few months, while Constantine III managed to move with whatever was left of the army to the Continent; despite some success against the army of Honorius, he was finally defeated and killed in 411 (Faulkner 2000).

The pattern of this last rebellion from peripheral Britain was that typical of centralised states with their need of exclusive control on resources. In N. Faulkner’s words:

> “That was how regional usurpation always worked. They arose from resentments at the centre’s neglect. But to defeat the centre, men and material were needed for the challenge. Either way, the centre was a black hole sucking troops out of the periphery. Without enough to go around, a centralised Empire was bound to succour the core at the expenses of the edges, and regional usurpation was never a long-term solution for elites located on the geographical margins of the system, since sooner or later the centre always sought a settling of accounts.” (Faulkner 2000, 170)

Despite the persistence of isolated garrisons in some areas, Britain had been left almost defenceless after Constantine III’s departure in 407. Soon after, the island was again targeted by Saxon raids along the eastern coast, a prelude to the larger migrations of the following decades. Zosimus, a Byzantine historian of the 6th century, specifies that around this time Roman rule over Britain officially ceased. In AD 411, local officers asked Honorius for military support; in his renown reply (the so-called ‘Rescript of Honorius’), the western emperor stated that, from now onwards, the towns of Britain had “to take precaution on their own behalf” (Zosimus, *Historia Nova*, VI, 10, 2. Translation from Ireland 1996, 165).

2.3 The transition

The period between the end of Roman Britain and the appearance of the first Anglo-Saxon polities is one of the most obscure in British history. Written sources, mainly Byzantine and later Anglo-Saxon historians, remain vague on this period, or offer unreliable, incomplete, or contradictory information (despite the existence of near-contemporary authors such as the British Gildas, writing in the first half of the 6th century). The archaeological record, when present, does not offer much more. It seems likely, and some written sources provide some indications on this, that local Romano-British authorities ruled over a politically fragmented territory, with some prominent leaders occasionally rising to dominate larger regions. Some scholars speculate this might have been a period of considerable economic and political instability, characterised by continuous peasant revolts (similarly to the contemporary *Bacaudae* of Gaul – see below) and shaken by the ambitions of local warlords (e.g. Thompson 1977; Faulkner 2000). At the same time, the archaeological evidence suggest that local Romano-British leaders did not passively adapt to new conditions, but attempted and sometimes managed to increase their control over people and territories (Hodges 1998; Innes 2007); such control is reflected by the re-establishment of a landscape dominated by hillforts, as well as by the increasing evidence for imports from long-distance trade (e.g. Fulford 1989; Reed *et al*. 2011; Duggan 2016).

Despite the dearth of information, there have been different approaches to the investigation of the transition between Late Roman Britain and Early Anglo-Saxon England, by historians and archaeologists alike. Different interpretations of historical events, changes in material culture, and chronology and duration of the process of change have generated lively debates which mainly gravitated around the concepts of continuity or discontinuity. In turn, scholars often presented different interpretations of what (dis)continuity actually means, and of what types of evidence would support the former or the latter (e.g. Wickham 2005; Ward-Perkins 2006).

Another subject of debate, as with all transitions, is chronology, namely when should we place the transition between the Classical and Medieval worlds. Some scholars, for example, identify the 3rd-century crisis as the breaking point: for them, the dramatic events and following developments of that period would mark the end of the Classical world (e.g. Reece 1980) and the onset of a process of 'medievalisation' of Europe during the so-called Late Antiquity (Brown 1971; 1978). Others suggest continuation, though at a reduced scale and limited to some regions, of Classical modes of landscape exploitation, medium-to-long-distance exchange, and urban life until the advent of the Carolingians in Europe, and the conquest of North Africa by the Arabs (mid-7th-early 8th centuries AD) (Pirenne 1937 and discussion on the so-called 'Pirenne thesis' in Hodges and Whitehouse 1983; Chadwick 1986).

Any analysis and characterisation of the transition between the Late Roman and Early post-Roman periods must, however, take into account regional variability. The political and economic history of the territories once occupied by Rome can vary considerably, depending on whether we consider Italy and other core regions of the former Empire, or more peripheral regions. In addition, the degree of Romanisation undergone by the landscape, society, economy and culture of a dominated population impacted considerably on continuity or discontinuity of Roman practices; similarly, the power held by the local aristocracy and its ability to continue influencing the administration and economic exploitation of the countryside played a major role in ensuring or undermining continuity, as did the different chronology and patterns of Barbaric migrations (Millett 1995; Webster 2001).

Britain has traditionally been seen as an example of discontinuity, as opposed to Gaul and other western provinces, where Late Roman structures, culture and practices are thought to have survived and been adapted by the new ruling elites (Esmonde Cleary 1989; Higham 1992). Examples of continued occupation, however, can be found also in Britain. Hamerow (2012) reports some cases, grouping the types of continued 'occupation' into four, largely overlapping categories.

The first one is that of actual continued occupation. At the Roman villa of Orton Hall Farm (Cambridgeshire), whose assemblage has been included in the site review of this study, Romano-British pottery is present in 5th-century contexts alongside Anglo-Saxon material culture (including a type of bone comb, a mortarium with an Anglo-Saxon fabric, brooches, girdle hangers, and weapons); part of its structure was soon remodelled as a post-Roman building (Mackreth 1996). The villa at Rivenhall (Essex) also presents evidence for structural continuity, with some parts of the Roman building adapted as separate dwellings, and the recovery of abundant Anglo-Saxon pottery; more intriguingly, a ceramic sherd recovered from post-Roman contexts presented a typical Roman form, but Anglo-Saxon fabric, suggesting some sort of cultural and/or technical influence which remains rare in England (Rodwell and Rodwell 1985). The case of Icklingham, a Roman site in northwest Suffolk, is discussed in Chapter 4, and also suggests the presence, however temporary and ephemeral, of Anglo-Saxon communities in the area (West and Plouviez 1976). The post-Roman contexts of Wroxeter (Roman *Viroconium Cornoviorum*, in Shropshire) have been widely investigated, and suggest a substantial rearrangement and occupation of Roman structures in the 5th and 6th centuries; despite the peculiar nature of its post-Roman occupation, however, Wroxeter was a major urban centre in Roman times and, similarly to other towns such as London and York, would have been more likely to experience some sort of continuity in occupation after the end of Roman rule (Barker *et al*. 1997; cf. Lane 2014).

The second type is the so-called ‘squatter occupation’: in the past intended as a reuse of abandoned sites, now it is actually interpreted as the final phases of occupation. In this view, the reasons for the use of more ephemeral, more ‘Anglo-Saxon’ building materials could have been the result of financial constraints, as well as of the collapse of the system of production and distribution of typically ‘Roman’ building material, among others; at the same time, the investment in and display of expensive architectural features may have become ‘socially irrelevant’ in a world where social status had become empowered by other means (Hamerow 2012).

The third and fourth types of ‘continued occupation’ listed by H. Hamerow (2012) do not refer to actual continuity. They include the reuse of abandoned villas at some point in the Anglo-Saxon period, and the establishment of settlements on Romano-British farmland. The former refers to Blair’s (1994) ‘created continuity’, whereby the appropriation of ancient sites would have enforced ownership of the land through cultural appropriation, and parallels studies on the symbolic and practical significance of the occupation of prehistoric sites in the Anglo-Saxon period (e.g. Crewe 2012). The latter type includes many examples, such as Mucking (Essex) and West Heslerton (North Yorkshire), where enclosures and buildings were partly reused within a relatively populated landscape (Hamerow 1993; Powlesland 1997).

However important the evidence for some sort of localised continuity might be, it is worth considering that: in the vast majority of cases post-Roman occupation was short-lived; *contiguity* of occupation (on or nearby ancient sites, but by different communities) is different from *continuity* of occupation (in economic, demographic, and cultural terms), and these are often difficult to tell apart in the archaeological record (Hamerow 2012); the density of Late Roman settlements and field systems as demonstrated by the Roman Rural Settlement project was such that, inevitably, some of the new foundations had to lie on or nearby previous sites, though without necessarily implying settlement continuity from the Roman period (and, even less, economic continuity); these rare cases should not be used to generalise on post-Roman continuity in Britain. Rather, they are important because of their exceptionality, supporting the overall apparent pattern of marked discontinuity (Hamerow 2012).

Discontinuity in settlement patterns, demographic density, scale and aim of economic activities, and cultural influences has an important impact on the interpretation of the results from this study. The absence/dearth of non-urban sites with solid continuity of occupation from the Late Roman into the Early Anglo-Saxon periods prevents direct comparisons of Roman and post-Roman assemblages from individual sites, which would obviously mitigate, to some extent, environmental and settlement-type variability as well as differences in excavation methods and recovery bias. At the same time, the abandonment of Late Roman settlements and the establishment of 'new' Anglo-Saxon sites produced faunal assemblages which are unlikely to be contaminated by each other. In addition, the diversity and abundance of Roman material culture allows reliable phasing of sites, where the Late Roman period can be easily isolated; changes in settlement patterns at the end of the Early Anglo-Saxon period often implied abandonment or evident changes on site use and layout, similarly isolating material from the earliest part of the Anglo-Saxon period. Strong settlement and economic discontinuity certainly impacted on agricultural production and animal husbandry as well, enhancing differences between the Late Roman and the Early Anglo-Saxon periods.

2.4 Early Anglo-Saxon England

The timing of arrival and permanent settlement of the Anglo-Saxons in post-Roman Britain has been widely debated. The few written sources available date from the 6th century onwards, and they provide specific dates or intervals for the beginning of the Anglo-Saxon migrations. Bede's *Ecclesiastical history of the English Peoples* (early 8th century), for example, draws on Gildas' earlier work (*De excidio et conquestu Britanniae*, 6th century) to account for a first incursion in AD 446-447, and a second one between 449 and 455; therefore, although the two sources adopt different approaches on the incoming Anglo-Saxons (violent invaders for the British Gildas, devoted and righteous people for the Anglo-Saxon Bede), they suggest a date for such incursions around the mid-5th century AD (Hills 2003). The anonymous *Gallic Chronicles* (mid-5th-6th centuries AD), on the other hand, provide slightly earlier dates; in particular, this latter source includes two brief statements on the raiding and settlement of the Anglo-Saxons in Britain:

"AD 410: The British provinces were devastated by the Saxons."

and

"AD 441: The Britains, having up to this time suffered various defeats and catastrophes, were reduced to Saxon rule." (*Chronica Gallica a CCCCLII et DXI*. Translation from Mommsen 1892)

Most of the dates provided by the *Chronicles* are largely considered reliable (Muhlberger 1983). However, references, like the first one above to continuous Saxon raiding of Britain in the early 5th century, might indicate that written sources were actually describing the results of a process that had started earlier. Saxon raids on the eastern coast of Britain have a long history dating back to the 3rd-century crisis, towards the end of which the Saxon Shore forts were established and later reinforced (see above). At the same time, there is evidence for Saxons entering Britain since the 3rd century as part of the Roman army, and the trend towards hiring more and more Barbarian troops increased considerably in the period leading to the end of Roman Britain (Bird 2017). The available archaeological evidence indicates that typical Anglo-Saxon material culture appears on the island from the second quarter of the 5th century (Scull 1993). Despite suggestions that this was the result of cultural influence from Continental Saxons already present in the island, scholars now agree that that the traditional dates for the earliest permanent Anglo-Saxon settlement are too late, and that multiple events of migration occurred. At the same time, written sources as well as archaeological evidence suggest that migrations could have continued into the 6th century, although at a reduced scale (Campbell 1982a). Recent aDNA research, for example, has revealed the presence of genetically distinct individuals in Middle Anglo-Saxon burials from Cambridgeshire, possibly suggesting that migration from the Continent continued for some centuries (Schiffels *et al*. 2016).

Other issues related to Anglo-Saxon migrations have been widely debated, and are important within the context of Early Anglo-Saxon England. These are the scale of migration, and its impact on the local population. The earliest models of Anglo-Saxon migration into Britain largely relied on written sources, and implied mass movements from the Continent and the consequent rapid, dramatic replacement of the local British population (Stenton 1947; Myres 1985). Since the late 1980s, however, a new theory became widely accepted among scholars – the ‘elite replacement model’; according to this approach, 5th-century migrations would have consisted of much smaller-scale invasions of groups led by an elite which, through military and socio-political supremacy, gained control over the much larger British population (Hodges 1989; Higham 1992). Such developments were in line with similar theories on early post-Roman migrations proposed for other regions of western Europe. Namely, the scale of Late and post-Roman migrations in the (former) territories of the Roman Empire, definitely exaggerated in written sources, should be downsized to small groups who moved through and settled within numerically predominant native (and variably ‘Romanised’) populations. It was estimated, for example, that the federation of Ostrogoths, who gained control of Italy in the late 5th century, was made up by no more than 100,000 people (Heather 1991).

In the last two decades, the nature and scale of the Anglo-Saxon invasion have been analysed through genetic studies of British and other northern European populations; Continental samples were mainly chosen based on the supposed areas of origin of Anglo-Saxon migrants. The aim was to estimate the extent of introgression (i.e. the amount of individuals necessary to account for genetic similarities between the English and other samples) of Continental groups during the migration period of post-Roman Britain (Weale *et al*. 2002; Capelli *et al*. 2003). Although the results differ in terms of the geographical origins of Anglo-Saxon migrants, they all calculated a very high estimate of Continental introgression (respectively for the two studies, migrants would have contributed to 50-100% and 24-73% to the gene pool of modern English populations). Such high contributions were interpreted as the result of mass migration from the Continent. This suggestion, however, was dismissed in a following study (Thomas *et al*. 2006) which, using computer simulations, revealed that the same result of high Continental genetic contribution would be achieved if an apartheid-like society was put in place by a small group of Anglo-Saxon migrants.

In other words, British natives would have had to deal with considerable economic and legal disadvantages compared to Anglo-Saxons; this could have led, through logics of ethnic segregation and self-preservation, to differential reproductive success (obviously in favour of the Anglo-Saxons) and limited, unidirectional intermarriage (i.e. Anglo-Saxon men marrying Romano-British women). If this system stayed in place for some generations, the degree of contribution of the migrants' genetic pool would have increased considerably. This model is not only a historically and ethnographically attested strategy adopted by dominant ethnic minorities, but is also supported, directly or indirectly, by textual and archaeological evidence (Thomas *et al*. 2006). An apartheid-society model in Early Anglo-Saxon England was also suggested by Woolf (2007), on the basis of linguistic, textual and archaeological evidence; this model could have led Britons to abandon their material culture and practices and adopt those of the dominant minority, once their territory was conquered by the Anglo-Saxons. More recent studies, however, have refined the amount of genetic contribution of Anglo-Saxon migrations, estimating it to 10-40% (Leslie *et al*. 2015) and 38% (Schiffels *et al*. 2016), while highlighting a greater genetic uniformity of the modern population of England in comparison to the western regions of the British Isles (Leslie *et al*. 2015). Interestingly, genetic analyses on selected archaeological remains revealed the existence of genetically mixed Anglo-Saxon communities, including wealthy individuals of British ancestry and migrant burials with poorer gravegoods, as well as populations were integration (in terms of interbreeding) worked less well; despite the small sample size, the study shows the different forms that migration and integration could have taken, suggesting that ethnic segregation was unlikely to have been the rule in Early Anglo-Saxon England (Schiffels *et al*. 2016).

In his work *Why did the Anglo-Saxons not become more British?* Ward-Perkins (2000) adds a key component explaining the unidirectional cultural influence whereby Anglo-Saxons, differently from many of their Continental counterparts (e.g. Franks and Ostrogoths), did not adopt many cultural elements of their native subjects: this element, reiterated also by Woolf (2007), was the rapid 'de-Romanisation' of post-Roman Britain, whereby sooner and more drastically than in other territories of the former Empire, the elements typical of Romanisation (urbanisation, complex economic systems, and craft productions) were abandoned, probably ending a process that had already began during the troubled period of the 3rd-century crisis (see, for example, Reece 1980). Both Woolf (2007) and Ward-Perkins (2000) draw comparisons with the nearby Continent, finding both useful parallels and contrasting patterns to those observed for England. Where Roman economic structures and socio-political practices had endured, the incoming Barbarians soon adopted such practices and shaped their culture and economic exploitation modes largely drawing on previous models; this was the case, for example, of the Franks in Gaul and of the Ostrogoths in Italy. Where Roman military and socio-economic structures were weaker and/or had already been compromised in the troubled years of the Late Empire, the assimilation of substrate Romanised cultures would have been unfeasible and unattractive: this was the case, for example, of the Rhineland and Frisia (where the Franks themselves struggled to impose their dominance) (Woolf 2007). Drawing from more distant parallels, a combination of de-Romanisation and legal and economic disadvantage of native subjects in the Arab North Africa and Middle East would have soon led to a similar process of unidirectional acculturation. An even more drastic example, later in time but probably closer in type of assimilation to Early Anglo-Saxon England, was that of the Magyars, who settled the territory of former Pannonia (modern Hungary) as an ethnic minority in the late 9th century, and managed to impose their culture and language on their predominantly Slavic subjects. More interestingly, during the 5th and 6th centuries the Britons themselves were imposing abroad, through immigration and conquest, the same process of unidirectional acculturation which they were undergoing at home, in that part of north-west Gaul which became known as Brittany (Ward-Perkins 2000).

The lack (or weakness) of political and administrative substructures in post-Roman Britain, as well as the tribalisation and resilience of independent Romano-British polities, could also be the cause of the slower process of state formation that characterised Early Anglo-Saxon kingdoms in comparison to, for example, Merovingian Gaul. The nature of political developments in such early stages has been widely debated, and necessarily rely on theoretical models substantiated by the little archaeological and historical data currently available. The archaeological evidence for the 5th-6th centuries, in particular the absence of complex settlement structures (Hamerow 2012), including the lack of proper urban centres (Speed 2014), and of differences in funerary treatments as revealed by the excavation of cemeteries (Innes 2007), suggest Early Anglo-Saxon communities lacked strong hierarchical structures and social stratification: these were broadly equal societies, with some degree of fluidity in power structures. Rather than regional embryonic states, Early Anglo-Saxon polities would have looked like small, mobile clans, where power was exercised on people rather than territories (Scull 1993; Innes 2007). Fewer and larger polities would have emerged with time through a process of peer-competition and competitive exclusion: elements of such competition could have included warfare, but also unequal gift exchange and ostentatious display, in a similar way to the gift exchange of precious exotica lying behind the socio-economic developments of the 8th century (Moreland 2000). The rise of local leaders and regional hegemonies, and the shift from personal-level to land-based power, gradually led to the formation of more permanent kingdoms around the mid-6th-early 7th centuries (Scull 1993) (Fig. 2.6). At this time, there are several indicators pointing to increased complexity of political and social organisation. Written laws like those of Aethelbert of Kent (early 7th century) and Ine of Wessex (late 7th century) reveal the existence of intermediate governments between the king and the countryside, as well as of a ranked society, while the Tribal Hidage (a 7th or 8th century assessment of Mercian territories) indicates the ability of royal authorities to levy taxes and tributes over large regions; in all these cases, some of the terminology used suggests the formalisation of a set of rules and conditions that pre-existed the written texts (Campbell 1982b; Innes 2007). Similarly, the maintenance of large armies required for the preservation and expansion of power, implied control over large populations and the extensive use of labour force. The lavishness of certain burials from early Kent and other regions, as well as the later high-status burials from Sutton Hoo (Suffolk, late 6th-early 7th centuries) and the discovery of the ‘royal’ site at Yeavering (Northumberland, 7th century), account for such increased social stratification and political centralisation (Campbell 1982b; Carver 1998).

The fluidity and graduality of Early/Middle Anglo-Saxon state formation warns against the oversimplification of political geographies proposed by traditional historiography, most notably the so-called ‘Heptarchy’. In the world proposed by the Heptarchy, Anglo-Saxon kingdoms (seven in total) are static entities with rigidly defined borders; the concept, first introduced in the 16th century by William Lambarde under the influence of Laurence Nowell, has been influencing Anglo-Saxon historiography up to the 19th and early 20th centuries (Goffart 1997). It is now acknowledged that these borders were poorly defined and moved with changes in dominant hegemonies; sometimes new polities emerged, and others disappeared or were greatly reduced in extent and power. Written sources and, to some extent, the archaeological evidence suggest a continuous flow of power between Anglo-Saxon polities, whereby certain kings gathered enough wealth and power to influence, or even dominate over other kingdoms. The *Anglo-Saxon Chronicle* schematises such flow of power listing seven kings (the so-called *Bretwalda*) who, from the late 5th to the 7th centuries, held power over larger parts of Britain (Campbell 1982b). Since early times, the Anglo-Saxon Kingdom of Kent was one of the richest, certainly as a consequence of its proximity to the Continent and continuous contacts with the Franks (Brookes 2003). Given its location, and especially the cultural and political influence from the Merovingians, it was the first Anglo-Saxon polity to convert to Christianity, starting with the reign of king Aethelbert in the late 6th century. The Christianisation of England was a slow process with fluctuating success, prompted by Frankish, Italian and Irish missionaries, which took over a century to accomplish (Campbell 1982b; Innes 2007). Interestingly, from the early 7th century, power seems to have moved from the eastern kingdoms to the frontier states of Northumbria (which lists the last three *Bretwalda*), Mercia (in the 8th century) and Wessex (in the 9th century), reflecting the importance of conquest and raiding of British territories for the accumulation of land, resources, labour force and, ultimately, power (Campbell 1982b).

Fig. 2.6 Known kingdoms and main towns and sites of Britain in ca. AD 600 (Campbell 1982b, 52, Fig. 50).

Such initial fluidity of power and non-specialisation of economic activities are particularly important for this study: local communities would have adapted to new conditions, rather than imposing a different system of economic exploitation. Interpretation of changes, therefore, would not have to deal with the identification of two complex, contraposed economic strategies, but more directly with a development from Roman exploitation to a basic response to its demise.

Settlement patterns between the 5th and 7th centuries do reflect the political development of local, unstable polities into territorially defined kingdoms. As seen above, despite an inevitable overlap with Roman settlement distribution, there seem to be a preference in the Early Anglo-Saxon period for lighter soils: these were mainly in raised areas, providing better visibility and defence, or on river terraces, providing both defence and easy access to watercourses (see, for example, Chapter 4: Sites and materials, and Figs. 4.22-4.24 therein); after all, clayey lands required the maintenance of drainage systems, as well as more labour to work the soil (including larger and robust cattle to plough the fields) (see Chapter 7: Discussion). Dispersed villages were the norm, with neither focal points nor clear settlement 'edges'; with few exceptions, settlements were short-lived, as were the buildings within them: these were simple timber constructions, sometimes in the form of larger halls surrounded by ancillary sunken-floor huts (the so-called sunken-featured buildings – SFBs –, or *Grubenhäuser*) (Powlesland 1997; Tipper 2004; Hamerow 2012). The best examples are provided by the large-scale excavations of West Stow (Suffolk), Mucking (Essex), and West Heslerton (North Yorkshire) (West 1985a; 1985b; Hamerow 1993) (e.g. Fig. 4.6 in Chapter 4). With time, but especially from the late Early Anglo-Saxon period (mid-7th century), enclosures around buildings and parts of settlements increase in frequency, along with drainage features, causeways and watermills. The increased importance of boundaries and additional facilities suggest investments on part of the elite, possibly driven by some degree of socio-political stability (Hamerow 2012); these developments might imply a greater specialisation in agricultural production, which will intensify further since the 8th-9th centuries (McKerracher 2016; Hamerow *et al*. 2019).

The Middle Anglo-Saxon period is beyond the scope of this study, but is nonetheless important to see the continuation of a process which had already started in late Early Anglo-Saxon England: the major economic developments of this period itself gave birth to the concept of the 'long 8th century' (Moreland 2000). The settlements which survived become more stable and 'nucleated', and specialisation of production increases further: arable fields gradually increase at the expense of pastures, hay meadows reappear, the heavy plough is introduced. These developments, coupled with other archaeological and historical evidence, may even lie behind the early origins of the open/common field system, first mentioned in written sources in the 10th century AD (Oosthuizen 2007). More importantly, at the same time as differential funerary treatments suggest increased social stratification, different settlement types appear: the so-called 'productive' sites and *emporia*, the first towns of Anglo-Saxon England functioning as major market centres (Hodges 1989; Campbell 2003). Such developments were backed up by the re-introduction of coinage, as well as by long-distance trade, and kick-started a new period of the history of England (Moreland 2000; Blackburn 2003).

2.5 The historical and archaeological backgrounds in the British study-areas

2.5.1 Suffolk

The area of modern Suffolk was conquered by the Roman army in the mid-40s AD, along with the rest of south-east Britain. Despite the abundant finds of mid-1st century pottery, most Roman settlements and infrastructures seem to have been developed after the Boudican revolt (AD 60) (Moore *et al*. 1988; Warner 1996). The Romanisation of the region, which lied between the *civitates* of the Trinovantes and that of the Iceni, impacted greatly on settlement patterns, although it is believed that landscape organisation was influenced by earlier Iron Age arrangements (Warner 1996).

The settlement and exploitation of the coastal areas is evidenced by the density of sites around Ipswich (Plouviez 2017), as well as by the presence of salt extraction sites and Late Roman military forts (these latter part of the the so-called Saxon Shore (Mattingly 2006)) facing the North Sea (Good and Plouviez 2007). Suffolk lacked proper urban centres in Roman times, with *Camulodunum* (Colchester, Essex) lying close to its southern border; the road linking this latter city to *Venta Icenorum* (Caistor-by-Norwich, Norfolk) crossed the region south to north (Warner 1996). This main road was integrated by a network of secondary routes, which linked rural settlements and market centres to the denser areas of occupation further west and south (Warner 1996; Allen *et al*. 2015). New itineraries fostered the settlement of the claylands, which dominate most of the region, although settlements are also found on lighter soils, such as on the Breckland (Fig. 4.22); this is the case of Late Roman Icklingham (§ 4.5.2).

In the Early Anglo-Saxon period, the archaeological visibility of settlement in Suffolk drops significantly. Most of the evidence consists of cemeteries and isolated finds (Newman 1992). West Stow is a remarkable exception, being one of the largest Early Anglo-Saxon settlements ever excavated in Britain (West 1985a; 1985b) (§ 4.2.3; Fig. 4.6); it developed along the southern edges of the Breckland, signalling a generalised move away from the clayey lowlands and a preference for lighter soils close to river courses (Scull 1992; Hamerow 2012). Although the intensity of agricultural production in the region might have decreased, there is no evidence for substantial changes in the proportions of arable land, pastures and woodland (Rippon 2018). By the late 6th century, more solid political entities had established in Anglo-Saxon England, including the kingdom of East Anglia (Scull 1992). Only a century later, however, will a port and urban centre (*emporium*) develop at Ipswich (Newman 1992; Good and Plouviez 2007); the late Early and Middle Anglo-Saxon periods also witness the appearance of religious centres

(St Botolph's monastery, Brandon), high-status settlements and cemeteries (Rendlesham, Bloodmoor Hill, and Sutton Hoo) (Newman 1992; Carver 1998; Scull *et al*. 2016).

2.5.2 Cambridgeshire

In the Roman period, most of the territory of Cambridgeshire fell into the *civitas* of the Catavellauni, a tribe which had controlled large parts of south-eastern Britain before the invasion (Faulkner 2000). The area was significantly affected by the reorganisation of settlement and landscape which followed the Roman conquest (Browne 1977). The Ermine Street crossed the region south to north, while the *Via Devana*, linking *Camulodunum* (Colchester, Essex) to *Deva* (Chester, Cheshire) crossed Cambridgeshire south-east to north-west (Browne 1977; Allen *et al*. 2015). Urban settlements were represented by the small towns of *Durolipons* (Cambridge), *Durovigutum* (Godmanchester), and *Durobrivae* (Water Newton) (Browne 1977), this latter the site of the famous Water Newton silver hoard (Painter 1997).

Military sites were identified, such as the legionary fortress at Longthorpe, but were only in existence for brief periods in the aftermaths of the conquest (AD 43) and of the Boudican revolt (AD 60) (Frere *et al*. 1974). The rural landscape would have been densely settled in the Roman period; however, not many villae have been identified in Cambridgeshire, differently from the villa-dominated landscapes to the west and south of the region (Allen *et al*. 2015). Agricultural work on the generally heavy soils characterising most of the area benefitted from the agricultural and zootechnical innovations introduced by the Romans (Chaper 3: Zooarchaeological background) (Fig. 4.23). Pottery and ironworking industries prospered in Roman Cambridgeshire, especially in the Nene Valley region (Browne 1977; Howe *et al*. 1980); artificial watercourses and salt production sites have been identified in the Fens (Simmons 1977; Potter and Jackson 1982), attesting the economic vitality of the whole region during the Roman period.

The territory of Cambridgeshire was occupied by the Anglo-Saxons in the 5th century. The Cam Valley would have represented the border between East Anglia and the Middle Angles, these latter incorporated into Mercia in the early 7th century (Taylor 1978; Oosthuizen 1998). A study based on place-names and landscape archaeology highlighted some degree of continuity in land use between the Roman through to the Middle Anglo-Saxon periods, especially in the eastern part controlled by East Anglia (Oosthuizen 1998); in the wider region of south-east England, this is also supported by relative continuity in the proportions of arable land, pastures and woodland (Dark 1999; Rippon 2018). The continuity of occupation suggested for Orton Hall Farm and possibly Stonea might partly reflect these processes (Jackson and Potter 1996; Mackreth 1996). In the late 7th century, an abbey is founded by St Etheldreda at Ely, one of many elements signalling the onset of different socio-cultural and economic dynamics (Taylor 1978).

2.5.3 Oxfordshire

In Roman times, Oxfordshire included parts of the *civitates* of the Catavellauni, Dobunni, and Atrebates. The rural settlement pattern seems not have been radically altered in the aftermath of the invasion, displaying some degree of continuity with the Late Iron Age; in the early 2nd century, however, a widespread rearrangement of settlements might have been the result of considerable changes in land holding, including the establishment of villa estates (Henig and Booth 2000). The complex local geology and variegated soil type distribution might partly explain the diverse organisation of the landscape, with areas dominated by villas and others by scatters of smaller farmsteads (Booth 2009; Allen *et al*. 2015) (Fig. 4.24); the few palaeoenvironmental and landscape use studies are indicative of mixed agricultural and pastoral activities (Booth *et al*. 2007) which, to some extent, might have persisted in the early post-Roman period (Rippon 2018). Metalworking was practiced in the region, and there is evidence for the existence of local pottery industries (Booth 2009).

Military sites were established, but by the late 1st century they had either disappeared or been converted into civilian settlements. This is the case of the two walled small towns of Alchester and Dorchester; other nucleated settlements have been identified in the region (Booth 2009; Sauer *et al*. 1999). Transport and communication were ensured by a road network which included, among others, the Akeman Street, built in the 40s AD and running east-west from *Verulamium* (St Albans, Hertfordshire) to Alchester, and a road running south-north from *Calleva Atrebatum* (Silchester, Hampshire) to *Lactodurum* (Towcester, Northamptonshire), where it met the Watling Street (Margary 1973). In sum, despite evidence for continuity in the early Roman period and the diverse character of later occupation, the overall settlement pattern and practices of landscape exploitation seem to follow those seen elsewhere in south-eastern Roman Britain.

Already in the 5th century, the lowlands around Dorchester hosted a mixture of immigrant and indigenous communities, although elements of Anglo-Saxon material culture were rapidly adopted (Blair 1994; Hills and O'Connell 2009); British enclaves could have survived for some time in areas such as the Chiltern hills (Mileson 2011). Dorchester itself was not abandoned in the early post-Roman period, and became the centre of the Anglo-Saxon political entity of Gewisse (Hawkes 1986; Dodd 2010). Landscape exploitation probably focussed on pastoral activities, with arable farming becoming more important in the late Early and Middle Anglo-Saxon periods (Mileson 2013; Rippon 2018). A bishopric was established at Dorchester in the 630s, and in the late 7th century the Benedectine monastery of Abingdon was founded (Blair 1994; Mileson 2012). In the 8th century the area became a contested border between the kingdoms of Wessex and Mercia; at the same time, metal finds suggest an increase of commercial activities (Mileson 2012; 2013).

2.5.4 Summary

The three study-areas described above are partly characterised by local-specific historical processes and environmental variables. However, it is possible to highlight similar overall patterns of political and socio-economic developments. Their territory fell under Roman rule in the mid-1st century AD; the organisation of the landscape, human settlement and economic activities were soon affected by the needs of the Roman State, and underwent radical changes; these aimed at the maximisation of outputs, which was favoured by the functional reorganisation of settlement hierarchies, infrastructures and redistribution strategies. Such developments stayed in place until, or were even reinforced in the Late Roman period.

The early post-Roman period saw the partial demise of urban life; settlements mainly consisted of smaller and more isolated villages. In the course of the 5th century, the three regions were occupied by Anglo-Saxon migrants, who soon imposed their cultural and political dominance over the British population. Evidence for trade, large-scale industries and agricultural production diminishes; more centralised political and economic control only reappeared in the late 7th and 8th centuries.

The many similarities highlighted for the three regions in the Roman and Early Anglo-Saxon periods allowed the selection of faunal assemblages located in different areas of south-eastern Britain, but still likely to reflect general trends rather than local individualisms. The analysis of these assemblages and other published zooarchaeological data from nearby regions, therefore, is likely to highlight genuine differences in animal husbandry practices between Late Roman Britain and Early Anglo-Saxon England; this, of course, does not exclude the possibility that such changes manifested themselves in slightly different ways in different regions and settlements. At the same time, the occasional occurrence of local-specific conditions could be used to assess the role of certain environmental and human-derived variables in shaping animal exploitation strategies.

2.6 The Roman and Merovingian Lower Rhineland

The Late Antique and Early post-Roman history and archaeology of the Lower Rhineland is strictly linked to that of northern Gaul (including Roman Germany) and *Germania Libera*, both of which it was part. As a result, this section will inevitably deal with these territories, with specific references made to the Lower Rhineland where possible. However, the dearth of written sources mentioning this region between the 5th and the late 7th century, as well as the difficult interpretation of the archaeological evidence, hinder to some extent our understanding of the political and economic history of the Lower Rhineland in the Early post-Roman period (Wood 1998); for this reason, the background presented for the Merovingian period mainly refers to the wider area of northern Gaul/western Germany.

Southern Gaul was always connected with the Mediterranean world, its coast having been involved in the process of Greek colonisation. In the late 2nd century BC, south-eastern Gaul was annexed to the growing Roman Republic as the province of *Gallia Narbonensis*. In the mid-1st century BC, Julius Caesar’s campaigns resulted in the conquest of the rest of Gaul, from the Atlantic coast to the river Rhine; the natural border represented by this river became a frontier between the Roman and Barbaric worlds (Cornell and Matthews 1982; Drinkwater 1983). Despite campaigning deep into Germanic territories, the economic unviability of the region east of the Rhine, combined with the belligerence of its many tribes, influenced negatively Roman ambitions in this part of Europe (Elton 1996b). Contacts between the two sides of the border, however, existed and intensified; in fact, the flow of people and goods between Germanic territories and the Empire was promoted as part of Rome’s political strategies: a planned distribution of ‘gifts’ in the form of Roman artefacts and goods, as well as the exchange of hostages, allowed not just the establishment of a profit-based economic trade, but especially the controlled creation of political and cultural ties, which aimed at maintaining the fragmentation and instability of neighbouring tribes (Elton 1996b; Carroll 2001; Innes 2007; Galestin 2010).

Central and northern Gaul were organised into provinces and towns were established, either as new foundations or on previous settlements, the countryside being organised to meet the requirements of the Roman State (surplus production and large-scale redistribution); in a similar way to what happened in Britain one century later, the region acquired certain typically Roman socio-cultural elements which, together with radical transformations of the economy and the permanent presence of the military, contributed to the Romanisation of the provinces of Gaul (Woolf 1998; Slofstra 2002; Carroll 2003; Roymans 2004). From a cultural and economic point of view, throughout its history, Roman Gaul can be divided into three areas: the Hellenised and densely urbanised south; the vast centre and west, with its open fields characterised by heavy soils, where large-scale agriculture could develop, and a landscape with fewer cities and largely dominated by villas; and the east, a militarised zone, whose economy was largely dominated by the demand of supplies for the army (Cornell and Matthews 1982). After Caesar's campaigns, the north-eastern part of Gaul was initially part of *Gallia Belgica*. From the conquest until the times of Augustus, the frontier tribes (e.g. the Batavi, which occupied the area of the lower Rhine) were probably incorporated as client kingdoms, while since the late 1st BC the region was organised into *civitates*, similarly to the rest of Gaul; at the same time, a programme of urbanisation of frontier areas began (Wightman 1985; Slofstra 2002; e.g. Van Enckevort and Heirbaut 2015). During the 1st century AD, the Rhine as a frontier was consolidated, and later in the century a new province, *Germania Inferior* (later called *Germania Secunda*) was created. Its establishment was contemporaneous with that, further south, of *Germania Superior* (later *Germania Prima*) which, stretching to cover a territory east and north of the upper Rhine and Danube respectively, contributed together with *Germania Inferior* to the defence of Gaul (Fig. 2.7). Both provinces were heavily militarised, with a dense network of military settlements creating a fortified border known as the *limes* (Elton 1996b; Carroll 2001; van Dinter 2013). The area of the Lower Rhineland considered in this study partly lies in the area east of the Rhine, while the western part was included in *Germania Inferior*. This province was made of the territories between the Rhine and the Meuse rivers, from the Ardennes-Eifel uplands to the North Sea coast, with the inclusion of some land west of the Meuse.

The need to produce a surplus in agricultural activities and animal husbandry was particularly high in the eastern Gaulish provinces, due to the need to supply the army; the landscape was organised accordingly, and agricultural and animal exploitation were adapted to local environmental conditions (Schutz 1985). However, changes in the organisation of rural settlement differed, and two different regions can be identified within *Germania Inferior* itself. In the southern part, which included the fertile loess region, many villas (large farming estates) were established; fewer villas are found in the sandy and riverine-clayey soils of the north, where native farmsteads (mainly two-aisled wooden byre-houses) and military sites prevailed; it is likely that both a poorer soil quality and a more intensive militarisation in the north were the reasons lying behind these differences (Roymans 1996; De Clercq 2011; Habermehl 2013; van Dinter 2013; cf. Jeneson 2011).

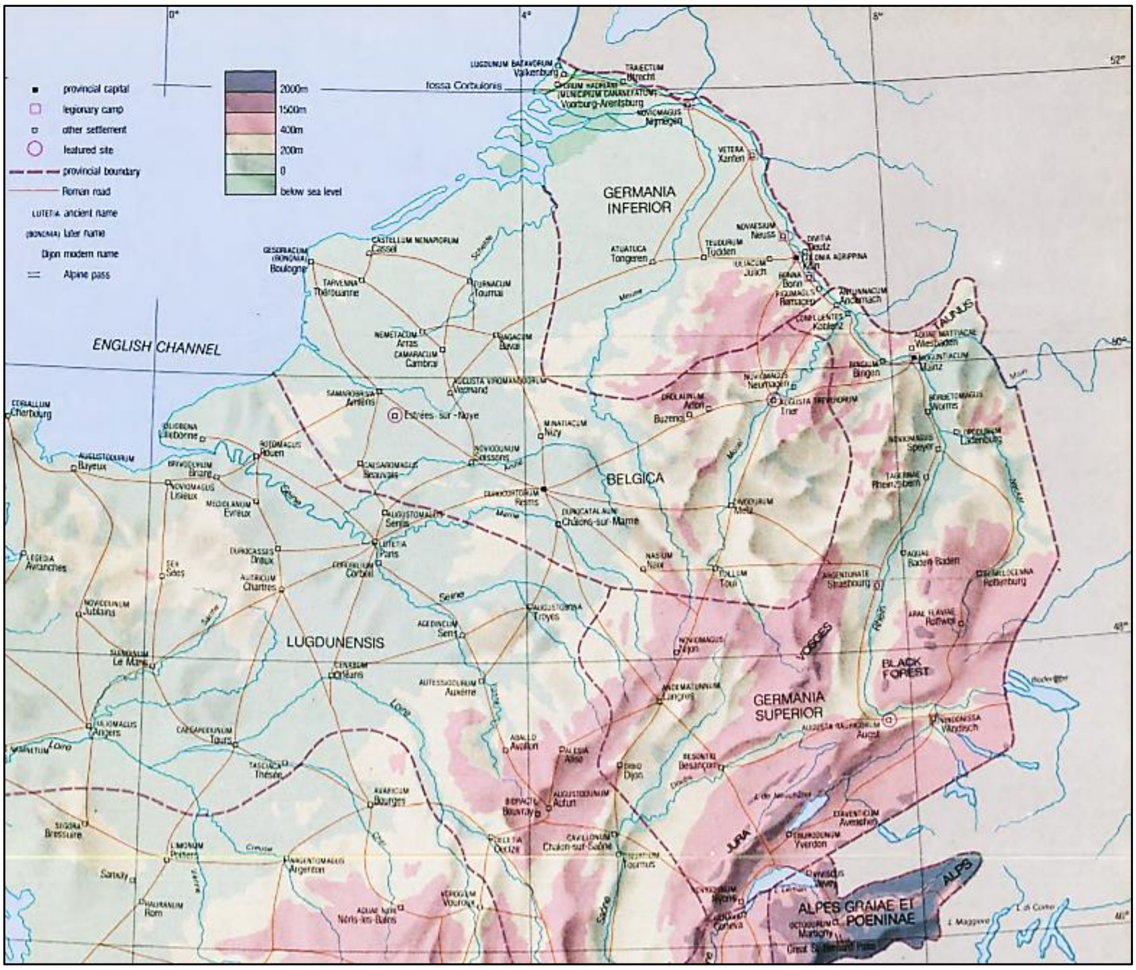


Fig. 2.7 Roman provinces in eastern Gaul (Cornell and Matthews 1982, 129).

The nature and extent of Romanisation of this frontier region also differs from that of 'inner' Gaul. The Batavians, who inhabited the Roman part of the Lower Rhineland, quickly adopted and maintained Roman cultural elements and practices; in *Gallia Belgica* and *Germania Inferior* more generally, the reorganisation of settlement and the introduction of new building types certainly contributed to this process (Habermehl 2011; Roymans 2011). However, the degree of change never matched that of the rest of Gaul, in particular as a result of the massive presence of the military (which could only partly contribute to the diffusion of Roman traditions) and of a more rural, impoverished provincial culture; local practices survived, and often political crises arose, as in the case of the Batavian revolt of AD 69-70 (Elton 1996b; Woolf 1998; Carroll 2001; Slofstra 2002; cf. Roymans 2011). The tribes that lived along the eastern bank of the Rhine were similarly influenced by Roman culture and economy. The case of the Frisii, settled north of the Rhine delta, is very well known; their political and socio-economic structures changed as a result of proximity to the border, and collapsed with the decline and fall of the Roman State (Meier 2003).

In the 3rd century AD, the economic conditions of *Germania Inferior* reflected the troubles of the ongoing politico-military crisis. In AD 260, following the defeat of invading Germanic tribes, which had destroyed most of the forts of the upper Rhine, Postumus (the governor of *Germania Inferior*), created an independent political entity, the Gallic Empire; this included Gaul, Spain and Britain. Despite the circumstances, the new administration managed to secure the borders and prevent further invasions, focusing on the reinforcement of military positions and the supply network which sustained them (Drinkwater 1983; Fanning 1992). Control over these provinces was regained in 273 by Aurelian. The political and military crisis, however, will only be terminated in 284 with the accession of Diocletian, and full control of the Lower Rhineland regained in the early 4th century (Corcoran 2000). The province experienced demographic and economic decline, with many settlements being abandoned and farming estates falling in disuse (Groenman-van Waateringe 1983; Schutz 1985; Willems 1986). In particular, near all countryside settlements in the province had been abandoned by the late 3rd-early 4th centuries AD (Heeren 2015; cf. Kropff and Van der Vin 2003). Elsewhere in Gaul, however, cities did not completely disappear, although Late Roman walls were built around an area covering only part of earlier settlements, which in some cases were reduced to mere military sites; these developments, along with the abandonment of the countryside, suggest that, with few exceptions, towns stopped acting as civilian administrative centres, their existence being only justified by the intensive presence of the military (Schutz 1985; Périn 2004; Heeren 2017, examples and references therein). Indeed, although the *Notitia Galliarum* (a 'civil appendix' to the *Notitia Dignitatum*) states that Late Roman *Germania Secunda* had two *civitates* (only the two southernmost ones surviving – Tongres and Cologne –, compared to the previous six), the northern part of the region remained intensively garrisoned up to the very end of Roman Gaul (Heeren 2017). Such presence of the military would have certainly required constant supplies in considerable quantities; whether these were provided by archaeologically unknown local rural settlements or from nearby areas, pressure on the production of surpluses would have remained very high in the region throughout the first half of the 5th century.

During the early 5th century AD, however, in most of northern Gaul, villas were abandoned; in some cases, evidence for squatter occupation has been attested, while genuine continuity of use is very rare (Schutz 1985; Percival 1992). Urban settlement, on the other hand, shows regional trends in Late Roman/Early Medieval Gaul (e.g. Sivan 1992). In general, despite the dramatic demographic decline and functional changes, urbanisation did not completely die off in Gaul as it did in Britain (Hodges 1998; Innes 2007). Certainly, the nature and scale of the relationship between town and countryside changed, and an overall pattern of decentralisation is discernible in the historical and archaeological record.

This period also witnesses the permanent establishment of Barbarian groups within the territory of the Empire, officially as allies of Rome. As early as the mid-4th century AD, for example, the abandoned areas of northern *Germania Inferior*/*Secunda* were reoccupied by Barbarian groups from the other side of the Rhine (Wallace-Hadrill 1996; Innes 2007). The typically ‘northern’ building tradition detected at their sites, consisting mainly of longhouses and sunken huts, as well as the introduction of rye cultivation, attest the ‘external’ ethnic origin of the new settlers; the hybrid Romano-Germanic nature of their material culture, also retrievable in the regions east of the Rhine before and after the collapse of the Empire, suggests these were Romanised groups of Frankish *foederati* (Heeren 2017). At the same time, however, the Roman frontier on the Rhine had always acted as an osmotic zone where provincials and Barbarians exchanged goods, interacted and absorbed each other’s traditions and identities: the impact of this new occupation and its wider implications, including on animal husbandry, therefore, should not be overestimated (Wells 1999; Carroll 2001).

The solution whereby Barbarian groups were accommodated within the Empire was often adopted since the 4th century, with the aim of absorbing and canalising inevitable invasions; the results were permanent settlement of some tribes (e.g. Alamanni, Franks, Visigoths and Burgundians), the ‘Barbarisation’ of the army, into which members of these tribes were recruited, and, at least in the West, a decreasing power of official emperors in favour of Barbarian chieftains (the case of the Vandal Stilicho has been mentioned above) (Heather 1991; Southern and Dixon 1996; Wallace-Hadrill 1996; Drinkwater 2007). In addition, in the Late

Roman Empire, politics became gradually more and more influenced by the senatorial class, large landowners, and the Church. This latter had proved a useful instrument for the survival of the Empire in the 4th century (see above); in the troubled decades of the 5th, it became identified with local resistance, through the instrumentalisation of the theological dispute between Arianism, supported by Christianised Barbarian groups, and the Trinitarianism of Augustinian theology, supported by the 'West' (Wiles 2001; Dünzl 2007). With time the Church gained more and more economic power, refined its political strategies, adapted its styles and language to that of the Empire. In the words of J. M. Wallace-Hadrill:

> "The Catholic bishops had become identified in men's minds with conservation, with continuity and with that very tradition of *Romanitas* that their predecessors had threatened." (Wallace-Hadrill 1996, 30)

In Gaul, as in the rest of the territories of the former Western Empire, the Church will play a key role in politics, state formation, and changes in settlement patterns and economic activities. It is not insignificant, in terms of political strategies, that the Franks converted directly from paganism to Catholicism, skipping the transition through Arianism that all other tribes went through (Wallace-Hadrill 1996).

Between 406 and 439, a series of invasions seriously undermined the stability of Gaul (Elton 1992). Such unstable political and military conditions favoured again the rise of local usurpers; shortly after the failure of Constantine III (see above), Jovinus briefly ruled over Gaul, although *de facto* under the control of settled Burgundians and Alans (Fanning 1992). At the same time, failing economic expectations and disruptions resulted in widespread peasant revolts, which, in written sources, went under the name of *Bacaudae* (Drinkwater 1992). Despite these events, between 439 and the arrival of the Huns in 451, the army managed to contain further invasions from the east, suggesting the survival of an articulated supply network relying on agricultural surpluses. Following the defeat of the Huns at the hand of Valentinian III and his general Aetius, the second half of the century sees a gradual, but constant decline of Roman authority in the region, again marked by the rise of local usurpers. After the death of Majorian in 461, control was mainly in the hands of local authorities and Barbarian tribes. Count Paul (probably a Roman commander) fought a Visigoth army on the Loire, while the *magister militum* of Gaul, Aegidius, refused to recognise Libius Severus as the new emperor. Rather than claiming the title for himself, he (with his son Syagrius) established a new ‘Roman’ political entity in northern Gaul, with the capital in Soissons; despite commanding a large part of the army, the political and social divisions within the kingdom will allow the Franks to gradually absorb it (Elton 1992; Fanning 1992). Within half a century the situation in Gaul had passed from relative stability to complete disaster, such contrast being evident in historical sources dated to both ends of the period (Muhlberger 1992). By the late 460s Gaul was lost; a last, unsuccessful attempt to regain part of the region was made in 471 by emperor Anthemius. In 475, Julius Nepos officially gave up Gaul (Elton 1992) (Fig. 2.8). The cultural and economic divisions schematised for Early Roman Gaul by Cornell and Matthews (1982) reappeared after the collapse of Roman authority, highlighting a strong regionalism which will impact on future developments (Elton 1992; Van Dam 1992).

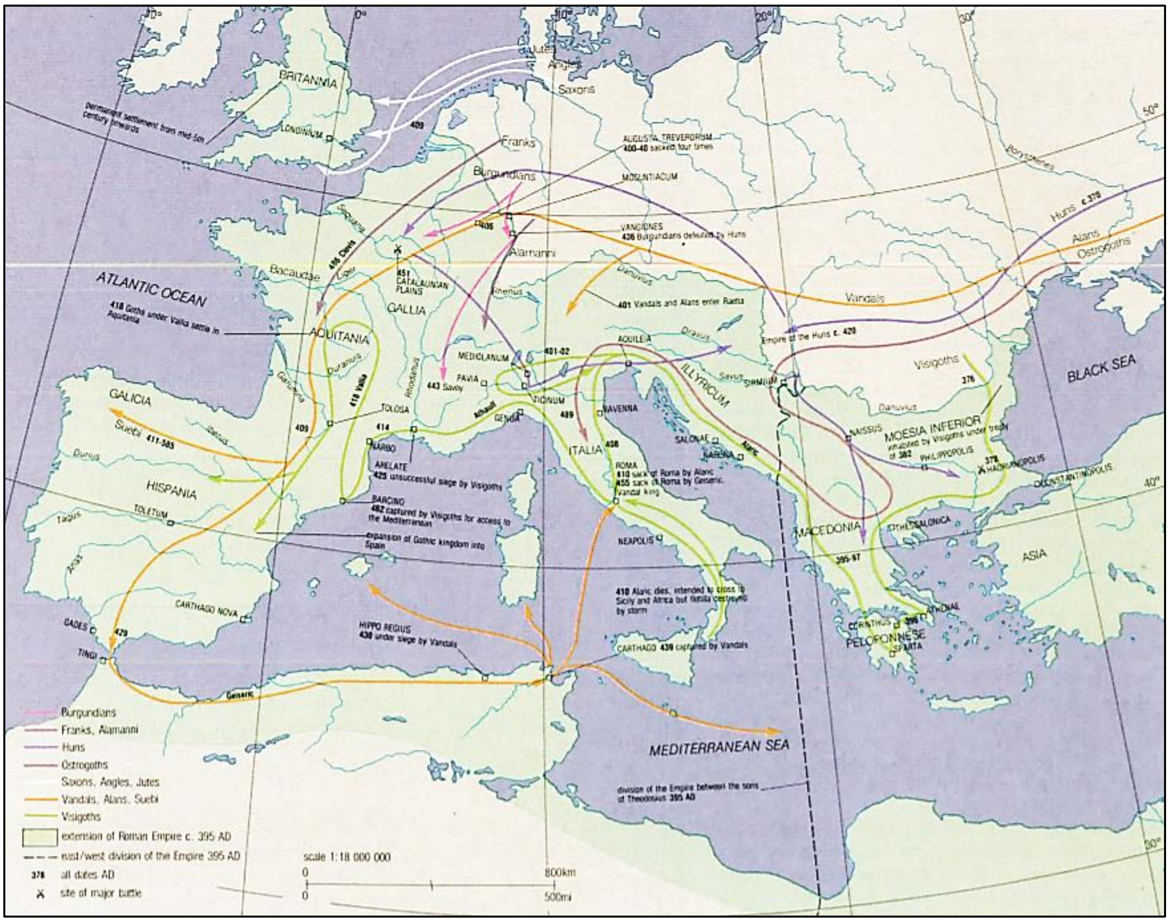


Fig. 2.8 Barbarian routes of migration and settlement at the end of the Roman Empire (Cornell and Matthews 1982, 209).

The tribe which successfully managed to settle and prosper in northern Gaul, and then to expand in the rest of the region, was that of the Salian Franks. Traditional historiography distinguishes them from the Ripuarian Franks, who originated from the Middle Rhineland and then extended their territory into the area of Cologne (modern central-western Germany); in the late 5th century, they defeated the Alamanni together with the Salian Franks, into which they merged soon after (Wallace-Hadrill 1996). The Salian Franks, instead, originated from the eastern part of Lower Rhineland, and in the mid-4th century came to settle west in the former province of *Belgica Secunda*. The earliest prominent figure of their kingdom was Clovis/Chlodovech I, a member of the Merovingian dynasty. In the late 5th and early 6th century he expanded his territory, which came to be known as Francia, in every direction: he subdued the Alamanni, absorbed the Ripuarian Franks, defeated Syagrius and annexed his kingdom in northern Gaul, and defeated the Visigoths in Aquitaine (Fig. 2.9). Once the Alamanni were removed, he entered in direct contact with the Ostrogoths. As tensions arose with their king Theodoric, Clovis got closer to the enemy of the Ostrogoths: the Byzantines in the east, and the Catholic hierarchy living within the (Arian) kingdom itself; by doing so, the Franks entered Mediterranean politics, something which, together with their conversion to Catholicism, proved very advantageous in the following centuries (Wood 1994; Wallace-Hadrill 1996; Drinkwater 2007).

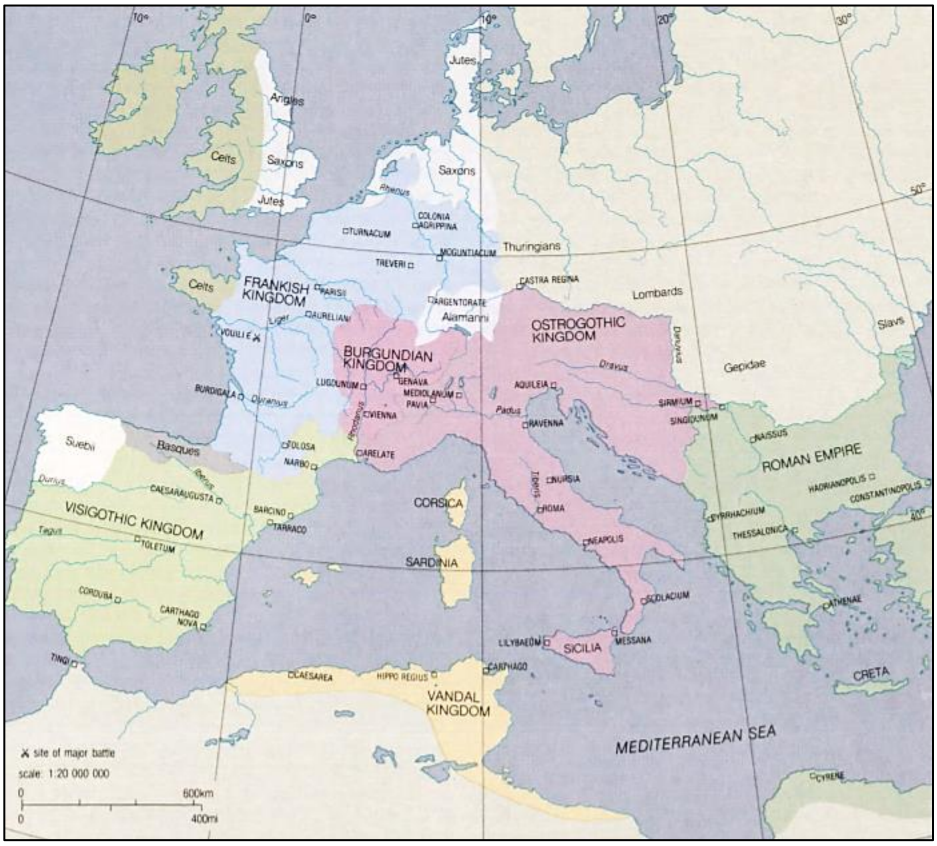


Fig. 2.9 Barbarian kingdoms in western Europe in AD 526 (Cornell and Matthews 1982, 214).

As was customary in the Merovingian dynasty, after Clovis' death (AD 511), the kingdom was divided among his sons. Although the territory of the Franks kept expanding during the 6th and 7th centuries, most importantly with the conquest of Burgundy, divisions and contrasts often resulted in long periods of civil war. Slowly but inexorably, the Merovingian dynasty entered a process of political decline and apathy. In this period, the Mayors of the Palace, formally appointed by the king to superintend administrative activities, gradually increased their roles and powers, often ruling almost independently whole regions of Francia. In 687 Pepin II of Herstal, Mayor of the Palace of Austrasia, defeated the Neustrians, unifying the kingdom and defining the central role of Austrasia and its Mayors. His grandson, Pepin III the Short, removed the last Merovingian king in 751, proclaiming himself king of the Franks and initiating the Carolingian dynasty (Wallace-Hadrill 1996; Wood 1998; Innes 2007).

Between the 5th and 7th centuries, the Merovingians relied on a diverse range of sources to sustain the state's administration as well as military campaigns. The political and economic policies of the Franks, like those of most tribes occupying territories on the former Roman Empire in the Continent, differed to some extent from that of Early Anglo-Saxon England. Here, the various tribes that migrated into the Western Empire at the very end of its existence settled relatively quickly in large regions, despite movements and re-settlements occurred as new tribes moved into former provinces, and/or as a result of warfare among existing groups (Wallace-Hadrill 1996; Innes 2007). Relatively quick conquests were followed by adaptation to local (Romanised) tenurial practices: having found a still functioning farming system, this could be exploited; soon enough, tax revenues could also be levied. Other sources of income were raiding, tributes from client tribes (until the early 7th century, Saxons had to deliver to the Franks 500 cattle every year), and the occasional subsidies from Byzantium (Wallace-Hadrill 1996; Wood 1998). Although the rudimentary taxation system of the Franks had to be supplemented in this way, the early Merovingians enjoyed relatively solid financial conditions, supported by coinage since the times of Clovis. Medium- and long-distance trade resumed soon as well, as proved by the recovery of goods from the Levant and other regions of the Mediterranean. In the very north, in a region partly overlapping with the Lower Rhineland, the Frisians developed a wool industry and sea-borne/Rhine-routed commerce, which soon attracted the interests of the Franks. The region of the Rhine estuary was only secured in the early 7th century by Dagobert I, the last ‘great’ Merovingian king, and silver coin-hoards testify intensive trade involving merchants from Gaul, England, and Scandinavia. At around the same time, market fairs became established, such as that of Saint Denis (near Paris), gradually transforming the way goods were produced and distributed (Wallace-Hadrill 1996; Innes 2007). Almost contemporaneously to developments in England, settlement, economic production and trade underwent a process of centralisation. Many of the sparse, small settlements of the Merovingian period disappeared, and larger ones were founded or expanded (including the *emporia* at Dorestad, Walichrum and Quentovic) (Wood 1994; Moreland 2000), marking the beginning of a new political and socio-economic era in this part of Europe.

CHAPTER 3

Zooarchaeological background

This chapter briefly summarises the current state-of-the-art of Roman and Early Anglo-Saxon/Merovingian zooarchaeological knowledge in Britain and the Lower Rhineland; it is not intended to represent an exhaustive review of all zooarchaeological works in these areas but rather, it serves as a baseline for the results presented in Chapter 6. The available evidence is presented separately for the two study-regions (i.e. Britain and the Lower Rhineland); however, references to each other are made to highlight similarities and differences in animal use.

3.1 Animal husbandry in Roman Britain and Early Anglo-Saxon England

Since the 1970s, the zooarchaeology of Roman Britain has benefitted from a large number of dedicated studies, and it has now become a well-developed field of research. It has grown side-by-side with other lines of archaeological research on this period, such as archaeobotany and landscape archaeology, which, together, have contributed to a better understanding of the Roman economy in this part of Europe.

As zooarchaeological studies developed, it was possible to identify some typical traits of Roman husbandry practices in Britain, as well as the reasons behind the patterns of change from Iron Age models of food production (King 1978; 1984; 1999; Grant 1989; 2004; Maltby 2016; Albarella in press). During Roman times, cattle replaced sheep as the most frequent of the three main domesticates (cattle, sheep, and pig); economic, social, and cultural variables could have all played a role in such change (Luff 1982; Hambleton 1999; Grant 2004; Albarella 2007; King 2015a; 2015b; Maltby 2016; Albarella in press) (Fig. 3.1).

Such large number of cattle in Roman times could have been used in agricultural works to contribute to the sustainment of large-scale, specialised food production practices, needed in order to feed a much larger group of consumers (most notably, the army units stationed in the island, as well as urban communities); at the same time, intensive agricultural production allowed the creation of surpluses, required to feed the Roman taxation cycle (§ 2.2).

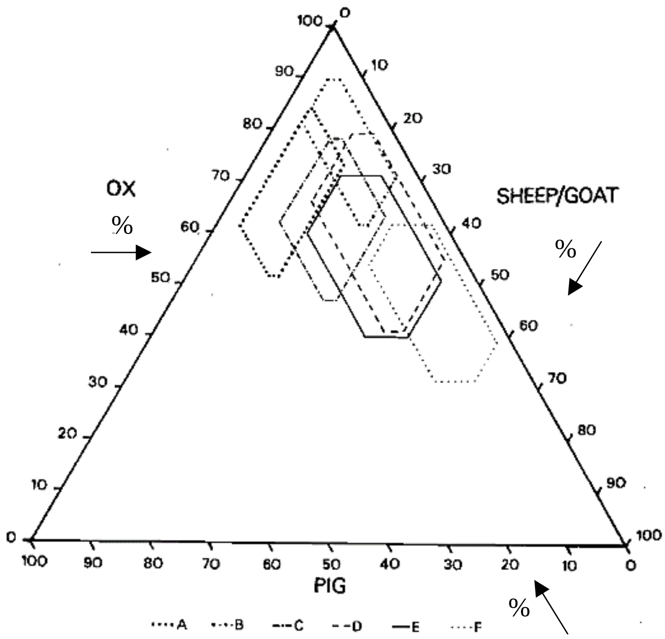


Fig. 3.1 Ternary plot for the NISP frequencies of cattle, caprines, and suids in Roman Britain. Each polygon represents one standard deviation around the mean percentage of each group. All polygons tend to plot towards the top of the triangle, indicating a higher incidence of cattle. A: legionary sites; B: auxiliary sites; C: *coloniae* and Romanised towns; D: *vici* and Romanised settlements; E: *villae*; F: un-Romanised settlements (adapted from King 1984, 3, Fig. 1).

The less specialised pastoralism of the Late Iron Age, therefore, was replaced by a different mode of exploitation of natural resources, and it only persisted in the more marginal territories of Roman Britain (Maltby 1981; Aniceti and Rizzetto in prep.). The main areas of Roman settlement, and those which underwent a more successful process of 'Romanisation', were the clayey lowlands of south-east and central England, rather than the hilly, less fertile, and peripheral regions of the west and north (Evans 1990; Hammon 2011; Allen *et al*. 2015) (§ 2.2); as cattle are well suited for exploitation in the lowlands, this environmental variable certainly favoured their increased use in these areas (Grant 1989; Duval and Albarella sub.). The sites chosen for this study are indeed located in the predominantly clayey lowlands of central England; this allowed to rule out one environmental variable which might have influenced developments in animal husbandry practices (§ 4.6, Figs. 4.22-4.24).

Another advantage of rearing large number of cattle was that, once unserviceable in the fields, their carcasses could provide large amounts of meat, which the well-organised butchery practices and redistribution networks of Roman times made possible and viable. Culling profiles, indicating that most animals survived into late adulthood, as well as clear evidence for a size and robustness improvement of cattle, support the hypotheses presented above (Maltby 1981; 2010; Luff 1993; Grant 2004; Albarella *et al*. 2008; Albarella in press).

A preference for beef, however, could have also been promoted by the soldiers stationed in Britain, most of which originated from eastern Gaul and the Lower Rhineland. In these regions, cattle is the most frequent taxon in the Late Iron Age, Roman, and post-Roman periods alike, suggesting that this indigenous cultural preference for beef could have contributed to the spread of cattle husbandry in the north-western provinces of the Empire (King 2015b). The butchery evidence highlights the importance of such cultural influence from the military on local dietary practices. Specialised beef products were intensively produced and exploited in Roman Britain, and aimed at a full exploitation of animal carcasses: cattle (and, to a lesser extent, other animal) bones were intensively butchered, meat being regularly scraped off the bones; long bones were split or otherwise chopped in small pieces to extract the marrow, a valuable and versatile resource in the past; horn sheaths were often removed to be shaped into objects, and surplus meat salt-cured for storage (Maltby 1989; Dobney *et al*. 1996; Grant 2004; Seetah 2006; Maltby 2007). Most of these practices are not detected in Late Iron Age British sites, nor in early post-Roman assemblages from the island. On the Continent, they are frequently recorded in the area ranging from the Lower Rhineland to the north-western Alps; here, however, these practices are very common in Roman and Germanic sites alike, and are still found in early post-Roman assemblages. One of the most common examples of 'Roman' butchery practices is the production of cured beef shoulders, the remains of which are found in large numbers in Romano-British assemblages; such remains are also often recovered from Roman and Germanic sites on the Continent, where they are common during the pre-Roman Iron Age as well (Schmid 1972; van Mensch and IJzereef 1977; van Mensch 1979; Lauwerier 1988; O'Connor 1988; Dobney *et al*. 1996; Maltby 2007; Score *et al*. 2010; Johnstone and Albarella 2015) (Fig. 3.2). It is likely, therefore, that such practices originated on the European mainland before the Roman conquest; they met the supply needs of the army and other provincial consumers (Stallibrass and Thomas 2008; Stallibrass 2009), to a point that they were widely adopted in Roman military and civilian contexts, and quickly spread from the Continent into Britain.

Fig. 3.2 Cattle scapulae from the Roman site of Heybridge, Essex. The hook marks on the blade suggest the shoulder was hanged, presumably during the process of smoking and/or for storage; scale: 5 cm (Johnstone and Albarella 2015, Fig. 599).

Other domesticates played a secondary role. Caprines, almost exclusively represented by sheep, are often the second most-represented taxon (King 2015a; Maltby 2010). Their exploitation did not usually focus on specific products; however, their size was improved in some cases, and such improvement was most likely meat-driven (Luff 1993; Maltby 2001; 2010; Grant 2004; Albarella *et al*. 2008). While pork was by far the favourite meat in Imperial Roman Italy, pigs are far less common on Romano-British sites (King 2015a; Grant 2004; Maltby 2010). This and other inconsistencies in animal exploitation between Roman Britain and the core of the Empire contribute to define the meaning and consequences of the 'Romanisation' of Britain: as highlighted by other lines of archaeological research on the topic, the conquest did not imply the imposition of standard sets of cultural traditions and economic models; change did happen, as evidenced by zooarchaeological data, but was adapted to local socio-cultural, economic, and environmental conditions. In addition, the pattern and extent of change varied within Roman Britain itself. The south-east and centre-east of the island were more influenced by the 'Romanisation' of animal husbandry, due to being closer to the Continent and largely dominated by fertile lowlands, where agricultural production could more easily be intensified. In the western and northern regions, Late Iron Age modes of animal exploitation survived through the Roman period, and were only marginally affected by change: sheep often continue to play a more important role than cattle, and size improvement did not occur, occurred later, or less successfully (King 2015a; Hammon 2005; Duval and Albarella sub.; Aniceti and Rizzetto in prep.) (see below).

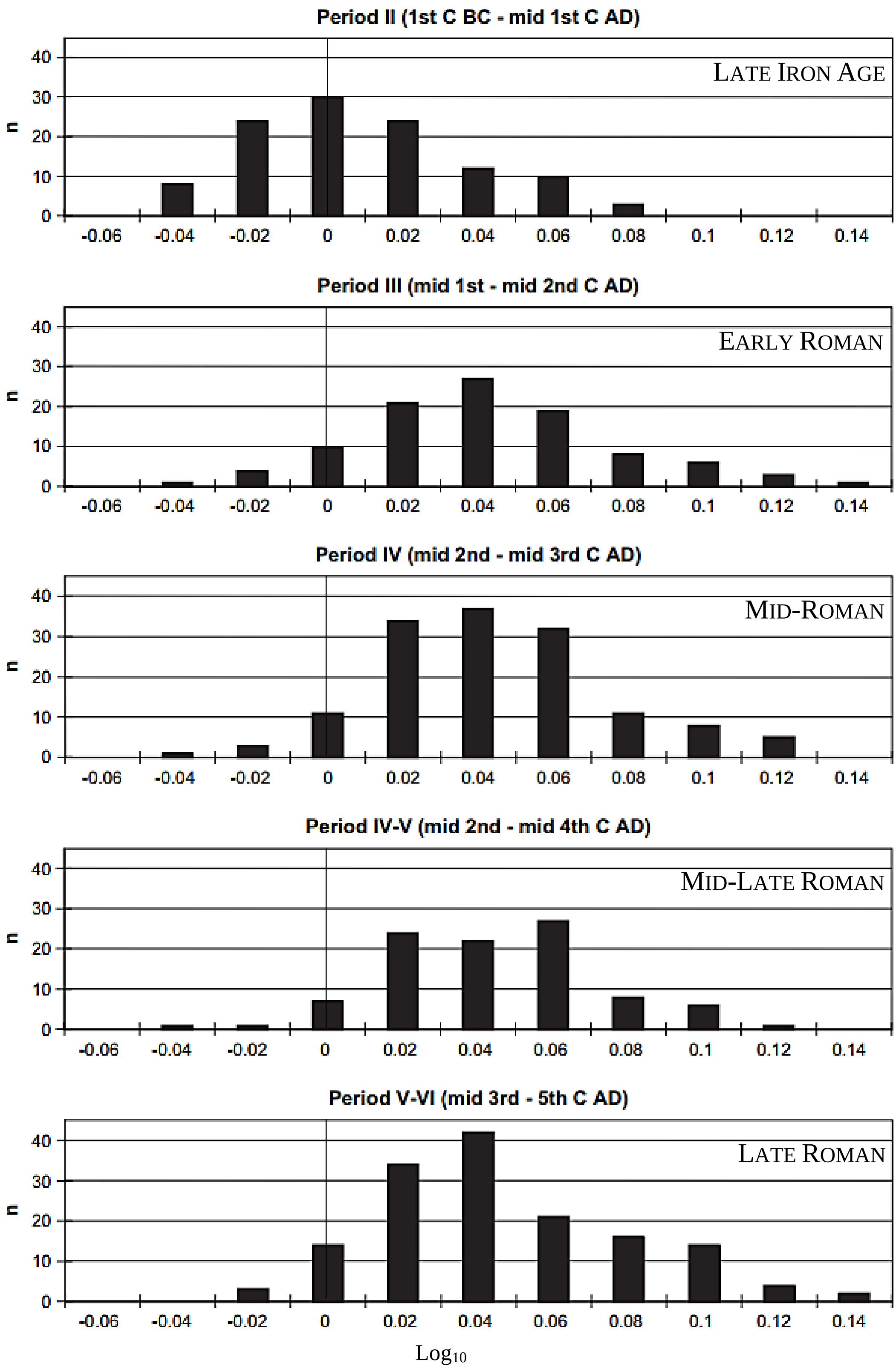
Horses were only common in roadside settlements; they played a major role in the army, and were very rarely consumed (Hyland 1990; Johnstone 2004; Wright *et al*. 2019). Their size was likely improved during the Roman period (Luff 1982; Albarella *et al*. 2008). Mules and donkeys have been occasionally recorded, but they remain very rare in the archaeological record of Roman Britain (Johnstone 2010). Chicken had been introduced to Britain during the Iron Age, but remained rare in this period and was mainly used in religious contexts and for display; it became much more common in Roman times, when it was regularly reared as a complementary source of animal proteins, and its size improved (Benecke 1993; Luff 1993; Parker 1988; Albarella *et al*. 2008; Yalden and Albarella 2009; Sykes 2012).

Differences occurred also between different site types within the same region, as settlements were reorganised hierarchically, with urban sites serviced by the surrounding countryside, and functionally, with a sharper distinction between producers (villages, *villae*, etc.) and consumers (military forts, urban centres). While cattle dominate at most sites, sheep is better represented in un-Romanised settlements, and remains the second most important domesticate in most *villae*, Romanised countryside settlements, and auxiliary (military low-status) sites; pig, on the other hand, is slightly better represented in towns and, especially, legionary (military high-status) sites, while in general variability in the frequency of the three main taxa seems higher in urban settlements (King 2015a; 2015b; Maltby 2010).

Similarly, chronological and regional studies on livestock morphometry in different regions and site types highlighted the complex dynamics and patterns of animal management which characterised Roman Britain (Maltby 1981; Albarella 2007; Albarella *et al.* 2008; Aniceti and Rizzetto in prep.; Duval and Albarella sub.). A first increase in cattle size occurred in the southern part of Britain during the Late Iron Age; such change in size has been interpreted as a result of increased economic and cultural influence from the Continent (Cunliffe 1991; Luff 1999; Valenzuela-Lamas *et al*. in prep.; Duval and Albarella sub.). A major improvement of domesticates, and in particular cattle, started with the arrival of the Romans in AD 43; it mainly impacted on the south-eastern part of the island (Figs. 3.3 and 3.4). Only in the Middle Roman period, the size of cattle from the Midlands and nearby regions was considerably improved. At the end of the process, cattle from the west and north of Britain, the largest during the Iron Age, had not been improved as much as animals from the other regions, and ended up being the smallest of Late Roman Britain (Maltby 1981; 2010; Albarella *et al*. 2008; Duval and Albarella sub.). The Late Roman-Early post-Roman assemblage from Wroxeter is a well-known example: although (mainly adult) cattle prevail in all phases, the size of this animal was never improved; consequently, cattle size did not decrease after the demise of Roman rule in the region (Hammon 2005; 2011). Similar regional differences apply to sheep as well (Maltby 2010; Aniceti and Rizzetto in prep.).

While such regionalism in the improvement of the main domesticates brought about an increase in size diversity throughout the island, differences can also be noticed between different settlement types (Duval and Albarella sub.). Animal improvements would have first been developed in rural sites from the south-east, located close to the coast and embedded in the functional settlement network which linked the countryside to urban and military sites (Grant 2004; Albarella 2020). The improvement of local stock, through better animal management (feeding, stalling facilities etc.) and selective breeding, was most likely favoured by the import of larger animals from the Continent (Albarella *et al*. 2008). Cattle was the first domesticate to be improved, as the development of more intensive agricultural practices would have immediately benefitted from the use of larger and more robust cattle for ploughing the fields; the size improvement of sheep, pig, horse, and chicken was not as pronounced, and occurred at a later stage (Grant 1989; 2004). Herds of local unimproved or less improved animals continued to exist, and were equally exploited to supply consumer settlements; towns, such as in the case-study of Colchester, were supplied with both improved and unimproved animals, and therefore often present a mixed pattern where improvement appears more gradually (Albarella *et al*. 2008) (Figs. 3.3 and 3.4). With similar patterns and distinctions between producer and predominantly consumer sites, improvement techniques gradually spread from the south-east and were adopted, to different extents, in other parts of the province. Animal mobility, therefore, is likely to have been greater than in the Late Iron Age, with domesticates being moved through longer distances; stable isotope analyses on cattle remains seem to support this hypothesis (Stallibrass and Thomas 2008; Minniti *et al*. 2014; Madgwick *et al*. 2019; Rizzetto *et al*. in prep.). Similarly, the trade of animal products has been attested, such as in the case of cured beef shoulders (above), and of salted pork products (Maltby 2006).

Differences between settlement types impacted on the process of selection of the assemblages to include in this study; as the aim is to highlight and interpret differences in animal husbandry between the Late Roman and Early Anglo-Saxon periods, it was decided to select assemblages deriving from rural (productive) sites, where the characters of Roman husbandry practices should potentially appear more clearly.



Period II (1st C BC - mid 1st C AD)

Period III (mid 1st - mid 2nd C AD)

Period IV (mid 2nd - mid 3rd C AD)

Period IV-V (mid 2nd - mid 4th C AD)

Period V-VI (mid 3rd - 5th C AD)

Fig. 3.3 Distribution of log ratio values of a selection of cattle bone widths from the Roman site of Heybridge, Essex. The mean measurements of cattle bones from the Late Iron Age phase were chosen as the standard in this study (adapted from Albarella *et al*. 2008, 1832, Fig. 2).

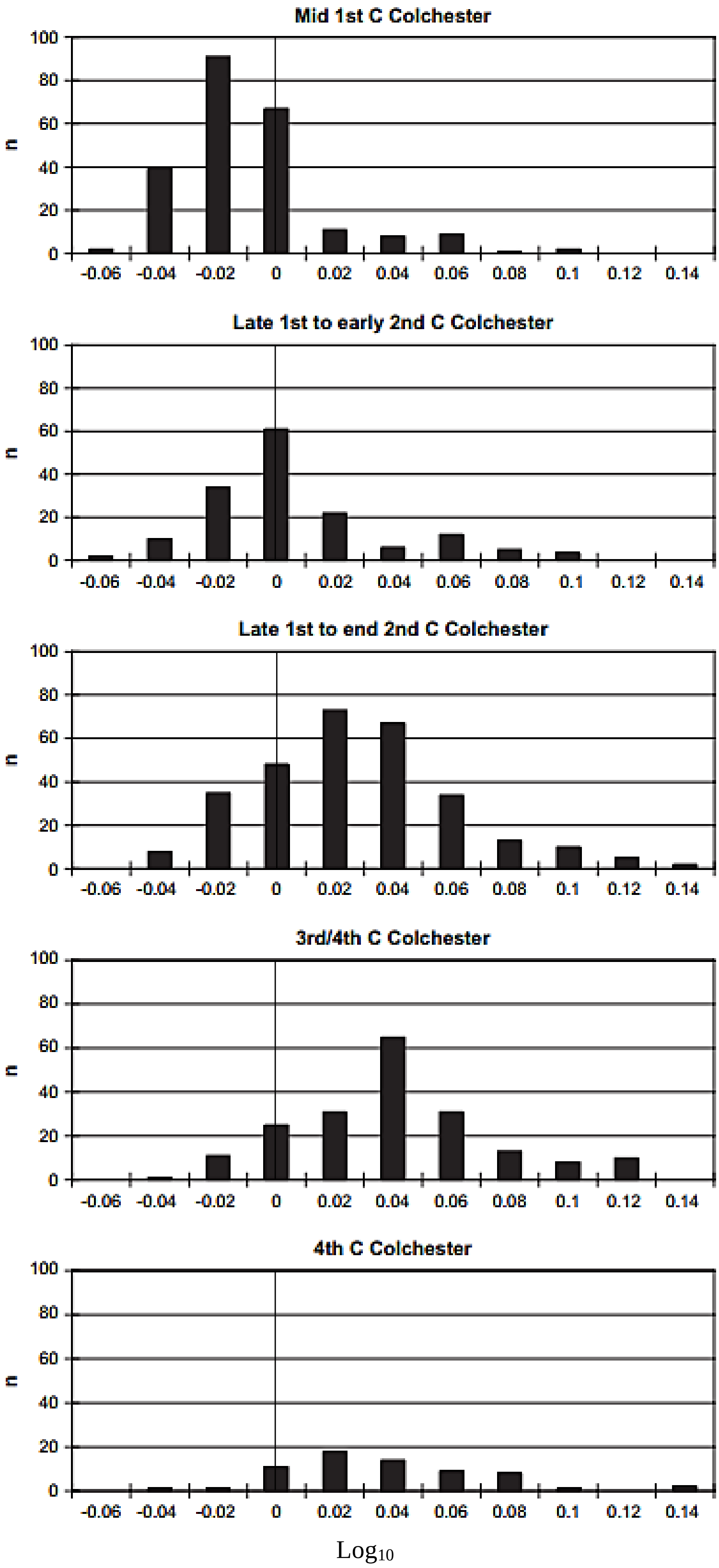


Fig. 3.4 Distribution of log ratio values of a selection of cattle bone widths from the Roman town of Colchester, Essex. The mean measurements of cattle bones from the Late Iron Age phase at Heybridge were chosen as the standard in this study (adapted from Albarella *et al*. 2008, 1835, Fig. 4).

The end of Roman rule over Britain brought about the collapse of the settlement networks it underpinned, as well as an overall rearrangement of economic activities. Most towns disappeared, population declined, and within a few decades the only settlements were small, self-sustained rural villages with post-built huts and rudimental infrastructure (§ 2.3 and 2.4). These new demographic and settlement patterns imply a decrease in the amount and visibility of archaeological contexts dated to the Early Anglo-Saxon period; inevitably, this negatively impacted on the development of archaeological, including zooarchaeological, research on early post-Roman Britain.

One of the first pioneering works on animal use in Early Anglo-Saxon times was the study of the remarkably large assemblage from West Stow, in Suffolk, by Crabtree (1989; 1990). Unlike Late Roman assemblages in the region, the material from West Stow, dated to the 5th to 7th centuries AD, was dominated by sheep. Kill-off patterns for cattle and sheep indicated a more generalised exploitation of these animals, while body part distributions and butchery patterns suggested a less specialised, occasional processing of carcasses which occurred on site. Pig was much better represented in the first subphase, possibly because it was used as a reliable and fast-growing source of meat during initial settlement. Comparing this evidence with nearby Late Roman Icklingham, Crabtree (1991; 2014; also Clutton-Brock 1976) interpreted the remains from West Stow as those typical of a producer-and-consumer self-sufficient community which engaged in small-scale, mixed-farming animal husbandry practices.

Commenting on the evidence from this and other sites, more recent studies suggested a widespread shift to more generalised husbandry practices in Early Anglo-Saxon England, with a high degree of inter-site variability indicating that strictly local economic restraints, traditions, and environmental conditions were determining the characters of animal exploitation (Holmes 2014a; 2016; 2017; O'Connor 2011; 2014; Albarella in press). The kill-off patterns of cattle and sheep reveal higher peaks of juveniles; such results not only support a more generalised exploitation of these animals, but were also interpreted as the culling of excess calves and lambs before their first winter, when poorer animal management strategies and lack of resources would have forced a reduction in the size of herds and flocks (Crabtree 2012; O'Connor 2014).

Despite evidence for a change in the scale and aims of animal economies in the Early Anglo-Saxon period, some aspects of continuity with Roman animal husbandry practices have been highlighted by Crabtree (1991; 2014) and in recent reviews by Holmes (2014a; 2014b; 2017) and Rizzetto *et al*. (2017). These studies, which rely on evidence from a larger number of assemblages, broadly confirm the trend towards a more generalised animal exploitation. However, some Early Anglo-Saxon sites still display a high incidence of cattle, especially in those rare cases of continuity of occupation from Roman times (Holmes 2014a; 2014b).

Biometrical data have also been used to suggest some degree of continuity. While cattle and sheep from West Stow were found to be slightly smaller than animals from nearby Late Roman Icklingham, they remained much larger than specimens from the Iron Age phase of West Stow; the persistence of large cattle and sheep at Early Anglo-Saxon West Stow, and an average size standing in between Iron Age and Late Roman values, were interpreted as a successful attempt, on the part of the West Stow post-Roman herders, to maintain some of the improvements of Roman times (Crabtree 1991). This suggestion was one of the first ones to 'soften' the dominant ideas of the collapse of economic activities after the end of Roman rule in Britain (§ 2.3).

Supporting this position, the evidence from archaeobotanical studies highlighted a continuity from Iron Age and Roman times in the predominant production of spelt, which will only be replaced by rye in the Middle Saxon period (ca. late 7th-mid-9th centuries AD) (Murphy 1985; Crabtree 2014). A recent review on biometrical changes in Anglo-Saxon England also presents some elements of continuity, and provides additional information on when and where change took place (Holmes 2014b; Rizzetto *et al*. 2017). In Early Anglo-Saxon times, cattle were larger in southern England compared to other regions; the largest sheep were found in East Anglia, while the higher degree of inter-site variability in the average size of sheep suggested the presence of different breeds throughout Early Anglo-Saxon England. Different explanations have been provided for the larger size of sheep from East Anglia, including a higher incidence of males (wethers), or even the possibility of introduction of larger animals from the Anglo-Saxons' homeland (approximately current north-western Germany and Denmark), where large sheep occurred (Audoin-Rouzeau 1991; Holmes 2014b). However, the presence (though not predominance) of large cattle and sheep from Early Anglo-Saxon West Stow was also seen as the survival and maintenance of large stock from Roman times, hence underlining some degree of continuity in post-Roman animal management (Holmes 2014b). The comprehensive review by Duval and Albarella (sub.), on the other hand, highlights a generalised decrease in the heights of cattle between the Roman and the Early Anglo-Saxon period, providing evidence for discontinuity in the management of this domesticate in early post-Roman Britain.

3.2 Animal husbandry in the Roman and Merovingian Lower Rhineland

Animal husbandry practices in the Roman Lower Rhineland developed similar characters to those observed in Roman Britain. Change from Late Iron Age animal exploitation patterns, however, was much less pronounced, and the Roman conquest only brought about some adjustments to previous practices, which aimed to optimise food production and its redistribution within a heavily militarised province (van Dijk and Groot 2013; Groot 2016). During the Late Iron Age, cattle was already the most represented of the three main domesticates, with frequencies ranging between 50 and 75%, while sheep came second; most cattle survived into adulthood, suggesting a focus on their use for traction and manure (van Dijk and Groot 2013; van Dijk 2016).

Two comprehensive reviews on the Dutch River Area highlight the key features of Roman animal husbandry in the region (Lauwerier 1988; Groot 2016), and are supplemented by other research works on the topic (Lauwerier 1986; 2009; Groot 2008a; 2008b; 2017; Groot *et al*. 2009; Vossen and Groot 2009). Cattle remained the most represented domesticate; sheep was also well represented in the Early Roman period. The incidence of cattle and horse increased in the Middle Roman period, mainly at the expense of sheep. In the Late Roman period, cattle frequencies increase only slightly, while pig experienced a stronger increase; this, coupled with a slight increase of wild game, could reflect a higher forest coverage in the Late Roman period, following the political and economic crisis of the 3rd century AD and partial abandonment of the region, and/or the need to supplement products from a less efficient farming system (Lauwerier 1988; Groot 2016). The incidence of cattle was particularly high in military and especially urban sites, most notably Nijmegen (*Ulpia Noviomagus*, the capital town of the *Civitas Batavorum*) (Lauwerier 1988; 2009), where the prevalence of meat-bearing elements suggests the introduction of processed carcasses (Stallibrass and Thomas 2008; Groot 2016). Higher frequencies of sheep are found in rural sites, while pig was more abundant in military sites, where it was probably supplied from the countryside; the neat predominance of meat-bearing elements from this taxon in military sites supports this hypothesis. Two military-urban sites from Nijmegen present a particularly high incidence of pig (Groot 2016), possibly reflecting patterns similar to those seen in British high-status military sites; the same assemblages included a high incidence of younger cattle, indicating the consumption of better-quality meat. Within *Germania Inferior*, the Dutch River Area (north-west) presented much higher frequencies of cattle (close to 70%) than the south-east (about 45%) (Groot 2017).

Already in the Iron Age, cattle were being mainly exploited for their traction force (van Dijk and Groot 2013; van Dijk 2016). This pattern becomes more evident during the Roman period, with an increasing number of animals surviving into late adulthood (Groot 2008a; 2016) and some with pathological conditions indicative of exploitation in agricultural works (Groot 2005a). Variations among sites and areas did occur: assemblages from rural sites present a higher incidence of young cattle, while old animals prevail in urban and military sites; although the prevalence of old cattle applies to the whole of *Germania Inferior*, higher numbers of older cattle and sheep were found in the south-east (Groot 2017), with some sites in the north-west displaying a stronger focus on meat production (Groot 2016). In general, sheep was raised for meat from the Iron Age to the Early Roman period, with a shift towards the keeping of older animals (wool) from the Middle Roman period. Horse meat was consumed in Roman times, but most animals were kept until old, being used for transport and often supplied to the army (Groot 2016).

Since the Early Roman period, there is a shift towards a prevalence of chop marks over cut marks, especially on cattle remains; this, and complementary butchery evidence, suggest animals were processed on a large-scale and following consistent, standardised procedures which aimed at full exploitation of the carcass (Groot 2016). Cattle scapulae with typical butchery marks and perforated blades, an indication that the meat cut had been hanged using a hook, represent the remains of cured beef shoulders (Schmid 1972; Seetah 2006). This product, also recorded in large quantities in Romano-British sites, is a common find in the area spanning from modern Switzerland to the Lower Rhineland (Lauwerier 1988; Maltby 2007). However, differently from Britain, the remains of cured shoulders are already found in Iron Age faunal assemblages (van Mensch and IJzereef 1977), suggesting that the practice originated in the Continent before the conquest and then spread to Roman military and civilian contexts (van Mensch and IJzereef 1977; van Mensch 1979; Lauwerier 1988; 2009; Dobney *et al*. 1996; Maltby 2007; Johnstone and Albarella 2015).

The size of cattle was improved in the Early and Middle Roman period, with a further slight increase in the Late Roman period (Fig. 3.5). The often considerable extent of such an increase and the appearance of specific non-metric traits in cattle mandibles (absence of the third hypoconulid on M_3s, absence of the P_2, and presence of an additional nutrient foramen) suggest the improvement was enhanced by the introduction of larger stock into the region (Groot 2016; Pucher 2013 in Groot 2016). Similar conclusions had been reached for explaining the particular large size of cattle from 4th-century Druten (Lauwerier 1986). The lower and later increase of length measurements in comparison to widths and depths suggests cattle became not only larger, but also more robust; this would have made the use of these animals in the field much more efficient (Groot 2016; 2017) (Fig. 3.6).

In the Dutch River Area, sheep did not increase in size. However, the appearance of a non-metric trait (an additional nutrient foramen on mandibles) suggests the introduction of a new breed of similar size, which could have improved wool or milk outputs without impacting on bone morphology and size; the same non-metric trait has been recorded on Late Iron Age-Early Roman material from the British site of Springhead, and interpreted in a similar way (Groot 2016). Horse size increased in the Early Roman period, with slight further improvements occurring up until the Late Roman period (Groot 2016); large horses, however, were much better represented at *villae* and military sites, while small horses prevailed in rural (especially native) settlements (Lauwerier and Robeerst 2001).

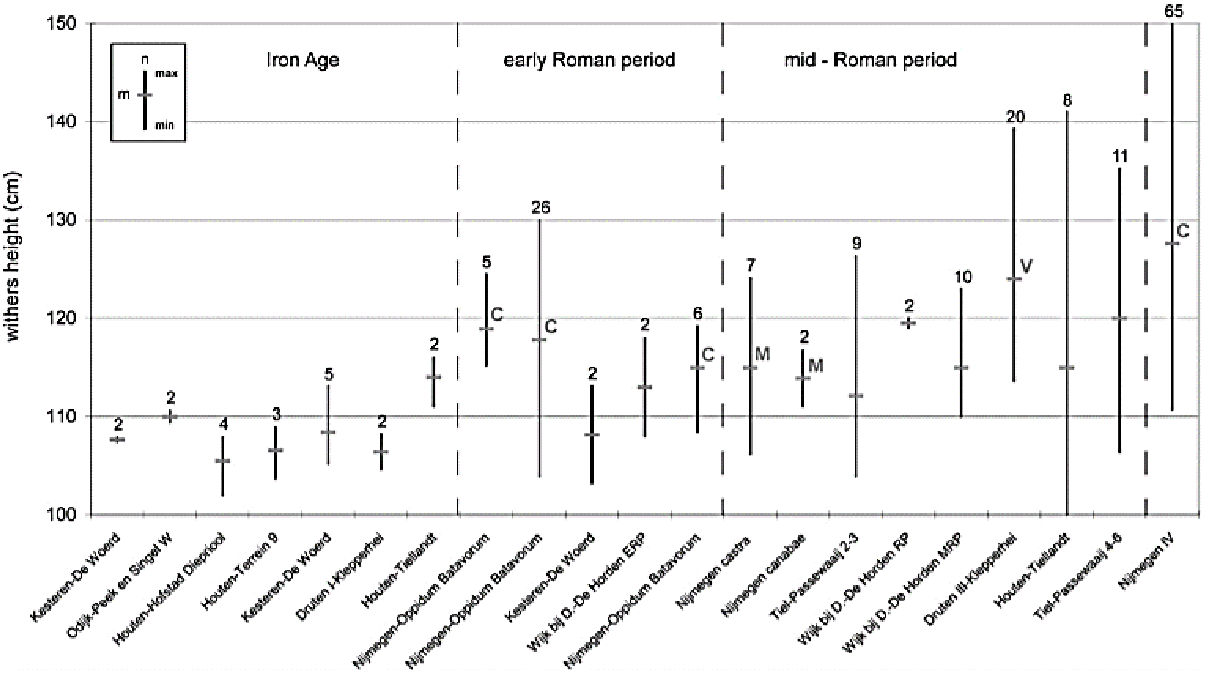


Fig. 3.5 Withers height of cattle (mean, minimum and maximum values) in different sites and periods. C: civil, M: military, V: *villa*. Data from Lauwerier (1988); Laarman (1996); Zeiler (2000; 2001); Esser and van Dijk (2004a); (Robeerst 2004); Groot (2005b; 2008a), elaborated in Lauwerier and Laarman (2012, 131, Fig. 5).

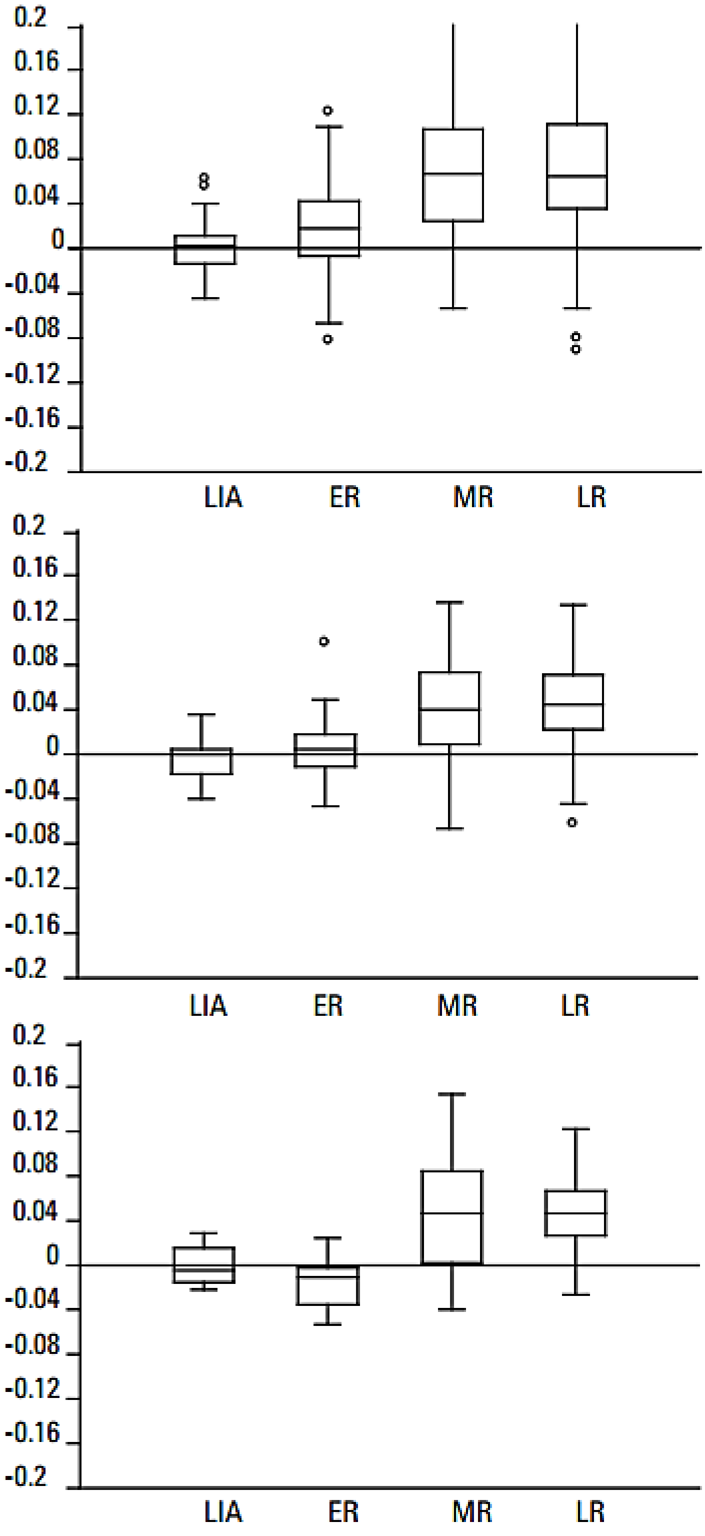


Fig. 3.6 Boxplots with whiskers and outliers of cattle bone width, length, and depth log ratio values from Lower Rhenish rural sites. LIA: Late Iron Age, ER: Early Roman, MR: Middle Roman, LR: Late Roman. The mean measurements of cattle bones from Late Iron Age Geldermalsen-Hondsgemet were chosen as the standard in this study (Groot 2016, 123, Figs. 5.49-5.51).

Much less is known about animal exploitation in the Merovingian period. A striking exception is represented by the site of Oegstgeest, on the river Rhine, which provides a good example for animal husbandry practices in the post-Roman Lower Rhineland. Studies of the material recovered during several seasons highlight a generalised husbandry regime, with a roughly equal representation of the main domestic species (Cavallo 2006; 2008). Traditional zooarchaeological analyses suggest this was a self-sufficient community which did not produce surpluses from animal exploitation, nor engaged in large-scale trade of animal products (Nagels 2012); however, stable isotope analyses on a sample of suid teeth revealed that half of them belonged to animals which were not born in the area around the site, suggesting that the large-scale trade network in which the inhabitants were involved may have included pork products (van der Jagt *et al*. 2012).

Similarly, animal economies beyond the *limes* of the Lower Rhineland did not receive the same level of attention as those of Roman territories; however, zooarchaeological analyses of assemblages from this region allow to reconstruct broad trends in animal exploitation. The regions on the eastern bank of the river Rhine were not immune from Roman influence, and this included influence on choices regarding animal exploitation. Political, military, and economic interests on both sides of the Rhine, Roman incursions and temporary occupations, and the inclusion of some Germanic tribes as *foederati*, made the *limes* an osmotic border through which people, objects, and indeed animals could pass (§ 2.6). Roman products were found at Feddersen Wierde, on the coast of modern Lower Saxony, and increased evidence for cattle stalling has been suggested to imply that cattle was being used as a trading product or to pay tribute (Wells 1999); provisioning from regions east of the Rhine, especially in the form of cattle (van Dinter *et al*. 2014) and cereals (Cavallo *et al*. 2008), would have been essential to sustain the large number of consumer individuals settled in the Rhine delta and Dutch River Area. The Frisian revolt itself (AD 69-70), would have been caused by an unreasonable tax in cattle hides imposed on the Frisians (Tacitus, *Annals* 4, 72). Animal movement between the Lower Rhineland and other eastern regions, in the form of trade or tribute, continued with the Franks; among the many examples, until the early 7th century the client tribe of the Saxons had to deliver to the Franks 500 cattle every year (Wallace-Hadrill 1996).

Cattle seems to have been indeed the most common of the main domesticates in the Germanic territories bordering the *limes*; its exploitation focussed on traction, which could be used in agricultural works (e.g. Zeiler 1998; Lauwerier *et al*. 1999). Unsurprisingly, the pattern seems similar to that observed for the Late Iron Age in the whole of the Lower Rhineland (van Dijk and Groot 2013; van Dijk 2016), and not that different from that of Roman times. Some differences, however, do occur. The prevalence of polled cattle at sites beyond the *limes*, for example, has been interpreted as a lack of resources or skills to maintain stable populations of horned cattle, something which could instead be achieved in Roman territories (Lauwerier and

Laarman 2012). Similarly, horses from sites on Germanic territories close to the *limes* were on average smaller than those from *villae* and Roman military sites (Lauwerier and Robeerst 2001), while large cattle were present (Lauwerier *et al*. 1999).

In Frisia too, cattle dominate assemblages from the Iron Age and Roman period. However, a higher incidence of sheep is recorded since Roman times; in the Merovingian period, this animal becomes the most represented in some of the sites, while pig is almost absent (Prummel 2001). The rearing of cattle and sheep would have been favoured by local environmental conditions, including the presence of extensive salt marshes (Prummel 2001; Prummel *et al*. 2013). At the same time, the rise of the early medieval wool trade, in which Frisians were involved, is likely to lie behind the intensification of sheep farming in the Merovingian and later periods (Heidinga 1997; Prummel *et al*. 2013). The exploitation of cattle and sheep was variable, and in some sites there does not seem to have been a focus on specific products (Hullegie 2010; Prummel *et al*. 2013); the few biometrical analyses available for the region highlight some degree of variability in the size of cattle and sheep, although animals smaller than in the Roman Lower Rhineland prevail (e.g. Hullegie 2010; Post 2012).

CHAPTER 4

Sites and materials

4.1 Introduction

The selection of sites included in this study depended on a wide range of considerations. First of all, a number of geographical areas were selected according to their potential to provide representative information on changes in animal husbandry at the transition between the Late Roman and the Early Anglo-Saxon/Merovingian periods.

The centre-east and south-east of England fit this purpose well, as the impact of Roman influence on animal management was greater in this area, making it easier to assess change at the transition (Grant 1989; King 1999; Millett 1990). However, the south-easternmost part of England (mainly Kent) was excluded, due to the privileged status that the region assumed in Early Anglo-Saxon England in comparison to other areas; indeed, closer contact with Merovingian France implied earlier economic expansion, including an earlier development of medium-to-long distance trade and region-specific reorganisations of the countryside that reflected such developments (Brookes 2003). This probably impacted on the rural economy in unusual ways in comparison to nearby regions, blurring the evidence for changes in animal management between the Late Roman and Early Anglo-Saxon periods, and providing an unrepresentative picture of early post-Roman British animal husbandry practices. Therefore, three microregions were chosen from the centre-southeast: ‘Suffolk’, ‘Cambridgeshire’, and ‘Oxfordshire’. The west-east gradient position of these microregions allows for an assessment of geographical differences proceeding from the eastern coastland towards the west. Sites from the literature were also chosen from these regions to complement data collected by the author; however, relevant studies on other regions of Britain provide useful comparisons, and will be referred to in the discussion (Chapter 7).

The sites from the Lower Rhineland chosen for this study are located on the western and eastern banks of the river Rhine which, during the Roman Empire, represented the border between the province of *Germania Inferior* (later *Secunda*) and non-Roman Germany. This allowed for further comparison between Romanised and Germanic territories, in addition to the diachronic comparison between the Late Roman and the Merovingian periods. In the end, this provided the opportunity for a better assessment and interpretation of changes, in relation to Roman influence on animal husbandry, indigenous practices, and early post-Roman developments.

The other main variable affecting site selection was the availability of sizeable faunal assemblages dated to Late Roman and/or to the Early Anglo-Saxon/Merovingian periods. In this study, the Late Roman period refers generally to the 3rd-4th centuries AD, while the Early Anglo-Saxon/Merovingian period refers to the 5th-7th centuries AD. These two chronological spans are obviously characterised by political and socio-economic developments which, to some extent, could have influenced animal husbandry practices. For example, Late Roman Britain, as is intended in this study, went through various politico-military crises followed by periods of relative stability and prosperity; similarly, 5th century England saw the establishment of Anglo-Saxon communities, their gradual development into territorial states, and finally the rebirth of urbanisation and long-distance trade in the last decades of the 7th century. However, all these developments are unlikely to have influenced very directly on animal exploitation within the two periods, and the comparison of these two broad chronologies is therefore expected to provide key information on differences in the animal economies of Roman and early post-Roman Britain, and to allow interpretations of their significance (see Chapter 2). The analysis of contemporary developments in the Lower Rhineland provides a comparison between the regions that are located west (Roman/former Roman) and east of the Rhine, shedding further light on Roman influence in husbandry practices in the north-western provinces; in turn, this contributes to a better understanding of changes in animal economies between the Late Roman and early post-Roman periods.

Inevitably, not all faunal assemblages are precisely dated to the 3rd-4th or 5th-7th centuries AD. Phasing at some sites might only include part of these periods, and/or extend slightly beyond them. More detailed chronological information is provided in the following sections.

Other practical variables had to be taken into account during the selection of faunal assemblages. With very few exceptions, Early Anglo-Saxon sites with large-sized faunal assemblages remain particularly rare. As a consequence, they are underrepresented in this study in comparison to Late Roman sites, and, in most cases, analyses and interpretation had to rely on relatively small samples. Similar considerations apply to the Merovingian period in the Lower Rhineland. In addition, this region underwent rapid depopulation during the 3rd century (see Chapter 2), and most sites available for the Late Roman period are functionally linked to military contexts along the *limes*. As a result, geographical and chronological comparisons are affected by differences in settlement types. At the same time, limitations such as accessibility to the relevant material and financial and time constraints influenced the process of selection and the quantity of data which could be recorded.

Part of the data analysed in this project were collected by the candidate; comparative data were also collected from the literature to provide a more representative dataset. The sites whose assemblages were recorded by the candidate are listed in the sections below; desultory descriptions of the main archaeological features and of the zooarchaeological material they produced are provided. The number of recorded fragments indicated for each site refers to the sum of entries for cattle, caprines, and suids; equid and galliform remains have been the subject of separate studies (Benkert and Rizzetto in prep.; de Groene *et al*. 2020).

Brief zooarchaeological results from previous studies for phases preceding or following the chronological span investigated by this study are discussed when available. The sites' main characteristics are summarised in § 4.6, while chronological tables are provided for those sites with more complex phasing. Inevitably, the quantity and quality of information available for each site vary depending on the availability of published material. Those sites whose data were collected from the literature are listed in Table 4.12. The maps below indicate the location of sites whose faunal assemblages have been included in this study (Figs. 4.1 and 4.2).

Fig. 4.1 Map with location of the British sites analysed in this study. Circles: Late Roman; crosses: Anglo-Saxon; circles with crosses: Late Roman and Anglo-Saxon; grey: sites whose assemblages were recorded for this study.

Fig. 4.2 Map with location of Lower Rhinish sites analysed in this study. Circles: Late Roman; crosses: Merovingian; circles with crosses: Late Roman and Merovingian; grey fill: sites whose assemblages have been recorded for this study.

4.2 Suffolk

4.2.1 Pakenham (Late Roman)

4.2.1.1 The site

The chronology of the site spans the whole period of the Roman occupation of Britain (mid-1st-4th c. AD). A short-lived fort was established at the site in the second half of the 1st century AD; after the military structures were abandoned, the site developed into a small market centre. It was linked to West Stow and Icklingham by a secondary route, which intersected the Icknield

Way just before reaching Icklingham (Fig. 4.3). The site was continuously occupied until the late 4th century (Plouviez 1986) (Tab. 4.1).

4.2.1.2 The faunal assemblage

The zooarchaeological evidence from the various Roman subphases is consistent with that observed at other Roman sites in Britain. The importance of cattle gradually increases at the expense of caprines (Fig. 4.4). Since the Early Roman period, culling strategies and butchery practices suggest that both cattle and sheep were reared primarily for their meat. In addition, the average size of both cattle and horse was improved through time (Beech 1991).

The sample of animal remains here considered was recovered from Late Roman (early/mid-3rd to 4th century) contexts, and consists of 528 recorded fragments.

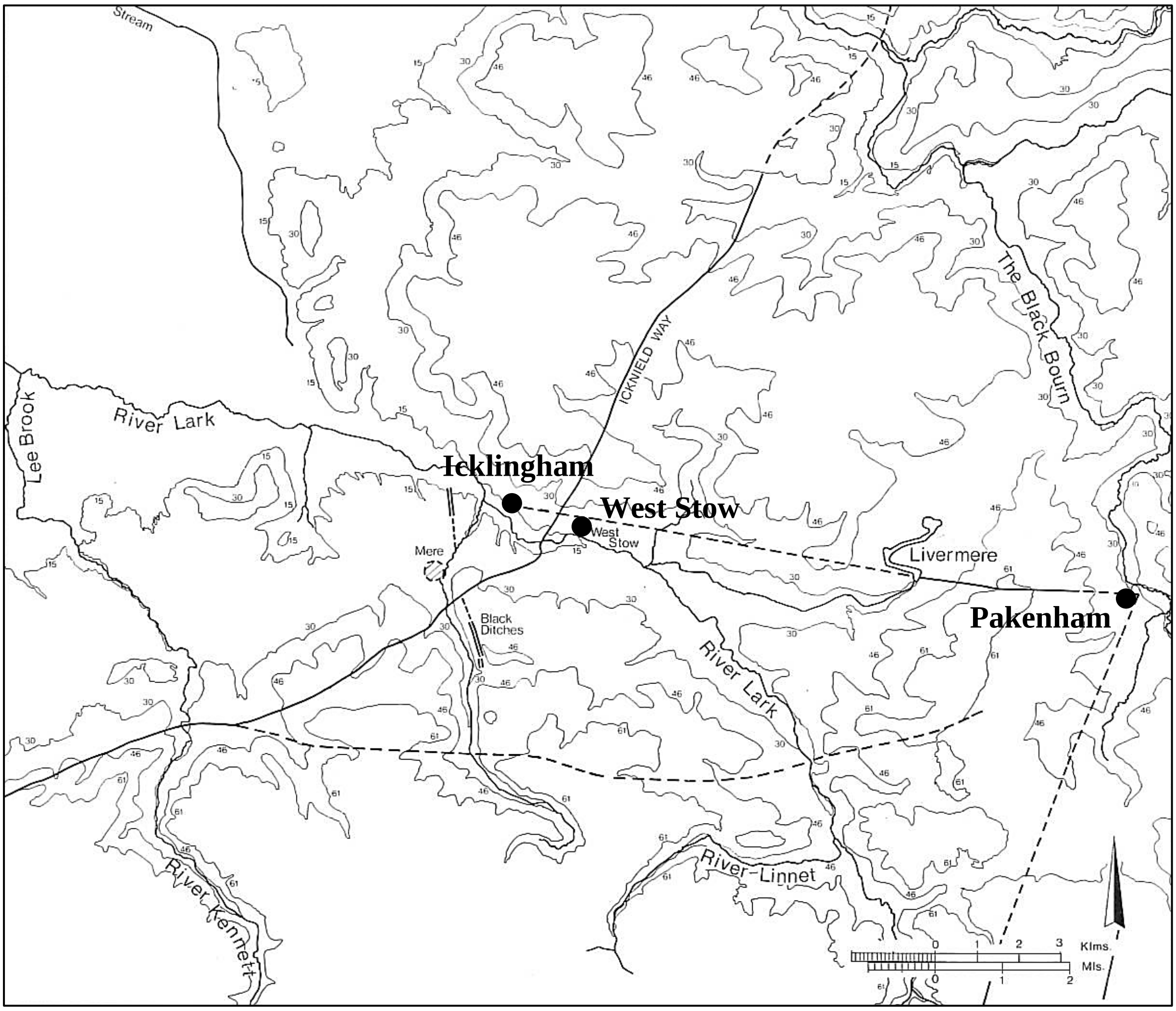


Fig. 4.3 The Lark valley in northwest Suffolk, with position of the Roman (Pakenham, Icklingham) and Early Anglo-Saxon (West Stow) sites whose faunal assemblages are included in this study. The Icknield Way, an ancient route running southwest-northeast, is also traced (black line), along with other secondary routes (dashed lines).

These include the supposed route linking Icklingham to West Stow and Pakenham (adapted from West 1985b, Fig. 2).

PAKENHAM	
Phase 1	Early Roman period (military), 2nd half of 1st century AD
Phase 2	Early Roman period (civilian), late 1st-early 2nd centuries AD
Phase 3	Middle Roman period, 2nd-early 3rd centuries AD
Phase 4	Late Roman period, 3rd-4th centuries AD

Tab. 4.1 Phases at Pakenham, Suffolk (adapted from West and Plouviez 1976; Beech 1991).

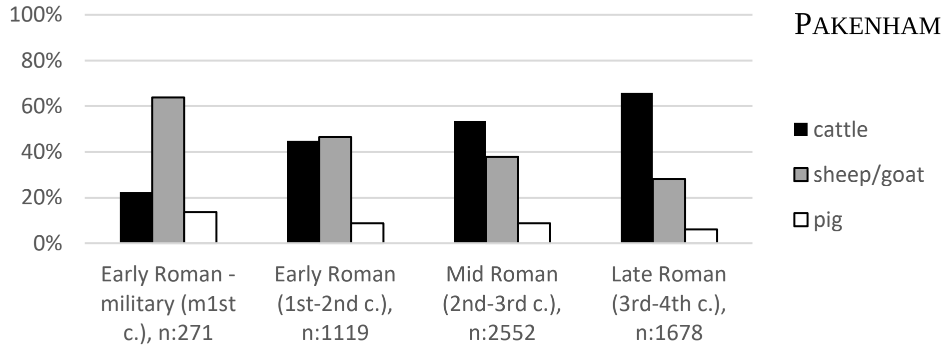


Fig. 4.4 Species frequency for the three main domesticates at Pakenham, Suffolk (Beech 1991).

4.2.2 Icklingham (Late Roman)

4.2.2.1 The site

The Roman site of Icklingham lies just above the flood plain of the river Lark, a tributary of the Great Ouse, and close to the south-western limits of the Breckland. The local complex geology results from the combination of river gravels of the Lark, wind-blown sands, post-glacial alluvia, and its proximity to the area of lighter soils of the Breckland in the north, to the clayland plateau in the south, and to the Fenland in the west (West and Plouviez 1976) (Fig. 4.22). Icklingham is located about five km north-west of the Early Anglo-Saxon village of West Stow (§ *4.2.3*), and about half km from the Icknield Way, an Iron Age south-north trackway which was probably still in use in Roman times (Margary 1973). It also lies along an east-west route along the Lark valley, linking the site to West Stow and Pakenham (Fig. 4.3).

19th century excavations in the area uncovered the remains of a villa. The 1970s excavations at the site revealed a series of features and buildings attributed to two main phases of occupation (Fig. 4.5). The first phase, mainly represented by pits and very limited evidence for structures, has been interpreted as part of the remains of an unenclosed Romanised settlement, which could have included some relatively high-status buildings; similar archaeological sites have been discovered elsewhere in the region. The settlement features were sealed by a thick layer of chalk ('intermediate' Phase 2), which preceded the use of the site as an early Christian cemetery (Phase 3) (West and Plouviez 1976).

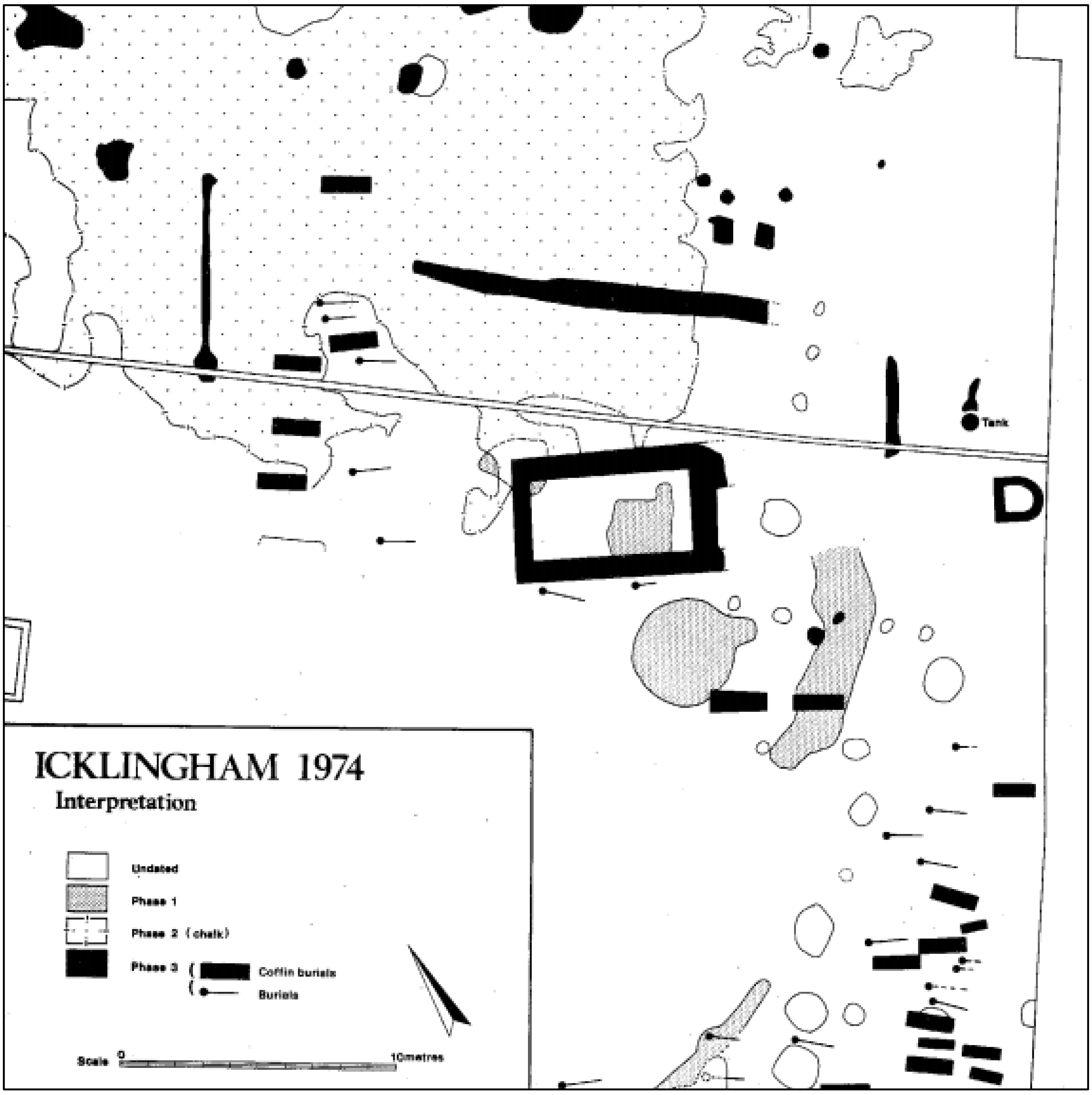


Fig. 4.5 Plan of the site of Icklingham, Suffolk (West and Plouviez 1976, 69). The faunal material analysed in this study was recovered from features (mainly pits) from Phase 1 (grey areas).

Despite the recovery of some late 1st-2nd c. AD pottery fragments, most of the pottery and coins are dated to between the late 2nd and 4th centuries. The abundance of 3rd and 4th c. pottery, as well as the absence of mid-late 4th c. coins, in features from the first settlement phase, suggest this flourished in the Late Roman period and ended in the mid-4th c. AD. The prevalence of later coins and materials in the cemetery features confirms this dating of the first phase. The sporadic Early Anglo-Saxon finds from the topsoil and related features are unlikely to suggest a continuation, however brief, of occupation into the 5th c.; at the same time, however, there could have been an overlap of a few decades with the initial settlement of West Stow (West and Plouviez 1976).

4.2.2.2 The faunal assemblage

The faunal material analysed in this study was recovered from the Late Roman features of the first phase settlement, and consists of 557 recorded fragments. The assemblage was previously studied by Crabtree (2010), who noticed a clear prevalence of cattle (> 60%) over caprines and pig. This prompted a more detailed biometrical investigation of cattle (as well as caprine, pig and horse) remains, which is presented in Chapter 6.

4.2.3 West Stow (Early Anglo-Saxon)

4.2.3.1 The site

The site of West Stow lies on the northern bank of the River Lark. This area represents the southern margins of the Breckland; it is located close to the chalkland south of the Lark and sandwiched between the Fenland to the west and the clayland plateau to the east. The presence of light, sandy soils typical of the dry upland area and of peat soils on the lower river valley would have allowed the exploitation of different environments for agropastoral purposes (Crabtree 1989; Natural England 2012) (Fig. 4.22).

The original archaeological excavations at West Stow were carried out between 1957 and 1972. The works revealed that the site was discontinuously occupied from the Mesolithic to the Early Middle Ages (West 1990) (Tab. 4.2). In the 1st and 2nd c. AD there were two pottery kilns functioning at the site, although there is no clear evidence of continuous Roman occupation (West 1990). During this period, the settlement lied on a crossroad between the Icknield Way, an Iron Age north-south communication route probably still in use under the Romans, and an east-west road which linked West Stow to Icklingham and Pakenham (Margary 1973; West and Plouviez 1976; West 1985a) (Fig. 4.3). The site, however, is better known from its following phase, which revealed one of the largest Early Anglo-Saxon settlements ever excavated: 69 sunken-featured buildings (SFBs), clustered around seven larger post-built structures, or 'halls' (West 1985a). A number of related features, including ditches and waste pits, were also identified (Fig. 4.6). The chronological organisation of these features spans from the early 5th to the 7th century and could be subdivided into four phases (Tab. 4.2). More recent rescue excavations exposed other Early Anglo-Saxon features, suggesting that the village was even larger than previously assumed (Crabtree 2012).

For some of the SFBs, the presence of specific pottery forms, brooch and comb types allowed dating them to the earliest part of the 5th century (Phase A); the other SFBs from that period were more generically dated to the 5th century (Phase B), although the lack of the earlier material suggests a later date within that century (West 1985a; Riddler 2012; Riddler and Trzaska Nartowski 2013).

In addition to this, the hypothesis of how the deposits within the SFBs had formed has been recently reformulated. Observations of the stratigraphic characteristics of the fills, complemented by the results from an experimental project, suggest that the lower deposits of the SFBs from West Stow are the result of single infilling events, rather than material slowly sifting through the floor during occupation (Tipper 2004). These deposits and the material they produce, therefore, are contemporary with the abandonment of the structures rather than with the previous, longer period of use.

On the basis of these considerations, it is possible to assume a narrower dating for the majority of material from the SFBs, limiting the potential bias of chronological overlap between deposits from different phases. For the purpose of this study, more reliable and well-separated dating of the material from the four phases facilitates the study of changes in animal husbandry practices within the Early Anglo-Saxon period itself at West Stow – something unique in England.

4.2.3.2 The faunal assemblage

The majority of animal remains originated from the deposits within the SFBs, although a fair quantity of material was recovered from other features as well, such as pits and ditches (Crabtree 1989). The faunal material was extensively analysed by P. Crabtree (1989a; 1990) (Fig. 4.7). The sample of animal remains here analysed and discussed is material from the old excavations; it is dated to the 5th-7th centuries AD, and consists of 3996 recorded fragments.

Fig. 4.6 Plan of the site of West Stow, Suffolk (West 1985b, Fig. 7).

WEST STOW	
Iron Age	3rd century BC – early 1st century AD
Early Roman	1st-2nd centuries AD
Early Anglo-Saxon A	first half of 5th century AD
Early Anglo-Saxon B	5th century AD
Early Anglo-Saxon C	6th century AD
Early Anglo-Saxon D	late 6th-7th centuries AD

Tab. 4.2 Phases at West Stow, Suffolk (West 1985a; Crabtree 1989; West 1990).

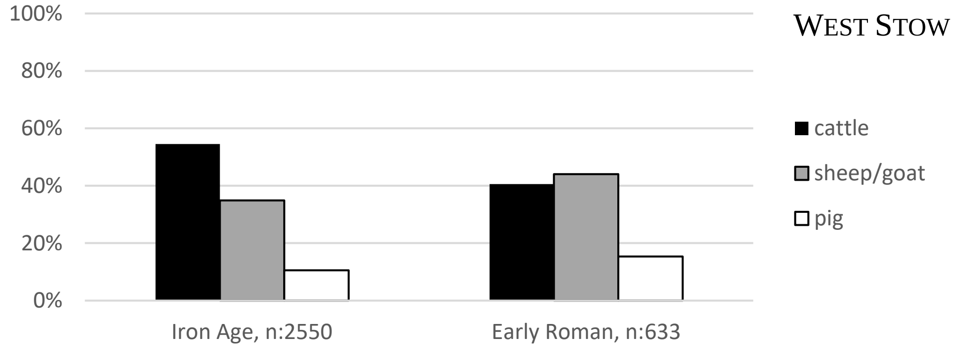


Fig. 4.7 Species frequency for the three main domesticates at West Stow, Suffolk, for the Iron Age and Roman period (Crabtree 1990).

4.3 Cambridgeshire

4.3.1 Cambourne (Mid-Late Roman)

4.3.1.1 The sites

A series of sites were excavated in the early 2000s in Cambourne, a planned town 12 km west of Cambridge, in advance of housing developments in the area. The local geology is dominated by clays, which form a generally flat landform; such permeable, heavy soils are prone to waterlogging and drought (Wright 2009a) (Fig. 4.23). The analyses of pollen sequences and of wild mammal, insect, and land mollusc remains suggest the existence of relatively open landscapes during the Roman period, with a high water table and occasional standing water; the presence of nitrogen-rich, disturbed soils is indicative of a ‘farmyard’ environment (Stevens 2009). Waterlogging occurred in Roman times as well as today, with the several ditches identified in all phases among arable land and pastures, and around the sites themselves, having been mainly interpreted as drainage features (Wright 2009a).

The sites have been assigned to various chronologies within the Roman period, with evidence of Late Iron Age and early post-Roman occupation at some of them (Tab. 4.3). The area lies halfway between two major Roman roads, the Ermine Street and the *Via Devana*; a secondary route, Roman Road 231, ran along the northern edge of the Cambourne area (Margary 1973). At the same time, the Cambourne settlements were probably linked to the Fens. Along with the intensification of movement, in Roman times the landscape around Cambourne was reorganised, with large-scale land enclosure and the spread of rectilinear field systems (Stevens 2009).

The settlements excavated at Cambourne appear to consist of farmsteads located between the arable fields and pastures, usually in sheltered positions and close to watercourses; the rural economy relied on mixed agriculture where pastoral farming predominated. The region around the Cambourne area seems to have been organised into estates and farms centrally managed by villas; however, it is not sure whether such organisation involved Cambourne itself. Not all settlements were contemporaneous, as they were occupied for relatively short periods; most farmsteads were small and low-status, with little evidence for expansion and nucleation (Wright 2009b). The only exception was Lower Cambourne, which was characterised by continuity of settlement from the Late Iron Age to the early 5th century AD, and produced a wider range of finds as well as a number of ‘placed deposits’. At this site, the transition to the Early Roman period sees no changes in the morphology of enclosures and buildings: roundhouses continue being built throughout the Roman period. The survival of Iron Age building traditions has led the archaeologists to suggest a failure of Romanisation in the area, although more pronounced changes in portable material culture have been observed. Only in the late 2nd-early 3rd centuries rectangular enclosures and buildings appear alongside roundhouses. Enclosures and associated droveways, as well as the drainage/boundary ditches identified in most sites, have been linked to livestock management (Wright 2009b) (Fig. 4.8).

CAMBOURNE	
Phase 1	Middle/Late Bronze Age
Phase 2	Middle/Late Iron Age (2A, 2B)-Early Roman period (2A, 2B, 2C), 400 BC-Mid-/Late 2nd century AD
Phases 3A-3B	Middle-Late Roman period, AD 150/200-400
Phase 4	Saxon, AD 410-11th century AD
Phases 5-6	medieval and post-medieval, 11th-20th centuries AD

Tab. 4.3 Phases at Cambourne, Cambridgeshire (adapted from Wright 2009a).

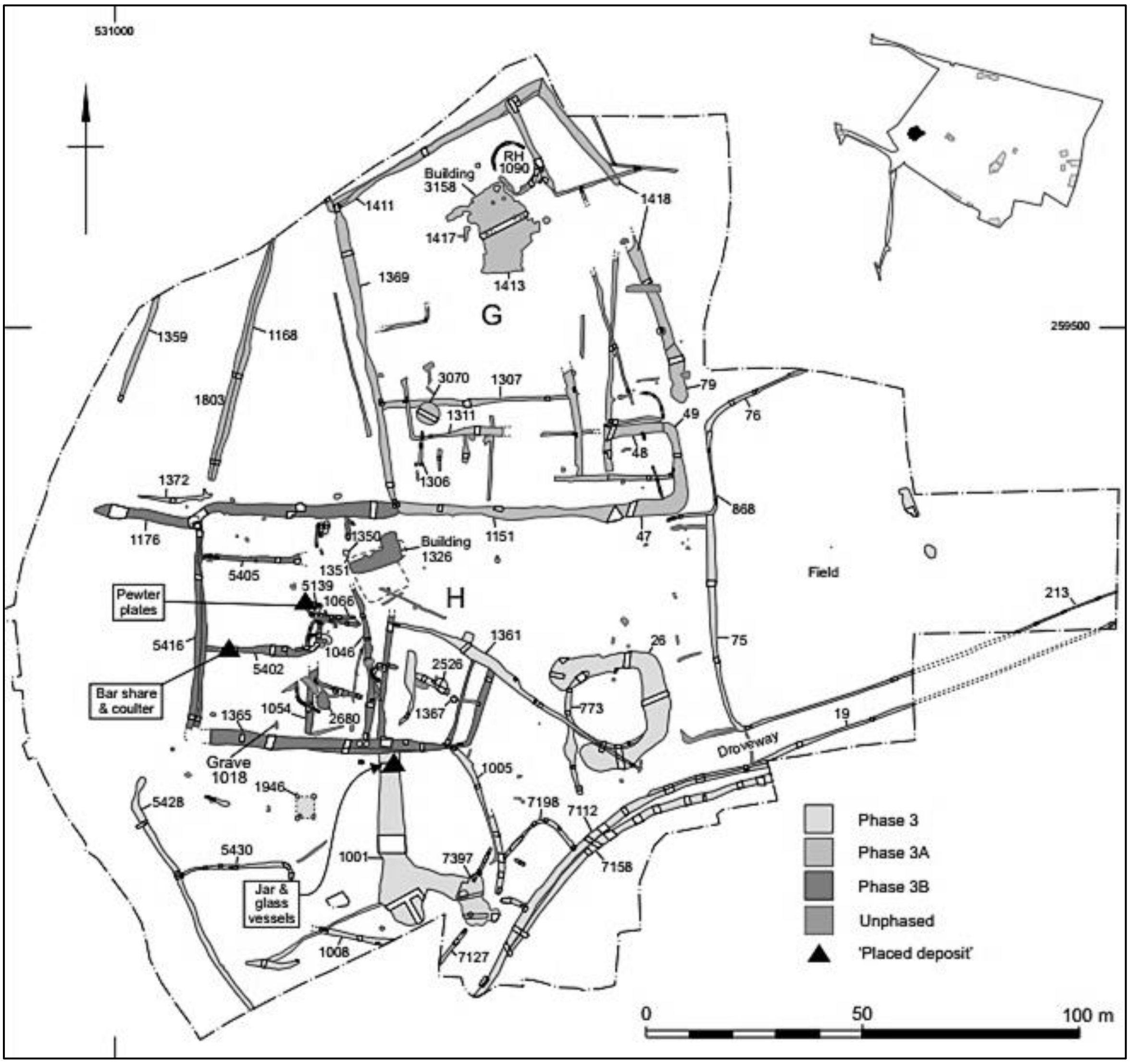


Fig. 4.8 Plan of all Phase 3 features at the site of Lower Cambourne, the largest one of Cambourne excavations, Cambridgeshire (Wright 2009c, 23, Fig. 10).

4.3.1.2 The faunal assemblage

The analysis of the faunal assemblage included in the publication of the site focussed on a selection of material from the largest assemblages; a further selection was recorded at a lower level of detail, while for the rest only desultory analyses were made (Hamilton-Dyer 2009).

According to the previous zooarchaeological study, cattle dominated both Iron Age and Roman contexts, its frequency increasing slightly in the Middle-Late Roman phase (Phase 3); caprines (mainly sheep) were also abundant (Fig. 4.9). The relatively low incidence of caprines in Iron Age contexts may reflect the environmental conditions of the area, mainly wet and low-lying. In both periods entire carcasses were butchered on site. Ageing profiles for cattle suggest the animals were exploited both for meat and traction; similarly, sheep were used for meat and wool production. There seems to be a trend towards the slaughtering of older cattle and sheep in Phase 3. Withers heights estimates suggest a slight increase in the size of cattle in Roman times. The frequency of horse is low but slightly increasing in Phase 3; horse remains recovered from the sites belonged to adult, pony-sized individuals. Other domesticates and wild animals were particularly rare (Hamilton-Dyer 2009).

In sum, the faunal analysis of material from Iron Age and Roman contexts suggests a partial continuation of Late Iron Age practices; changes in Roman times are subtler than elsewhere, but they do occur and are consistent with trends detected at other 'Romanised' sites (Hamilton-Dyer 2009).

The faunal material recorded for this study belongs to Phase 3 (Middle-Late Roman contexts), and consists of 1112 recorded fragments. Animal remains from all Cambourne sites were recorded and analysed together, although the majority of them were recovered from Lower Cambourne.

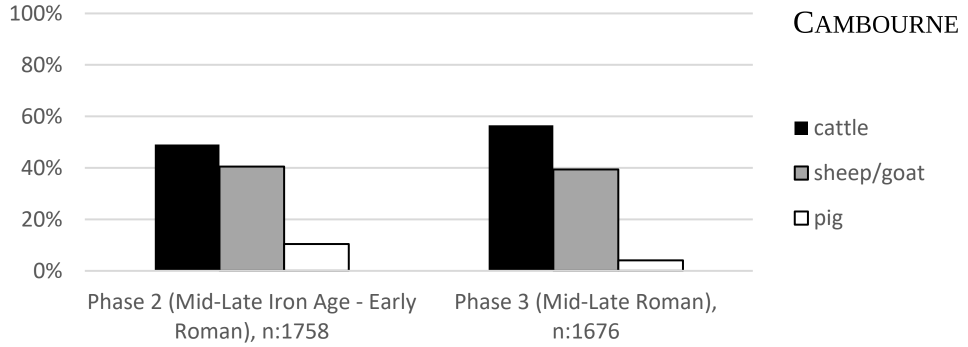


Fig. 4.9 Species frequency for the three main domesticates at Cambourne, Cambridgeshire (Hamilton-Dyer 2009).

4.3.2 Gamlingay (Early Anglo-Saxon)

4.3.2.1 The site

The site of Station Road, Gamlingay, was excavated in 1997. The settlement lied in lighter soils in comparison to Cambourne, with marginal heavier land areas nearby the site (Fig. 4.23). In the Early Anglo-Saxon period, a farmstead with several SFBs was established; it was enclosed by a large causewayed ditch (Phase 1). Such enclosure was later truncated by a new droveway, associated with a long timber building and adjacent livestock enclosure (Phase 2). A third enclosure or field system was detected in the southern part of the excavated area, representing the last feature of this period. Relatively large amounts of pottery were recovered from these features, along with items related to textile and comb production; evidence for cereal production and processing was also identified. Since the Middle Anglo-Saxon period, occupation became more scattered, allowing a clear separation of the two phases; in the same period a Christian cemetery was established at the site (Murray and McDonald 2006) (Tab. 4.4 and Fig. 4.10).

4.3.2.2 The faunal assemblage

The faunal analysis included in the publication of the site revealed a mixed animal economy, with little change observed between the Early and Middle Anglo-Saxon phases (Roberts 2006). The material recorded for this study was collected from the Early Anglo-Saxon features (Phases 1 and 2); it can be broadly dated to the 5th-7th centuries AD, and consists of 946 recorded fragments.

GAMLINGAY	
Prehistoric finds/phases	Mesolithic, Neolithic/Bronze Age
abandonment	Iron Age-Roman period
Phases 1-2	Early Anglo/Saxon period, 5th-7th centuries AD
later phases	Middle Anglo-Saxon period, 8th-9th centuries AD

Tab. 4.4 Phases at Gamlingay, Cambridgeshire (adapted from Murray and McDonald 2006).

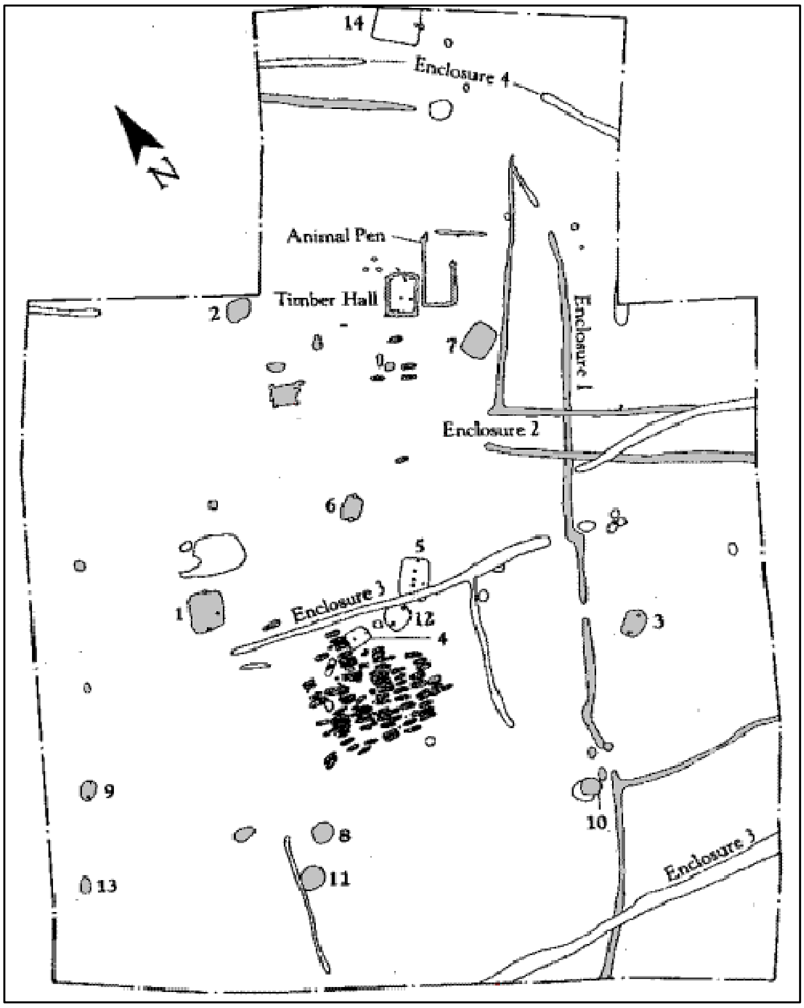


Fig. 4.10 Plan of the site of Area 24, Station Road, Gamlingay, Cambridgeshire; Early Anglo-Saxon features (Phases 1 and 2) highlighted in grey (adapted from Murray and McDonald 2006).

4.4 Oxfordshire

4.4.1 Asthall (Late Roman)

4.4.1.1 The site

The Roman site of Asthall (north-west Oxfordshire) lies along the Akeman Street, which linked Alchester to Cirencester, at the point where the road crossed the river Windrush. The local geology is dominated by limestones and clays, with very composite soil types ranging from sandy clay, to sandy gravels, and sand and gravel deposits (Fig. 4.24).

Nucleated settlements are present along the Akeman Street, while the rural landscape of the region is largely dominated by villas. The roadside settlement of Asthall has been tentatively identified as a ‘small town’, although only a very small part of the site has been excavated. The two areas investigated, Area A and Area B, revealed a sequence spanning the whole period of Roman occupation, from the mid-1st to the 4th centuries AD. Seven phases were identified (Tab. 4.5).

The foundation and development of the site owed much to the presence of the Akeman Street, which in Asthall was frequently resurfaced throughout the Roman period. The main features identified at the site include stone and timber buildings, two wells, a side road, enclosures (including ditched boundaries and other fenced property boundaries), pits, a gully, and a burial ground; in Area B ironworking (smithing) related features were identified for Phases 3 and 4 (early 2nd-early 3rd centuries AD), while in Area A a sequence of ovens (unknown function) was in use in Phases 4 and 5 (mid-2nd-3rd centuries AD) (Booth 1997) (Fig. 4.11).

ASTHALL	
Phase 1	Pre-Roman (miscellaneous)
Phase 2	mid-1st – early 2nd centuries AD
Phase 3	early-mid 2nd century AD
Phase 4	mid-2nd – late 2nd/early 3rd centuries AD
Phase 5	3rd century AD
Phase 6	4th century AD
Phase 7	Post-Roman (miscellaneous, no Early Anglo-Saxon)

Tab. 4.5 Phases at Asthall, Oxfordshire (Booth 1997).

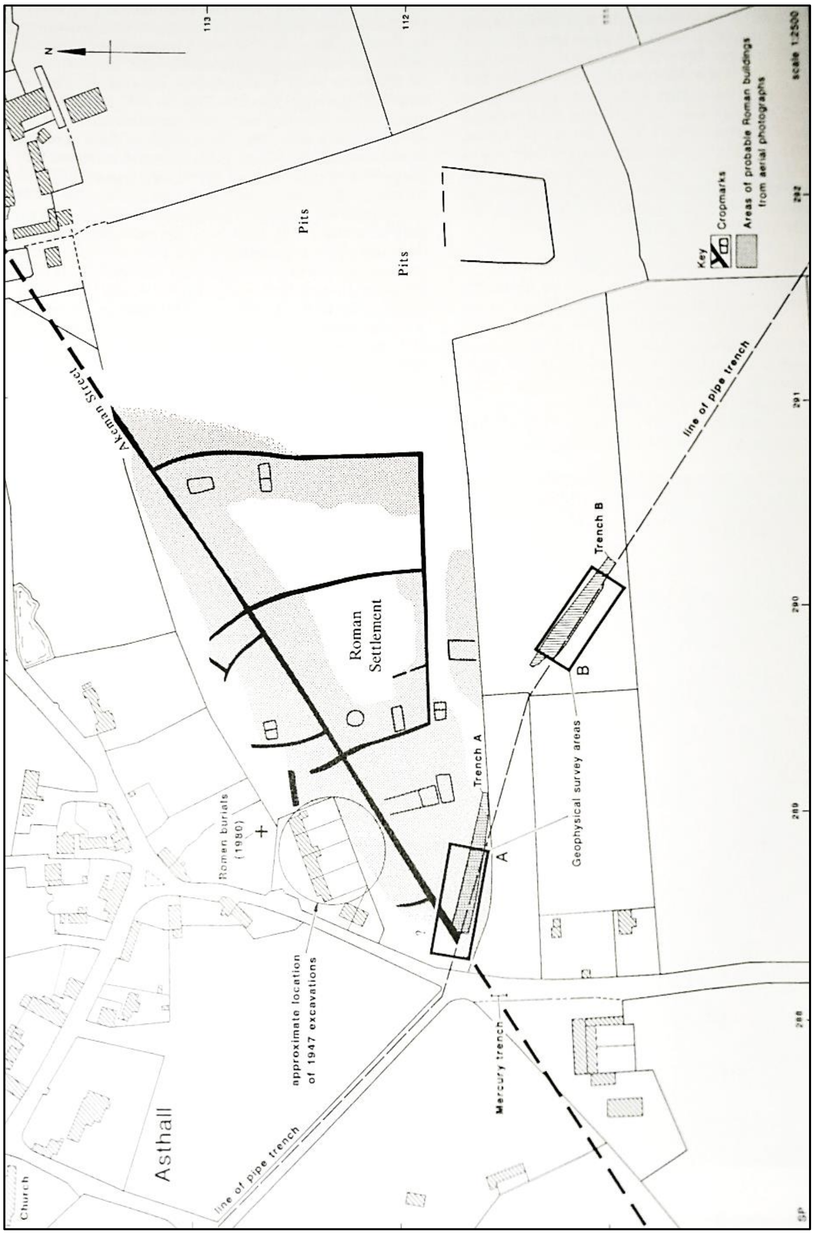


Fig. 4.11 Plan of the site of Asthall, Oxfordshire; area of Roman occupation (grey) and cropmarks visible on the ground before excavation (black) (Booth 1997, 4).

4.4.1.2 The faunal assemblage

The analysis of the faunal assemblage included in the publication of the site focussed on species frequency, ageing, and butchery of animals during the Roman phases (Powell *et al*. 1997). Caprines, mainly sheep, predominate, although the incidence of cattle increases through time and, by the Late Roman period, it equals that of caprines (Fig. 4.12). Horse and other domestic and wild species are particularly rare. Cattle were slaughtered at all ages, suggesting a generalised exploitation of this domesticate, and possibly the introduction of veal from nearby rural settlements; subadult and adult sheep are equally represented, suggesting a focus on meat and wool production. Butchery marks concentrate on cattle bones, with a major incidence of chop marks and the presence of other butchery practices traditionally linked to Roman processing practices.

In sum, since Early Roman times, animal exploitation at Asthall presents a combination of typically rural and urban features, probably reflecting the little defined nature of roadside settlements (Powell *et al*. 1997).

The faunal material recorded for this study belongs to Phases 5 and 6 (3rd-4th c. AD), and consists of 391 recorded fragments.

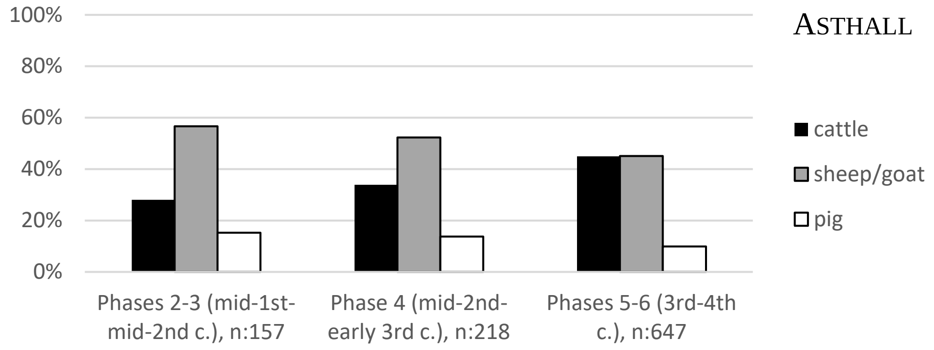


Fig. 4.12 Species frequency for the three main domesticates at Asthall, Oxfordshire (Powell *et al*. 1997).

4.4.2 Wantage, Denchworth Road (Mid-Late Roman)

4.4.2.1 The site

The site of Denchworth Road, Wantage, was excavated in 1996 and 1998. Local geology implies subsoils characterised by stiff clays and marl with pockets of silty clay (Fig. 4.24). The supposed Roman road linking Wantage to Frilford and Alcester would have passed next to the site. In the Early-Middle Roman period (Periods 1 and 2) a metalled trackway flanked by ditches probably led to the main road; plot boundaries, some pits, and a curvilinear enclosure (probably for livestock control) are also dated to this phase. By the late 3rd century AD a silty-clay horizon, most likely agricultural ploughsoil, sealed part of these features. Around 270 AD a stone building was built on top of it; it had four rooms and was contained within a ditched enclosure. Other ditches and pits are contemporary to the building, which was systematically dismantled and robbed of building material in the late 4th century (end of Period 3). Although a pottery sherd broadly datable to the 6th-8th centuries was recovered from one of the robber trenches, no evidence of post-Roman occupation was identified (Barber and Holbrook 2001) (Tab. 4.6; Fig. 4.13).

4.4.2.2 The faunal assemblage

A previous analysis of the faunal material highlighted a good degree of preservation. The main domesticates, especially cattle and sheep, make up most of the assemblage; wild food animals are very rare during all phases. Since the Early Roman period, standardised butchery practices detected on cattle bones suggest the presence of specialised butchers (Maltby 2001). The material recorded for this study belongs to the Middle-Late Roman period (Periods 2-3). Considering similarities in site-type, the small-sized sample from this site (116 recorded fragments) was combined in this study with the Roman one from Mill Street, Wantage (§ *4.4.3*).

	Denchworth Road	Mill Street
Period 0	residual prehistoric finds	
Period 1	late 1st-mid-2nd c. AD	late 1st-mid-2nd c. AD
Period 2	mid-2nd-mid-3rd c. AD	mid-2nd-mid-3rd/early 4th c. AD
Period 3	mid-3rd-late 4th c. AD	mid-3rd/early 4th-late 4th c. AD
Period 4	after late 4th c. AD	Early Anglo-Saxon period, 5th-7th c. AD
Period 5	post-medieval and modern	
Period 6	-	medieval and post-medieval

Tab. 4.6 Phases at the sites of Denchworth Road and Mill Street, Wantage, Oxfordshire (Barber and Holbrook 2001; Holbrook and Thomas 1997).

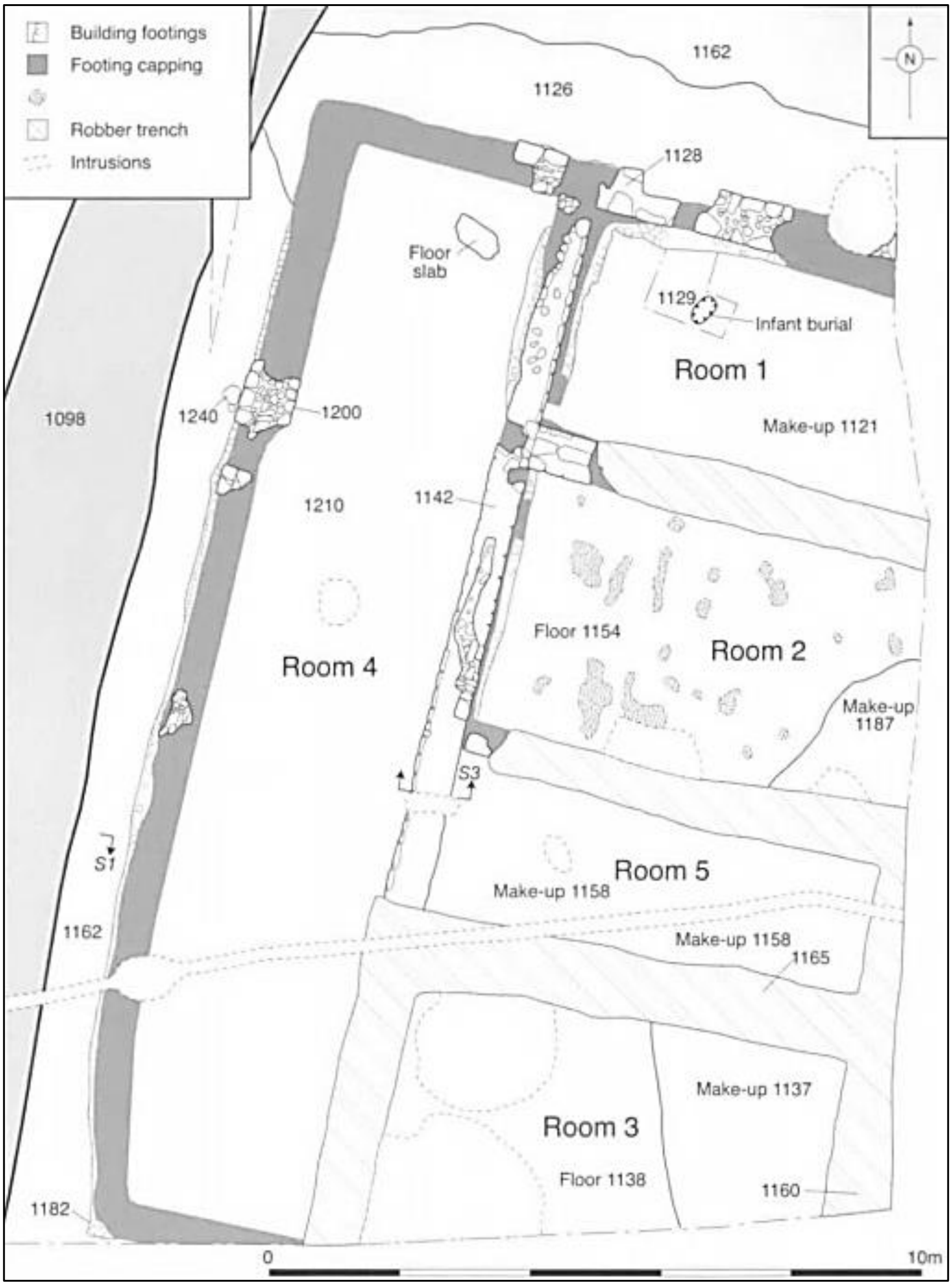


Fig. 4.13 Plan of the stone building from Period 3 at the site of Denchworth Road, Wantage, Oxfordshire; other ditches from the same period were identified next to ditch 1098, along with pits and other features (Barber and Holbrook 2001, 298, Fig. 6).

4.4.3 Wantage, Mill Street (Mid-Late Roman and Early Anglo-Saxon)

4.4.3.1 The site

The site of Mill Street, Wantage, was excavated in 1993-1994. Local subsoils consist of colluvial deposits with highly calcareous properties which, to some extent, limited the preservation of animal remains (Fig. 4.24). The site was located next to the Letcombe brook and close to the supposed Roman road linking Wantage to Alcester. For the Early Roman period (Period 1), some field boundaries, ditches and one pit were the only identified features. In the mid-2nd century (Period 2) a small timber granary was constructed, along with a rectangular (probably domestic) building and other aligned timber structures; these remained in use until the mid-3rd century. Three ditches, a number of pits and a well are also dated to this phase. In the mid-3rd/early 4th century (Period 3) the timber granary was demolished and replaced with a stone multi-storey structure (a 'tower' granary); some contemporary ditches may represent livestock enclosures. In the Early Anglo-Saxon period (Periods 4 and 5), the tower was demolished, previous ditches were infilled and deposits sealed. A series of new ditched enclosures appear; previous middens were excavated and redeposited, probably for the creation of agricultural plots. Finds from this period include concentrations of loom weights, which provide evidence for textile production at the site (Holbrook and Thomas 1997) (Tab. 4.6 and Fig. 4.14).

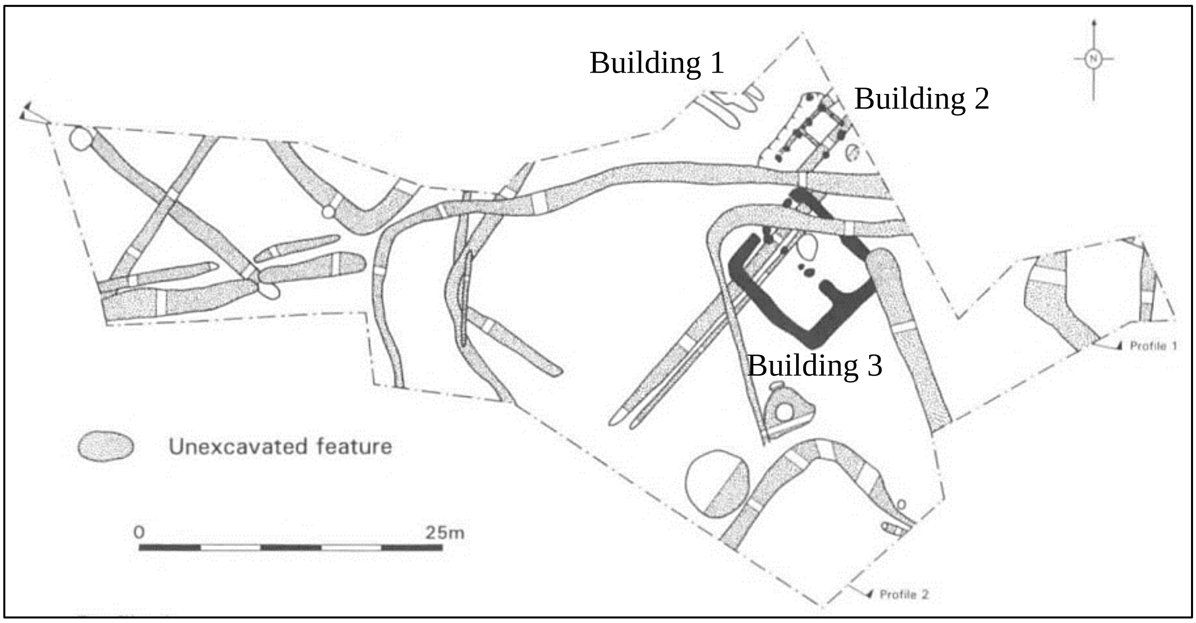


Fig. 4.14 Plan of all features from the site of Mill Street, Wantage, Oxfordshire. Building 1 (timber granary) and Building 2 are from Period 2, while Building 3 (tower granary) belongs to Period 3 (adapted from Holbrook and Thomas 1997, 113, Fig. 3).

4.4.3.2 The faunal assemblage

The report on animal remains in the site publication indicates a mild level of surface erosion for much of the material, although the overall preservation was good (Maltby 1997). The assemblage is dominated by the main domesticates, especially cattle and sheep; the incidence of cattle increases throughout the Roman period, and many cattle bones from Roman contexts present evidence for specialised butchery practices. Wild food mammals (mainly cervids and hare) are very rare in all phases (Maltby 1997). The animal remains included in this study belong to the Middle-Late Roman and Early Anglo-Saxon periods (Periods 2-5). Considering similarities in site-type, the small-sized Roman sample from this site (217 recorded fragments) was combined in this study with that from Denchworth Road, Wantage (§ *4.4.2*).

4.4.4 Benson (Early Anglo-Saxon)

4.4.4.1 The site

The site of St Helen's Avenue, Benson, was excavated in 1999. Occupation covered a long time span, from the Neolithic to the Early Anglo-Saxon period, although the main phase of occupation refers to the 5th-7th centuries AD. Roman activity at the site was minimal. The main Early Anglo-Saxon features are three SFBs and associated post-holes; fills from their hollows produced a good amount of Saxon pottery, other portable objects, and animal remains. Radiocarbon dating for one of the buildings produced a date of 545-659 cal. AD. Other contemporary features include an elongated rectangular ditched enclosure, probably related to agricultural activities or animal rearing, which has been tentatively interpreted by the excavators as a paddock; a smaller sub-rectangular enclosure, possibly a small animal pen; a gully, various pits, and apparently unrelated post-holes (Pine and Ford 2003) (Fig. 4.15).

4.4.4.2 The faunal assemblage

A previous study of the animal remains from the site revealed a sheep-dominated assemblage in pre-Roman phases. Most of the faunal remains were recovered from Early Anglo-Saxon contexts. It is unsure whether the material cumulated during occupation or shortly after abandonment; most likely, it was a combination of both (Hamilton-Dyer 2003). As a result, the assemblage cannot be more closely dated than to the 5th-7th centuries AD; it consists of 173 recorded fragments.

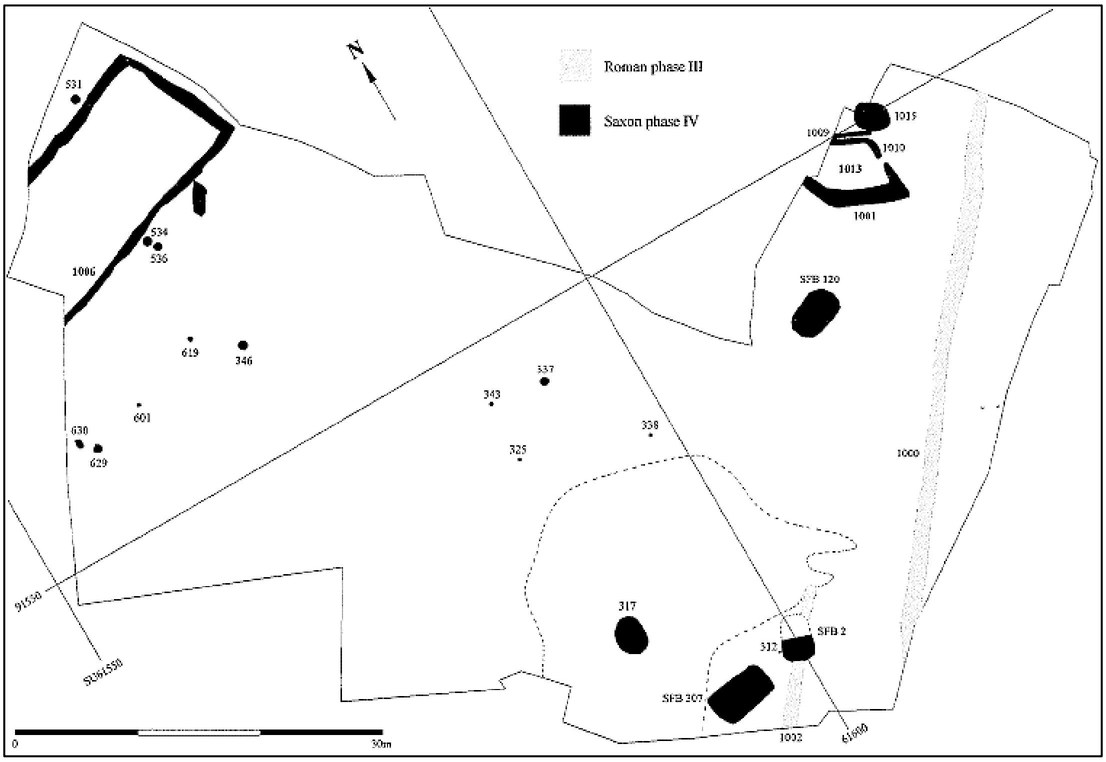


Fig. 4.15 Plan of the site of St Helen's Avenue, Benson, Oxfordshire; Roman and Early Anglo-Saxon features (Pine and Ford 2003, 142, Fig. 8).

4.4.5 Oxford Science Park (Early Anglo-Saxon)

4.4.5.1 The site

Excavations at Oxford Science Park, Littlemore, took place in 1999 and revealed a long sequence of occupation, spanning from the Mesolithic to the Middle Ages (Moore 2001) (Tab. 4.7). The local subsoil is characterised by sandy clays with occasional limestone layers (Fig. 4.24); the Littlemore brook, passing by the site, was probably managed at one or more points in antiquity to counteract flooding. Only residual pottery sherds attest to occupation during the Roman period. Most of the features and materials recovered date to the Early Anglo-Saxon period (Moore 2001). About 12 SFBs and associated post-holes and stake-holes were dated to the 6th-early 7th centuries AD; as an average life of 20-25 years is generally assumed for these buildings, no more than 3-5 buildings would have been in use at any single time. Items related to textile production and other objects were recovered from the SFBs' fills. A number of pits were identified as well and were dated to the same phase (Fig. 4.16). The fills of SFBs and pits contained very little residual and intrusive material, highlighting the reliability of the date of the faunal assemblage (Moore 2001).

4.4.5.2 The faunal assemblage

Most of the Early Anglo-Saxon animal remains were recovered from the fills of the SFBs, which were apparently used for food waste disposal after abandonment. The assemblage is dominated by the main domesticates, with very few wild taxa recorded (mainly cervids and hare) (Ingrem 2001). The material used in this study is dated to the 6th-early 7th centuries AD, and consists of 342 recorded fragments.

OXFORD SCIENCE PARK	
Period 1	Mesolithic-Bronze Age
Period 2	Iron Age
Period 3 (abandonment?)	Roman period
Period 4	Early Anglo-Saxon, 6th-early 7th centuries AD
Period 5	medieval
Period 6	post-medieval

Tab. 4.7 Phases at Oxford Science Park, Oxfordshire (Moore 2001).

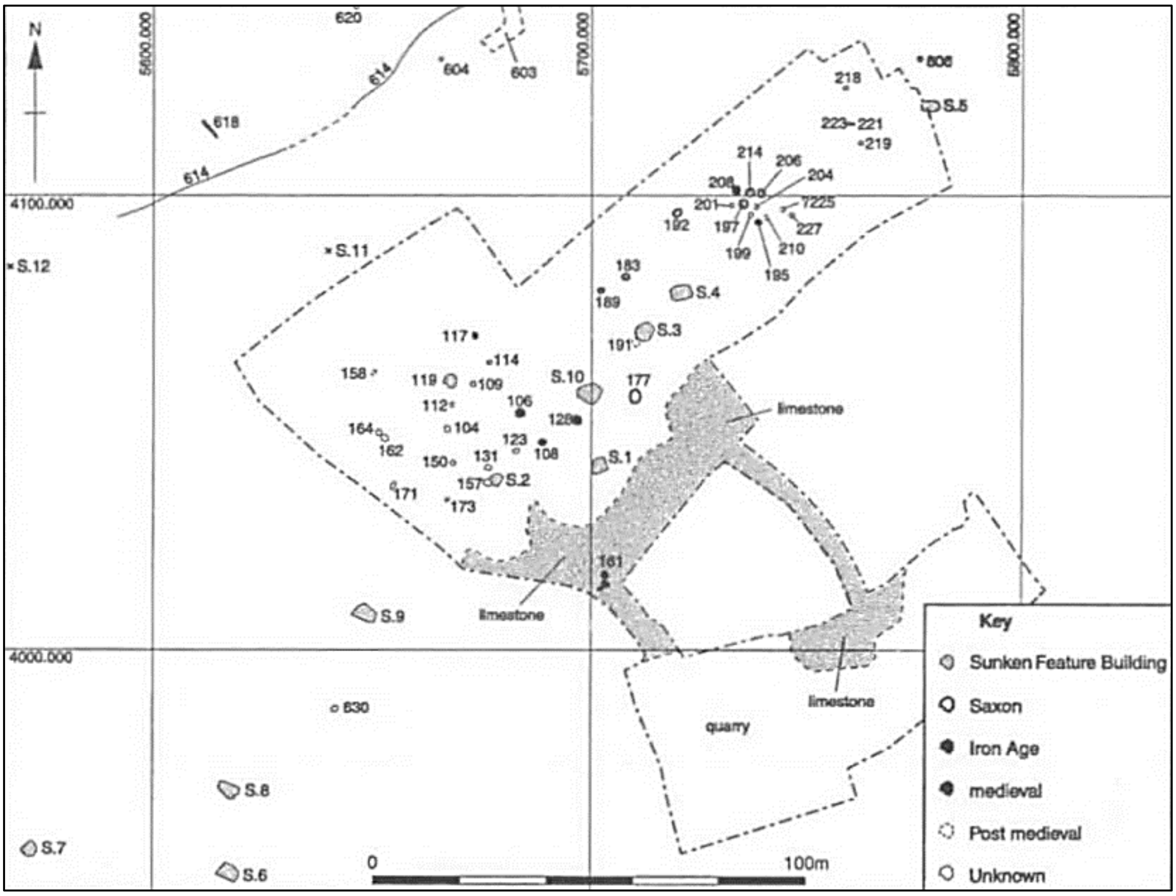


Fig. 4.16 Plan of the site of Oxford Science Park, Oxfordshire (Moore 2001, 169, Fig. 3).

4.5 Lower Rhineland

4.5.1 De Geer (Late Roman)

4.5.1.1 The site

The site of De Geer (prov. Utrecht; excavated between 1989-1994) occupies part of the western edge of the broad river basin created by a bifurcation of the river Rhine; as a consequence, it is surrounded by a low-lying, wet terrain (Fig. 4.26). Archaeological evidence from the site spans from the Late Bronze Age to the Carolingian period (750-850 AD) (Tab. 4.8). Unlike most sites in the region, De Geer flourished in the Early-Middle Roman as well as in the Late Roman periods, when most settlements become archaeologically invisible. In the 2nd century, the construction of an enclosure suggests a continuation of Late Iron Age and Early Roman building traditions (van Es and Verwers 2010).

Following a brief period of abandonment between the late 3rd-early 4th centuries AD, when the whole Lower Rhineland suffered Frankish raids from Germany, the site was reoccupied as order was re-established under Constantine. While in the Early-Middle Roman period contacts with the north-western coast of Frisia had ceased and been replaced by more local productions and Roman imports, in the Late Roman period Germanic pottery is again present; in particular, the Rhine-Weser Germanic (RWG) style group, typical of the region north of the Rhine, is well represented (van Es and Verwers 2010).

The Lower Rhineland was at this time settled by Frankish communities. However, it is unknown whether developments in De Geer derive from forced occupation, following invasion, or accommodation agreed with Roman authorities; the politico-military history of the area, along with the continued presence of Roman material culture in this period, seem to support the latter hypothesis. Roman-type brooches were common in Late Roman De Geer, as were Roman coins and other metal finds from the so-called *Foederatenhorizont*. At this point the site was composed of a number of farmsteads, possibly still lying within the 2nd-century enclosure. For the Merovingian period only clusters and rows of pits have been identified, these having been used for waste disposal and/or as latrines; elsewhere in the regions such features were located next to timber buildings, which could have been present at De Geer as well. A number of wells were also excavated (Fig. 4.17). Although the full extent of the site is still unknown, occupation continued into the Carolingian period (van Es and Verwers 2010 and references therein).

4.5.1.2 The faunal assemblage

The faunal material selected for this study belongs to the Late Roman phase (Phase 5: ca. AD 300-450), and consists of 637 recorded fragments.

DE GEER	
Phase 1	Late Bronze Age, 1300-700 BC
Phase 2	Middle-Late Iron Age, 500 BC-0
Phase 3	Late Iron Age-Early Roman period, 50 BC-AD 70
Phase 4	Middle Roman period, AD 70-250/275
abandonment	AD 250/275-300/325
Phase 5	Late Roman period, AD 300/325-450
Phase 6	Merovingian period, AD 450-650
Phase 7	Late Merovingian-Early Carolingian periods, AD 650-750
Phase 8	Carolingian period, AD 750-850

Tab. 4.8 Phases at De Geer, prov. Utrecht (adapted from van Es and Verwers 2010).

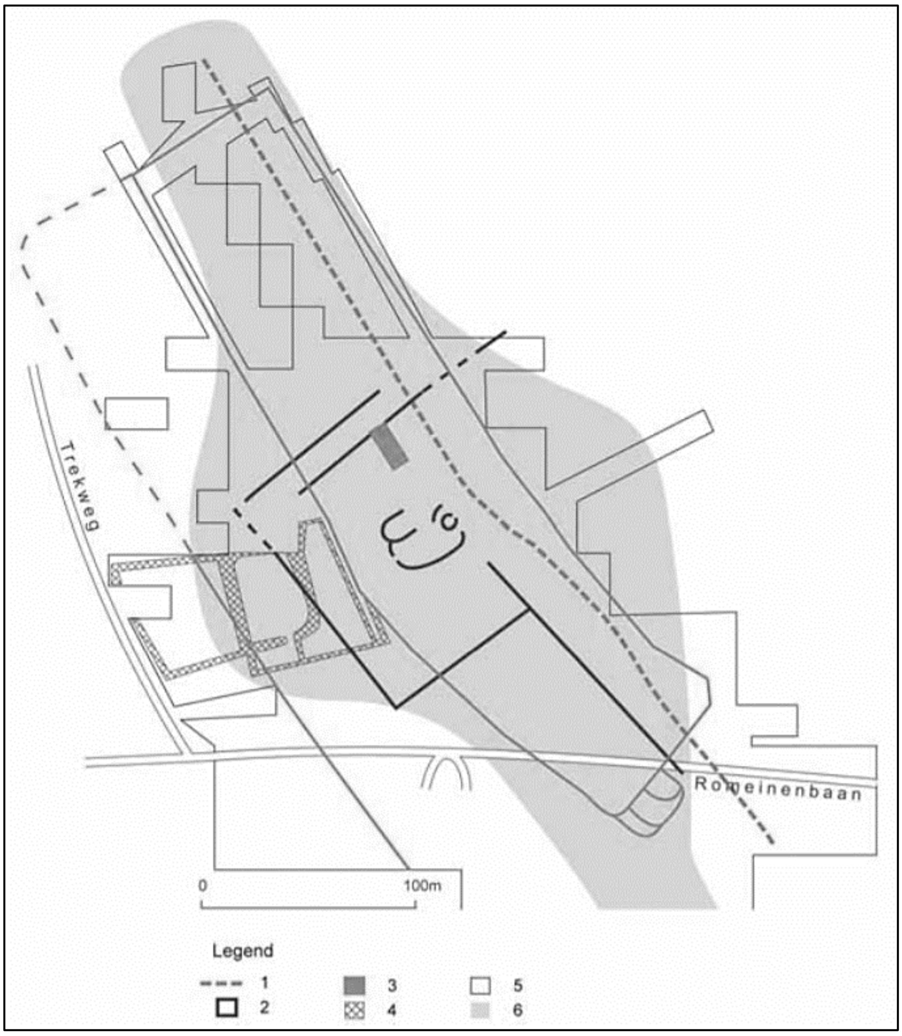


Fig. 4.17 Plan of the site of De Geer, prov. Utrecht; 1: western bank of former riverbed, 2: Roman remains, 3: Carolingian remains, 4: moated dwelling site, 5: limits of excavated area, 6: phosphate concentration (van Es and Verwers 2010, 17, Fig. 9).

4.5.2 Oegstgeest (Merovingian)

4.5.2.1 The site

The site of Oegstgeest (prov. South Holland) was excavated between 2004 and 2014. It lies on the eastern bank of the Rhine, opposite the Early Medieval settlement of Valkenburg (§ *4.5.3*), on top of a sand ridge (Fig. 4.27). Palaeochannels detected at the site indicate it was partly surrounded by water courses; like Valkenburg, its location close to the river and channels would have favoured the transport of goods and people. The site includes rectangular timber dwellings with associated smaller outbuildings. All features are dated to the 6th-7th centuries AD; the settlement was abandoned by ca. 700 AD, when the secondary water courses silted up

(Fig. 4.18). The abandonment of Oegstgeest is paralleled by the disappearance of other similar small settlements in the area, following a process of political and economic centralisation which led to the rise of the *emporium* at Dorestad; later features date to the 10th-11th centuries (Dijkstra 2011).

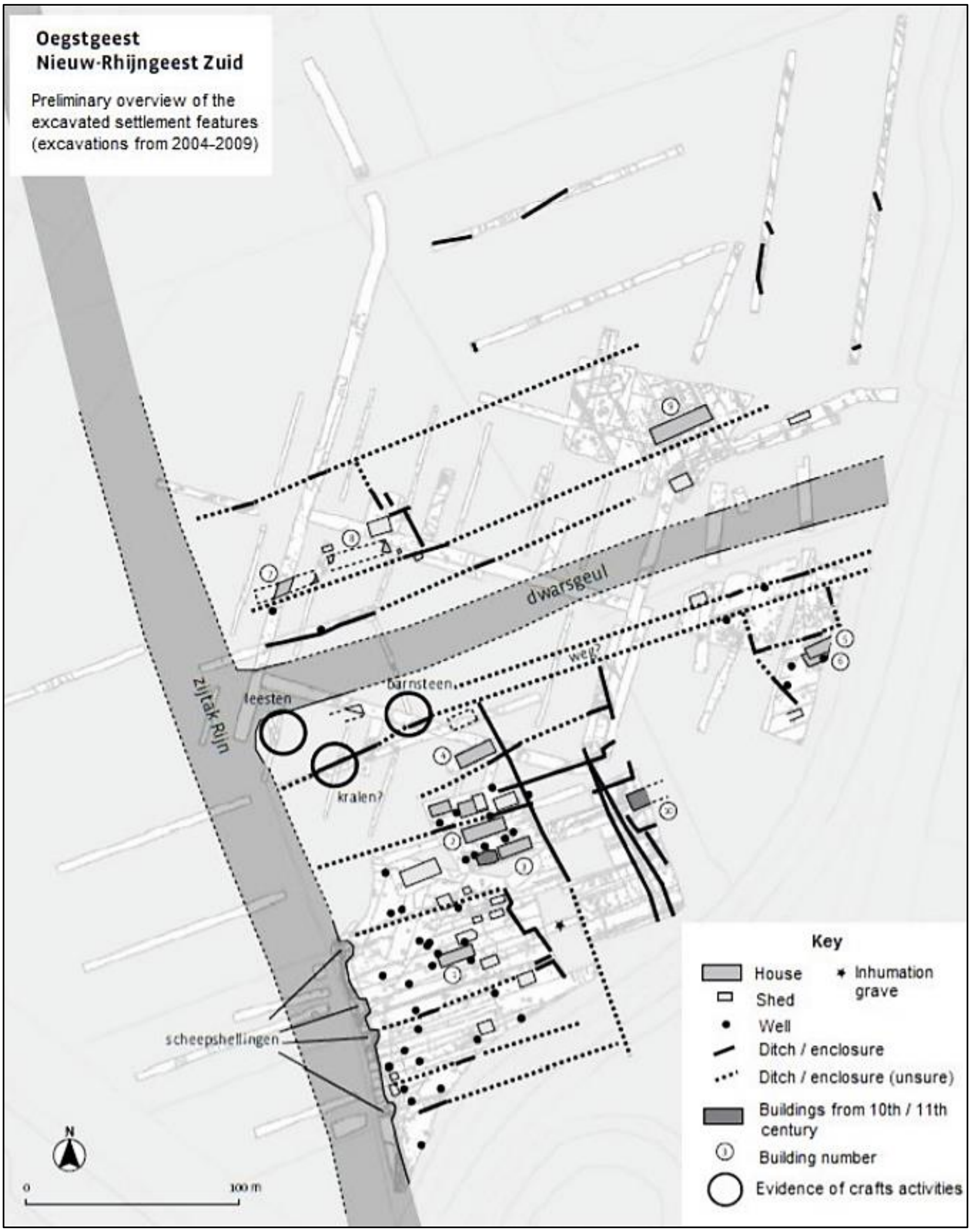


Fig. 4.18 Partial plan of the site of Oegstgeest, prov. South Holland (excavated features up to 2009) (Dijkstra 2011, 135, Fig. 4.15).

4.5.2.2 The faunal assemblage

The animal bones and teeth analysed for this study represent a selection of those collected from the site, and consists of 2784 recorded fragments. The wet conditions of most deposits, as well as the disposal of some of the food waste in contexts associated with the palaeochannels, allowed for an overall good preservation of the faunal material. The whole assemblage is dated to the 6th-7th centuries AD.

4.5.3 Valkenburg (Merovingian)

4.5.3.1 The site

The site of Valkenburg – De Woerd (prov. South Holland) was a major Roman military and civilian settlement. In the mid-1st century AD a military harbour was established on the western bank of the river Rhine. A *vicus* or *castellum* developed close to it. In the 2nd century a larger civilian settlement replaced the port, although military presence at the site continued. Like other sites in the region, Roman occupation ceased in the first half of the 3rd century. The excavation of the site in 1986-1988 revealed evidence of Early Medieval occupation, starting in AD 575/600 (Tab. 4.9) (van Es and Verwers 2010). Lying along the inner curve of a meander of the Rhine, the site was located opposite from the river to Oegstgeest (§ *4.5.2*), with which it was certainly in close relation (Fig. 4.27). The shore of the Rhine, along which the Early Medieval site is located, was divided in narrow plots perpendicularly to the river; such plots contained rectangular timber buildings. A number of wells, organised in a row along the settlement, were identified (Bult and Hallewas 1987; Bult *et al*. 1990). The site has been interpreted as a small, secondary trading settlement which also engaged in agricultural production; it is one of many such settlements in the area, which are considered precursors of the larger *emporium* of Dorestad (van Es and Verwers 2010).

4.5.3.2 The faunal assemblage

The animal remains selected for this study (519 recorded fragments) are broadly dated to the Merovingian period (late 6th-early 8th centuries AD), and originate from deposits excavated within the house plots and related features.

VALKENBURG	
Period 1	Early Roman period, 2nd half of 1st century AD (military)
Period 2	Middle Roman period, 2nd-early 3rd centuries AD (civilian and military)
Period 3 (abandonment)	Late Roman and Early Merovingian periods, early 3rd-late 6th centuries AD
Period 4	Merovingian period, late 6th-early 8th centuries AD

Tab. 4.9 Phases at Valkenburg, prov. South Holland (adapted from van Es and Verwers 2010).

4.5.4 Heeten (Late Roman)

4.5.4.1 The site

Excavations at the site of Heeten (prov. Overijssel) in 1994 revealed an occupation sequence spanning from the late 2nd to the 4th-5th centuries AD. The site lies on the edge of a large coversand ridge and is surrounded by a marshy depression lacking natural drainage (Fig. 4.26). Pollen analyses suggest the presence of open landscapes; the oak forest in the vicinity of the settlement had disappeared by the 4th century. Most of the occupation evidence at Heeten is dated to the 4th century, and its inhabitants were probably part of the Germanic tribe of the Franks (Verlinde 1995). The settlement was enclosed by a large rectangular defended trench; it hosted several timber buildings, including about 20 SFBs, a dozen large granaries, and some wells, one of which was dendrochronologically dated to the 280s-330s AD (Fig. 4.19). The recovery of large amounts of iron slag throughout the site indicates large-scale iron production, which may be responsible for the disappearance of most of the oak forest. In sum, according to the archaeological evidence, Heeten represents a site of special importance in the area, probably controlled by the local elite, thus suggesting the existence of some degree of socio-economic stratification (Verlinde 1995).

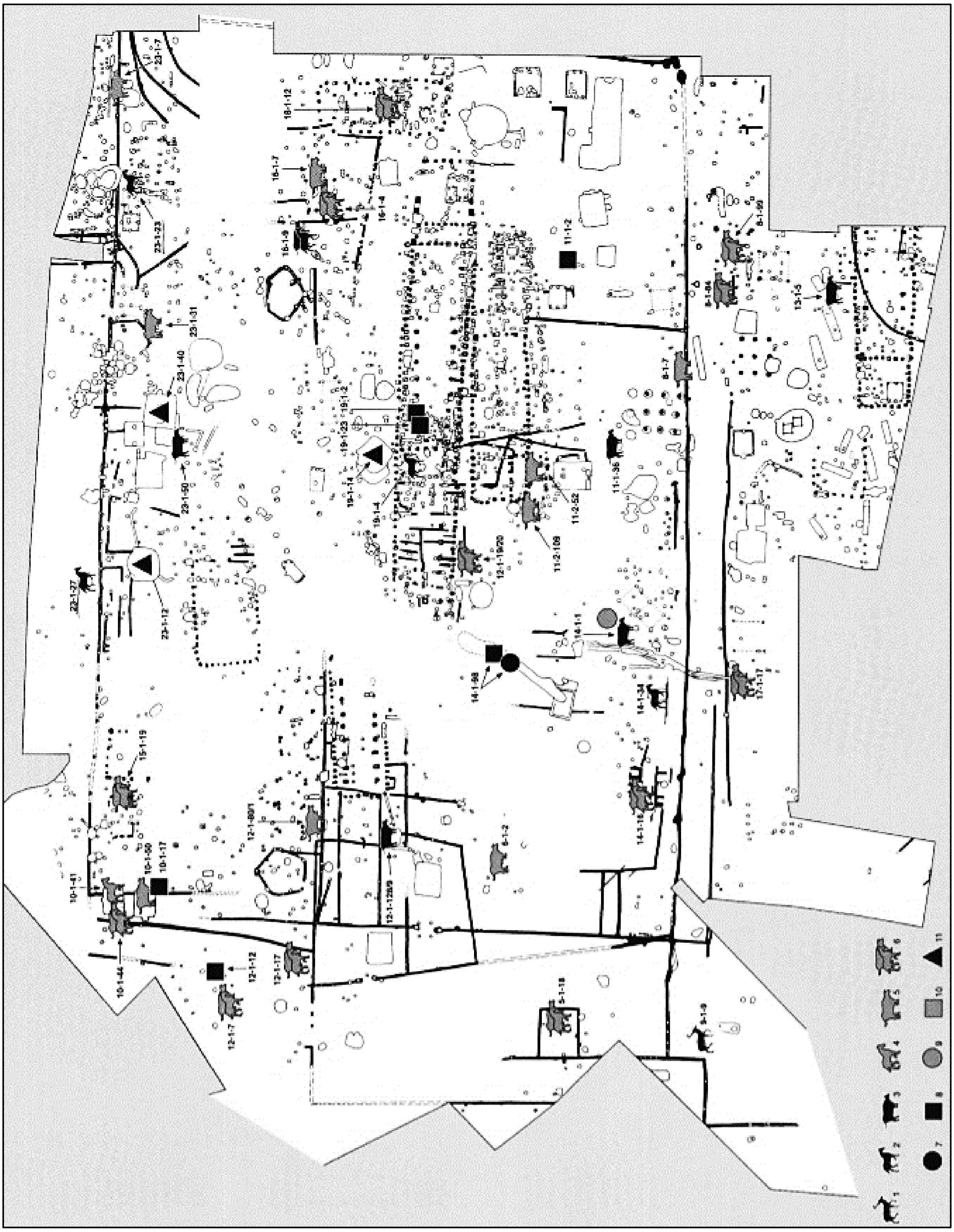


Fig. 4.19 Plan of the site of Heeten, prov. Overijssel, showing the identified features along with animal burials, heads, and bone dumps (1: red deer; 2: horse; 3: cattle; 4: probably horse; 5: probably cattle; 6: possible animal burial; 7: horse head; 8: cattle head; 9: probably horse head; 10: probably cattle head; 11: bone dump) (Lauwerier *et al*. 1999, 158, Fig. 3).

4.5.4.2 The faunal assemblage

Animal remains were recovered from a variety of features. Non-articulated remains from pits, trenches, SFBs' fills and postholes were interpreted as food waste disposal; several large bone 'dumps' could have had a different function, but are treated in this study together with remains from food disposal features, as they have not been interpreted as certain ritual contexts. Some pits containing whole articulated skeletons might have a ritual origin; these are not considered in this study. Considering the nature of the settlement, it is possible that animal resources were imported from the surrounding countryside; a similar conclusion was made for the rye seeds recovered from the site (Lauwerier *et al.* 1999). Game was present but uncommon, suggesting that hunting was rarely practiced and that most of the meat consumed was from domestic animals. The material analysed for this study is dated to the 3rd-4th centuries AD, and consists of 583 recorded fragments.

4.5.5 Wijnaldum-Tjitsma (Mid-Late Roman and Merovingian)

4.5.5.1 The site

The site of Wijnaldum-Tjitsma (prov. Friesland), excavated in the early 1990s, presents a sequence of occupation spanning from the late 2nd to the mid-10th centuries AD (Tab. 4.10). It was founded on a brackish marsh overlaying sandy tidal flat deposits (Fig. 4.26). The gullies and streams around the site would have facilitated communications as well as drainage. Flooding during high tides and the gradual sea-level rise would have required constant management; like elsewhere in the terp region, a dyke-like structure was built to protect arable fields and pastures, and the first buildings (before the terp built up) were constructed on raised platforms. Two such structures were the first buildings at the site. After a period of demographic growth, the whole region experienced demographic decline in the second half of the 3rd century. Between the mid-4th and early 5th centuries the site was abandoned. New occupation since ca. AD 425 shows changes in material culture, settlement layout and building practices; old Frisian elements were abandoned in favour of Saxon ones, although it is not clear whether as a result of migration or acculturation. In this period (Phases III-V) the settlement expanded outside the terp and the main timber structures are associated with SFBs; three-aisled timber buildings only appeared around AD 700. Occupation at the site continues into the Carolingian and Ottonian periods. Finds from all phases suggest contacts and long-distance trade with other regions around the North Sea as well as with the Rhineland. Craft production played a major role at the site; agriculture was practiced, and the marshy area around the site was very well suited for grazing. The importance of manufacture, including that of medium-high status items, highlights the peculiar role of the settlement in the region, especially since the 5th century (Gerrets and de Koning 1999).

4.5.5.2 The faunal assemblage

The faunal assemblage from Wijnaldum largely derives from food waste disposal; it presents similarities with other terp sites in the region, at least in terms of species frequency (predominance of sheep) and use. Although the main domesticates predominate, intensive fowling and fishing were practiced, suggesting this was a specialised activity (Fig. 4.20). Deer skins were imported at the site, although the contribution of wild mammals to the diet was very low (Prummel *et al*. 2013). The assemblage analysed for this study is dated to the late 2nd-mid-3rd and to the early 5th-mid-8th centuries AD, and consists of 942 recorded fragments.

WIJNALDUM-TJITSMA	
Phases I-II	Roman period, AD 175-350
abandonment	AD 350-425
Phase IIIA	Migration period, AD 425-475
Phase IIIB	Migration period, AD 475-550
Phase IV	Merovingian period, AD 550-650
Phase V	Merovingian period, AD 650-750
Phase VI	Carolingian period, AD 750-800
Phase VII	Carolingian period, AD 800-850
Phase VIII	Ottonian period, AD 850-900/950

Tab. 4.10 Phases at Wijnaldum-Tjitsma, prov. Friesland (Gerrets and de Koning 1999).

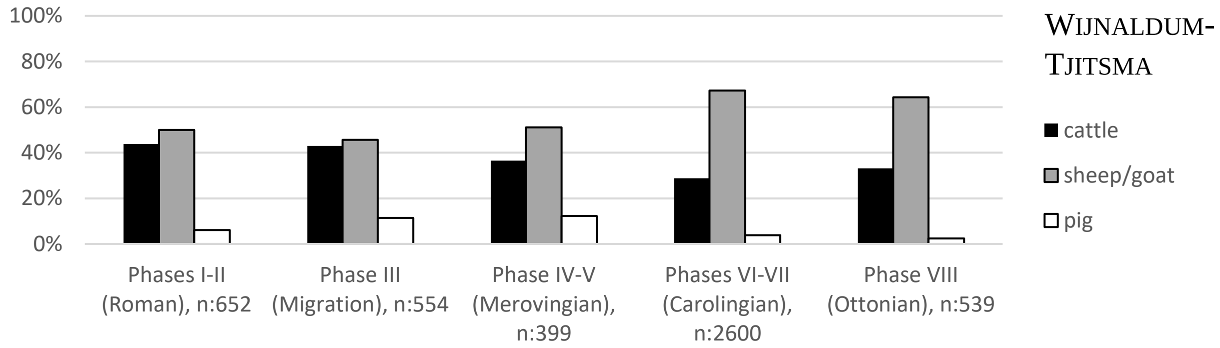


Fig. 4.20 Species frequency for the three main domesticates at Wijnaldum-Tjitsma, prov. Friesland, from the Roman to the Ottonian periods (Prummel *et al*. 2013).

4.6 Summary and reference maps

Tab. 4.11 summarises essential information on the assemblages analysed as part of this study. Fig. 4.21 summarises the chronologies for the sites described in § 4.2-4.5, specifying the chronological span covered by the assemblages selected from each site and analysed in this study. The geological and soil type backgrounds for each of the study-regions are provided in Figs. 4.22-27; these maps support the descriptions provided in § 4.2-4.5, and are also referred to in Chapter 7: Discussion.

SITE	COUNTY/ PROVINCE	CHRONOLOGY AD	SITE TYPE	RECORDED FRAGMENTS	REFERENCE TO PREVIOUS STUDIES
Pakenham	Suffolk	mid-3rd-4th c.	rural	528	Beech 1991
Icklingham	Suffolk	late 2nd-mid-4th c.	rural (close to villa)	557	Crabtree 2010
West Stow	Suffolk	5th-7th c.	rural	3996	Crabtree 1989; 1990
Cambourne	Cambridgeshire	mid-2nd-4th c.	rural	1112	Hamilton-Dyer 2009
Gamlingay	Cambridgeshire	5th-7th c.	rural	946	Roberts 2006
Asthall	Oxfordshire	3rd-4th c.	rural/urban (roadside settlement)	391	Powell *et al*. 1997
Denchworth Rd, Wantage	Oxfordshire	mid-2nd-late 4th c.	rural (roadside settlement)	116	Maltby 2001
Mill Street, Wantage	Oxfordshire	mid-2nd-7th c.	rural (roadside settlement)	217	Maltby 1997
Benson	Oxfordshire	5th-7th c.	rural	173	Hamilton-Dyer 2003
Oxford Science Park	Oxfordshire	6th-early 7th c.	rural	342	Ingrem 2001
De Geer	Utrecht	4th-mid-8th c.	rural	637	-
Oegstgeest	South Holland	6th-7th c.	rural/trading settlement	2784	-
Valkenburg	South Holland	late 6th-early 8th c.	rural/trading settlement	519	-
Heeten	Overijssel	3rd-4th c.	rural (consumer site, specialised productions, high status?)	583	Lauwerier *et al*. 1999
Wijnaldum-Tjitsma	Friesland	late 2nd-mid-4th and early 5th-mid-8th c.	rural (specialised productions)	942	Prummel *et al*. 2013

Tab. 4.11 Summary of essential information on the assemblages analysed for this study. Chronologies refer to the part(s) of the assemblages selected for each site to be included in the analyses (see text and Fig. 4.21 for more detailed chronologies). c.: centuries. Recorded fragments refer to the sum of entries for cattle, caprines, and suids.

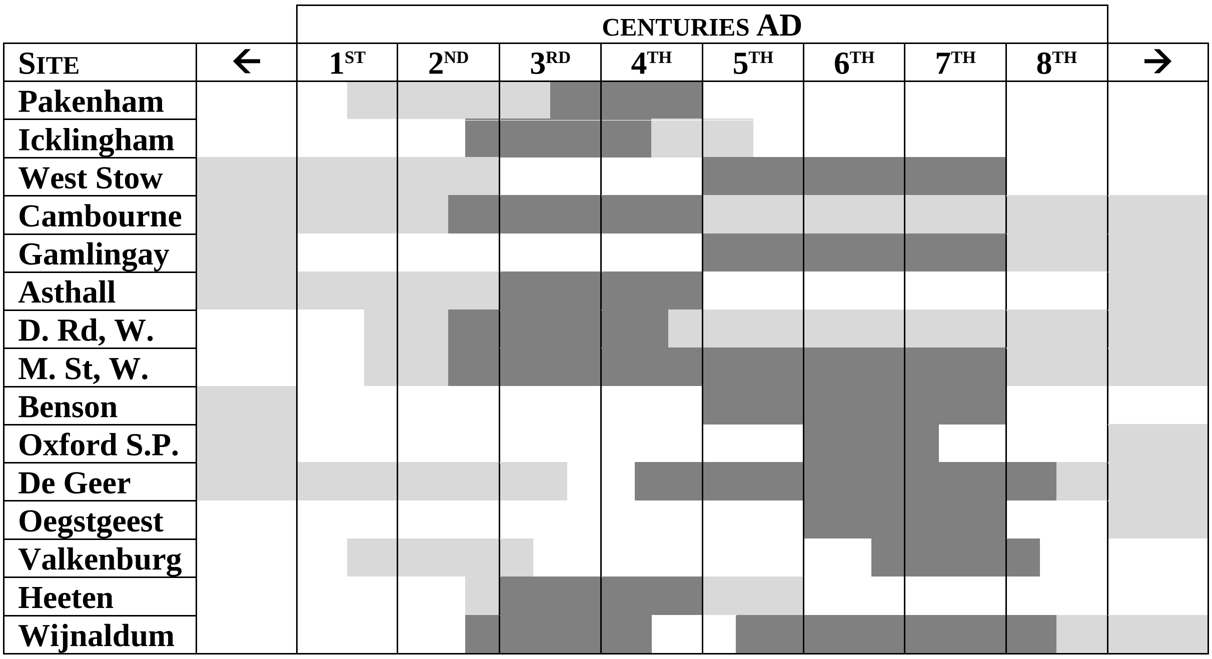


Fig. 4.21 Summary of chronologies for the sites whose assemblages have been analysed in this study; occupation phases in light grey, chronological spans of the assemblages selected for this study in dark grey.

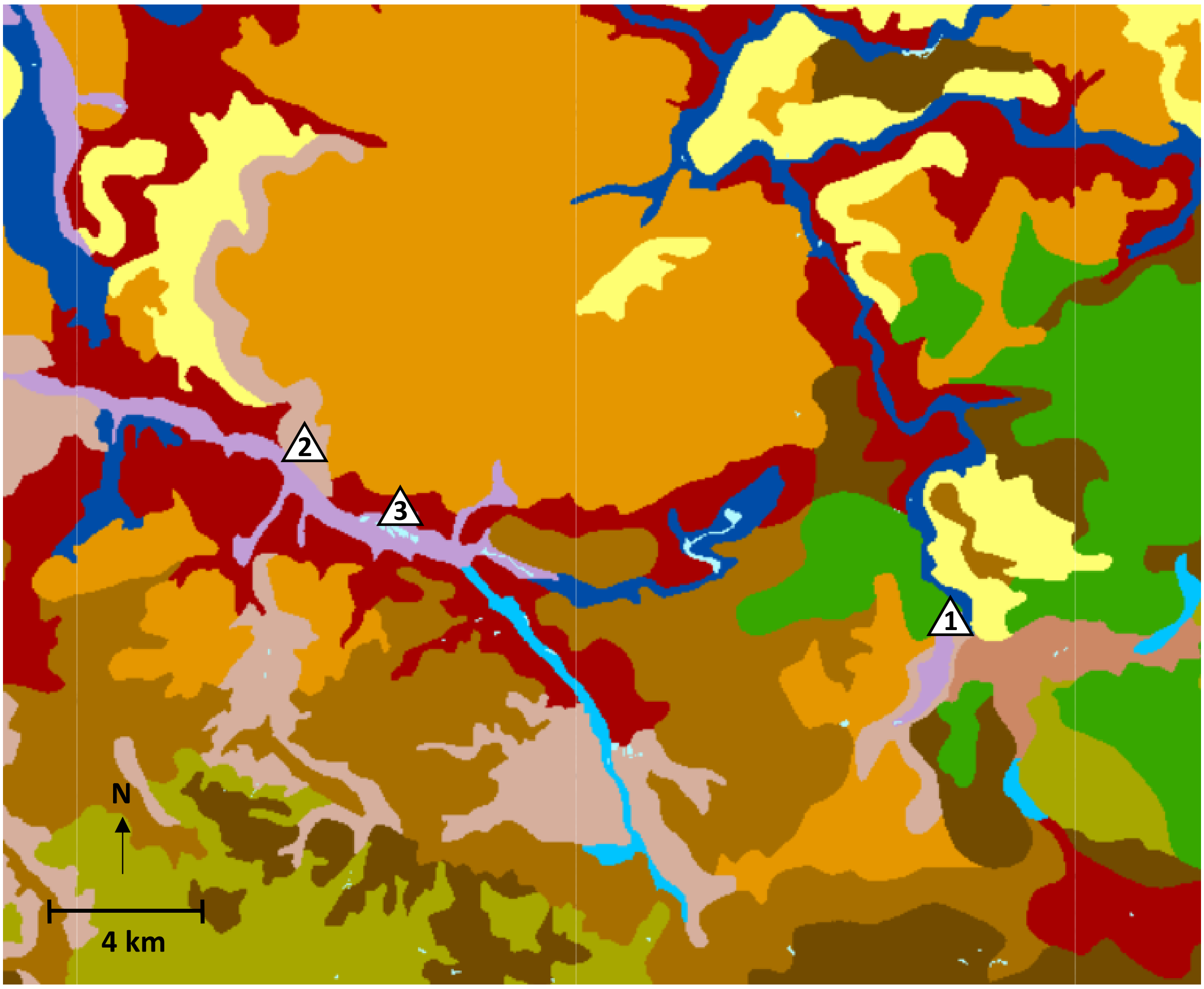


Fig. 4.22 Distribution of soil types in northwest Suffolk (© LandIS 2019). The Breckland is a natural microregion characterised by lighter soils (Natural England 2012). The sites analysed in this study have been added (1: Pakenham; 2: Icklingham; 3: West Stow). The legend to soil types is provided in Fig. 4.25.

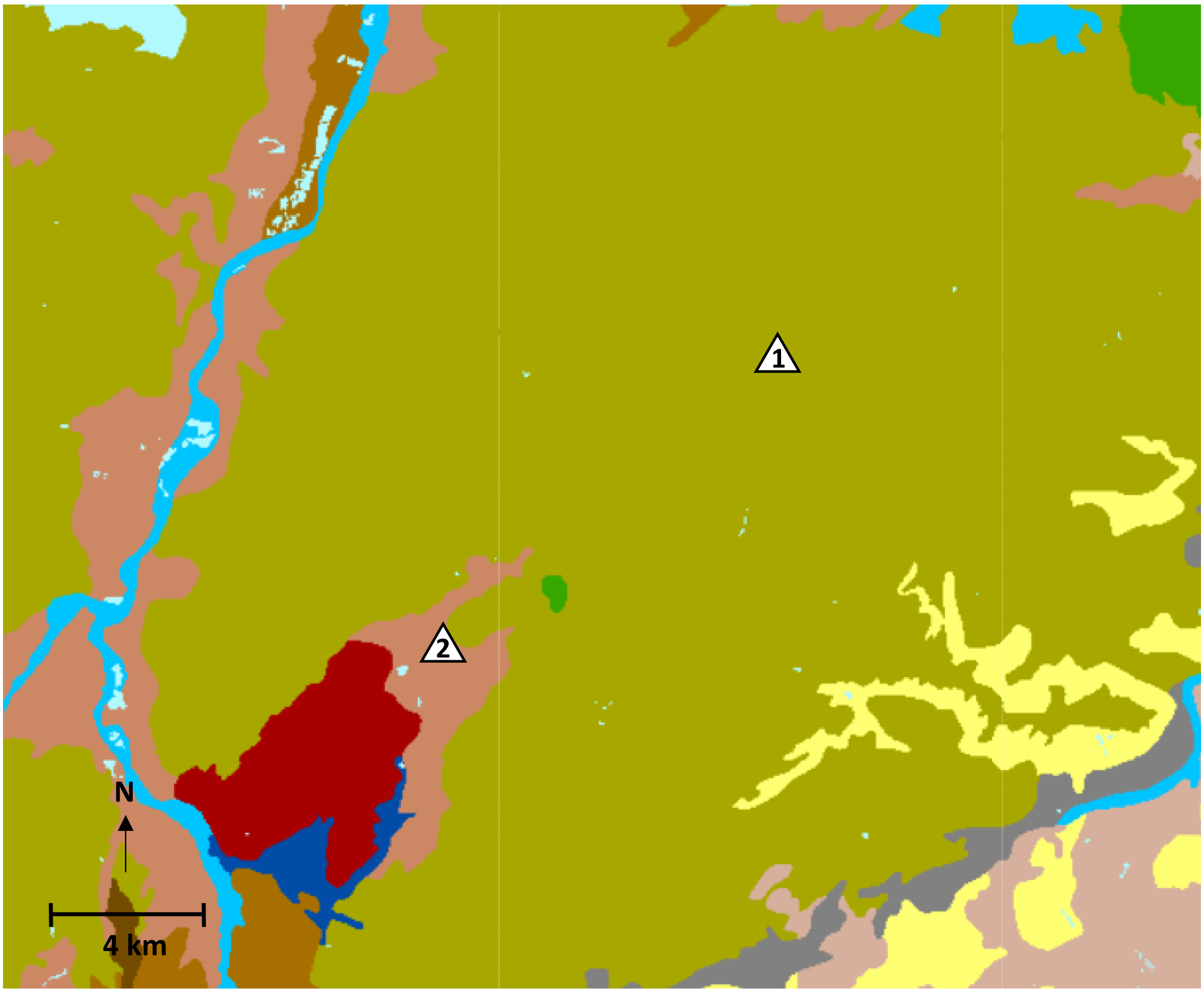


Fig. 4.23 Distribution of soil types in southwest Cambridgeshire (© LandIS 2019). The area is dominated by lime-rich loamy and clayey soils. The sites analysed in this study have been added (1: Cambourne; 2: Gamlingay). The legend to soil types is provided in Fig. 4.25.

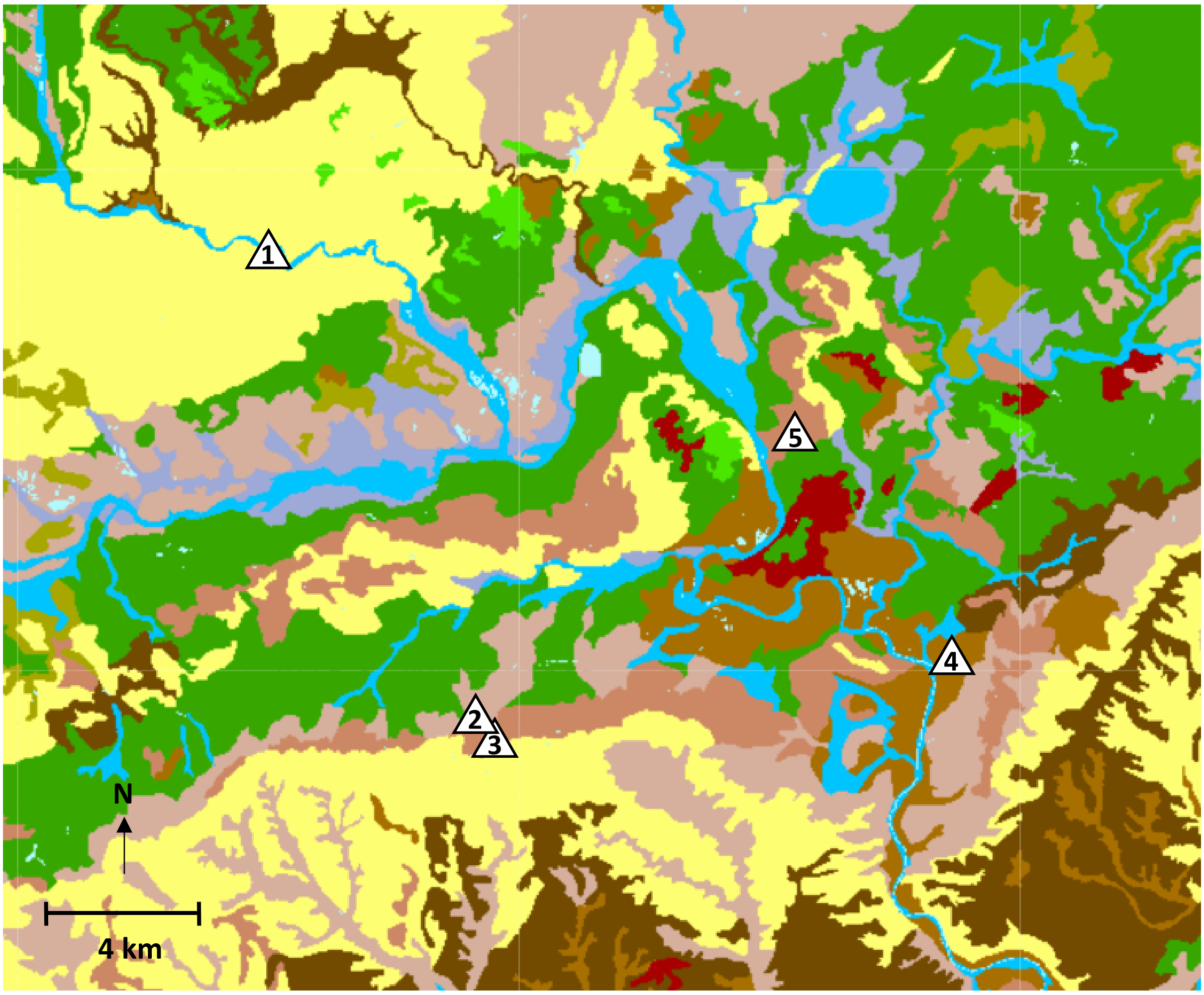


Fig. 4.24 Distribution of soil types in central Oxfordshire (© LandIS 2019). The sites analysed in this study have been added (1: Asthall; 2: Denchworth Road, Wantage; 3: Mill Street, Wantage; 4: Benson; 5: Oxford Science Park). The legend to soil types is provided in Fig. 4.25.

Fig. 4.25 Legend for the soil type maps in Figs. 4.22-4.24 (© LandIS 2019).

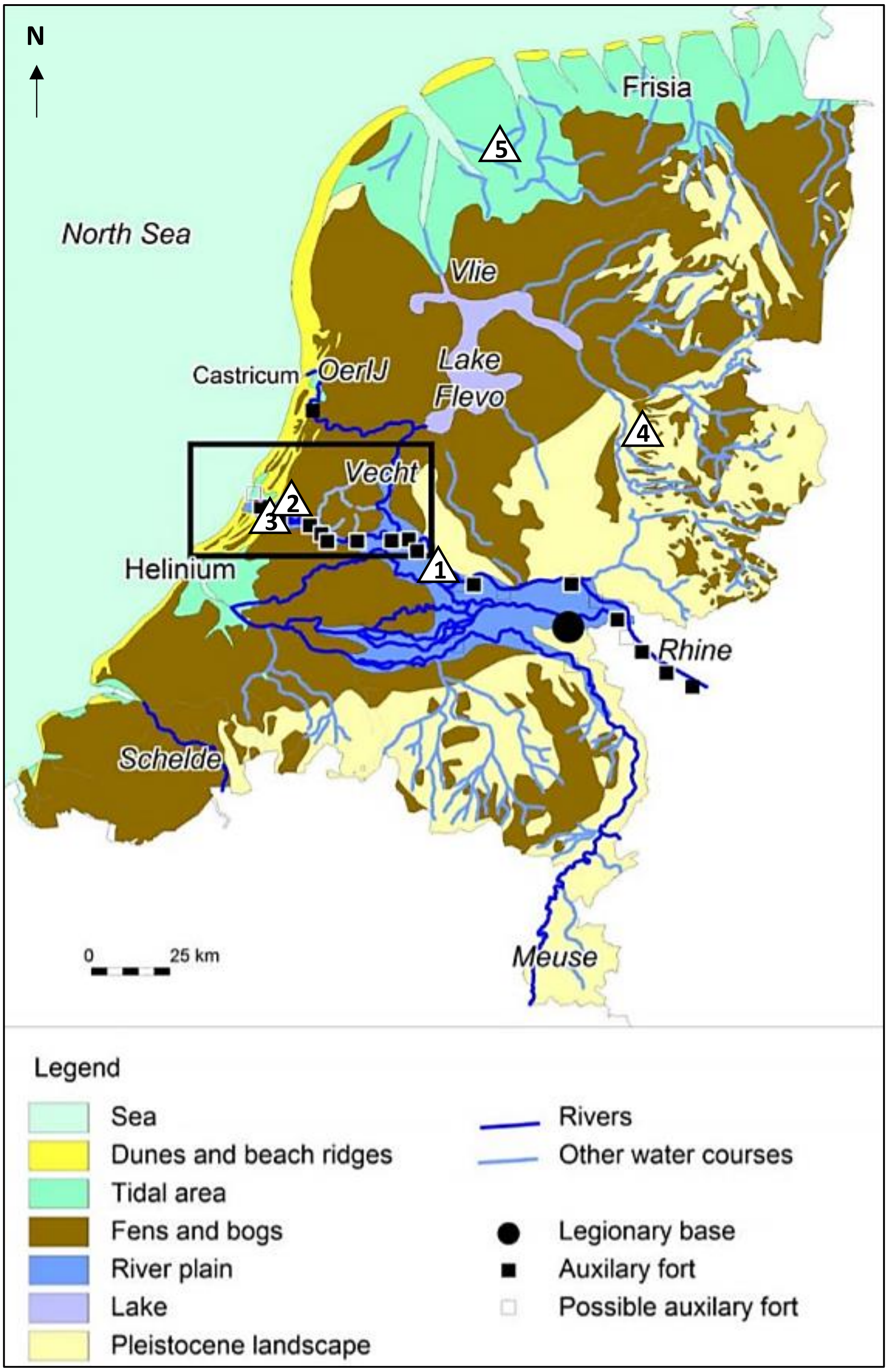


Fig. 4.26 Palaeogeographic map of the Netherlands (largely including the Lower Rhineland and the regions north of the Rhine) during the Roman period; the area of the western Lower Rhine delta, along which the *limes* ran, is indicated by a black rectangle, and zoomed in in Fig. 4.27; the sites analysed for this study have been added (1: De Geer; 2: Oegstgeest; 3: Valkenburg; 4: Heeten; 5: Wijnaldum-Tjitsma) (adapted from van Dinter 2017, 29, Fig. 2.2).

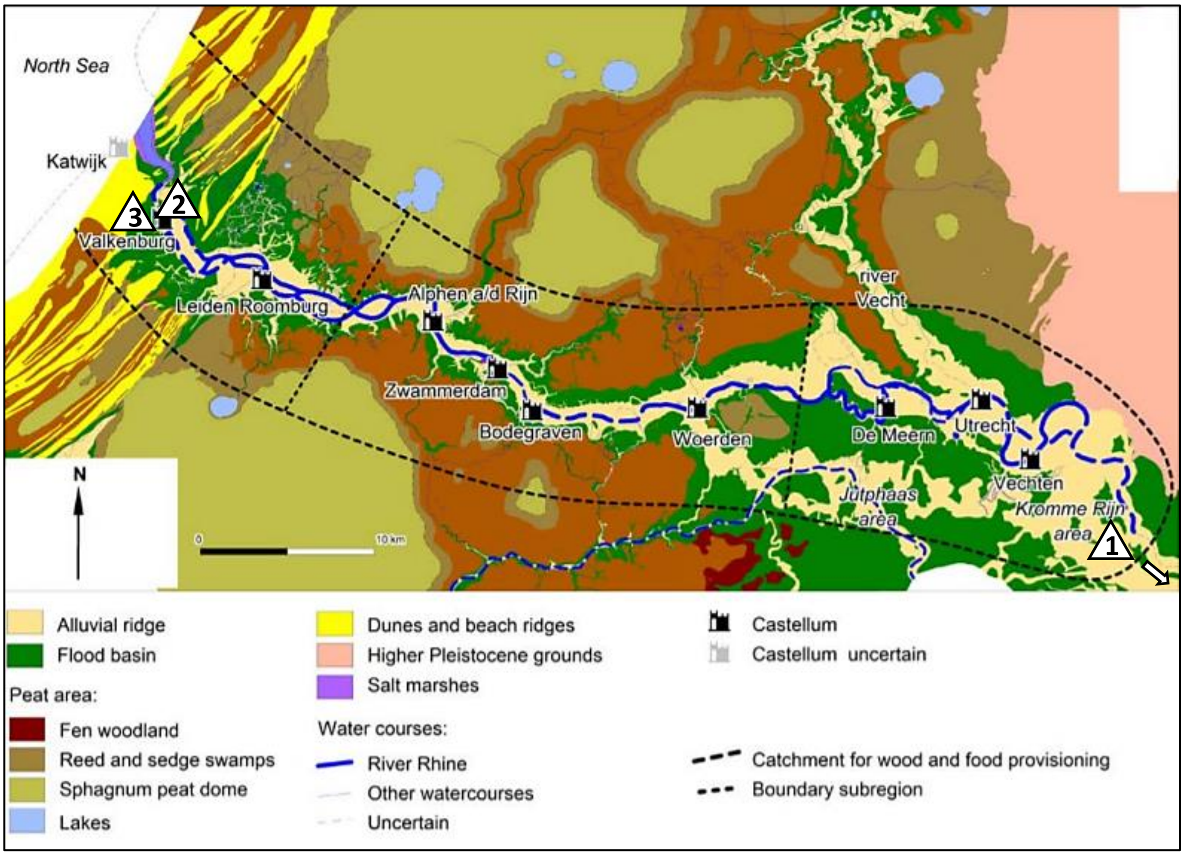


Fig. 4.27 Palaeogeographic map of the western Lower Rhine delta during the Roman period; the three conventional subregions identified by the dashed lines are: the eastern river region, the central peat region, and the western coastal region; the sites analysed for this study have been added (1: De Geer; 2: Oegstgeest; 3: Valkenburg) (adapted from van Dinter 2017, 70, Fig. 4.2).

4.7 Assemblages from the literature

A number of assemblages from the three British study-regions (‘Suffolk’, ‘Cambridgeshire’, and ‘Oxfordshire’) and from the Lower Rhineland were selected in order to enlarge the available dataset, providing more integrated and reliable information on animal husbandry during the analysed chronological span, and allowing to draw general conclusions on changes at the transition. Essential information on each of these sites is provided in Tabs. 4.12 and 4.13.

Site	County	Chronology	Settlement type	Data type	Reference
Aelfric's Abbey	Oxfordshire	late 5th-late 7th c.	rural (high-status?)	1	Ayres *et al*. 2003
Bancroft	Buckinghamshire	3rd c.	villa	1, 2	Levitan 1994
		4th c.	villa	1, 2	
Barnsley Park	Gloucestershire	AD 140-275	rural	1, 2	Noddle 1985
		AD 275-4th c.	rural	1, 2	
		5th c.	rural	1, 2	
Burystead/Langham Road	Northamptonshire	Early/Mid-Anglo-Saxon	rural	1, 2	Davis 1992
Clapham, Oakley Road	Greater London	Early/Mid-Anglo-Saxon	rural	1	Maltby n.d.a
Collingbourne Ducis	Wiltshire	5th-6th c.	rural	1, 2	Hamilton-Dyer 2001
		5th-8th	rural	1, 2	
Fossetts Farm	Essex	5th-7th c.	rural	1	Grimm 2007
Gill Mill	Oxfordshire	Late Roman	rural	1	Strid n.d.
Grandford	Cambridgeshire	mid-2nd-3rd c.	rural	1	Stallibrass 1982
		3rd-4th c.	rural	1	
Great Holts Farm	Essex	3rd-4th c.	rural	1, 2	Albarella 1997a
Harlington	Greater London	5th-7th c.	rural	1	Grimm 2009
Harrold	Bedfordshire	Early/Mid-Anglo-Saxon	rural	1	Maltby n.d.b
Heybridge	Essex	mid-3rd-mid-4th c.	rural/small town	1, 2	Johnstone and Albarella 2015
		mid-4th-5th c.	rural/small town	1, 2	
Higham Ferrers	Northamptonshire	5th-6th c.	rural	1, 2	Albarella and Johnstone 2000
Love's Farm	Cambridgeshire	3rd c.	rural	1	Baxter 2018
		4th c.	rural	1	
		late 4th-early 5th c.	rural	1	
Lynch Farm	Cambridgeshire	3rd-first half 4th c.	rural	1	Wilson 1975

Maxey	Cambridgeshire	5th-7th c.	rural		Seddon *et al.* 1965
Melford Meadows	Suffolk	5th-late 6th/7th c.	rural	1	Powell and Clark 2002
Mucking	Essex	5th-7th c.	rural	1, 2	Done 1993
NW Cambs. complex	Cambridgeshire	1st-3rd c.	rural	1, 2	Albarella 1997b (sites of Norman Cross, Tort Hill East, Tort Hill West, Vinegar Hill)
		late 2nd-4th c.	rural	1, 2	
Old Down Farm	Hampshire	5th-7th c.	rural	1, 2	Bourdillon 1980
Orton Hall Farm	Cambridgeshire	early 3rd-early 4th c.	rural	1	King 1996
		AD 300-375	rural	1	
		AD 375-early 6th c.	rural	1	
Pennyland	Buckinghamshire	Early/Mid-Anglo-Saxon	rural	1	Holmes 1993
Ramsgate	Kent	5th-7th c.	rural	1, 2	Hamilton-Dyer 1997
Redcastle Furze	Norfolk	6th-7th c.	rural	1	Wilson 1995
Redlands Farm	Northamptonshire	2nd-5th c.	rural	1, 2	Davis 1997
Shakenoak Farm	Oxfordshire	mid-3rd-4th c.	villa	1, 2	Cram 1973
		AD 350-400	villa	1, 2	
Spong Hill	Norfolk	mid-3rd-4th c.	rural	1	Stuart and Rickett 1995
		5th-7th c.	rural	1	Bond 1995
Stonea Grange	Cambridgeshire	2nd-3rd c.	rural	1, 2	Stallibrass 1996
		3rd-4th c.	rural	1, 2	
		Early/Mid-Anglo-Saxon	rural	1, 2	
Wavendon Gate	Milton Keynes, Buckinghamshire	2nd-3rd c.	rural	1, 2	Dobney and Jaques 1996; Rielly 1996
		3rd-4th c.	rural	1, 2	
Wayside Farm	Wiltshire	Late Roman	rural	1	Ingrem 2002
Wimpole	Cambridgeshire	late 2nd-4th c.	rural	1, 2	Platts 2018

Tab. 4.12 (previous pages) Essential information on the British assemblages selected from the literature. Data type: 1: species frequency, 2: biometry. c.: centuries.

SITE	PROVINCE	CHRONOLOGY	SETTLEMENT TYPE	DATA TYPE	REFERENCE
Arnhem-Schuytgraaf	Gelderland	Late Roman	rural	1	Esser and Van Dijk 2004b
Didam-Aalsbergen	Gelderland	4th-5th c.	rural		Zeiler 1998
Ferwerderadeel-Oosterbeintum	Friesland	AD 250-400	rural	1	Post 2012
Geldermalsen-Hondsgemet	Gelderland	AD 270-350	rural	1, 2	Groot 2009
Houten-Binnenweg	Utrecht	Late Roman/Early Med.	rural	1	De Vries and Laarman 2001
Naaldwijk II	South Holland	late 3rd-4th c.	rural?	1, 2	Groot 2008c
Nijmegen Valkhof	Gelderland	4th c.	military/urban	1, 2	Lauwerier 1988
Odijk-Singel West/Schoudermantel	Utrecht	Late Roman	rural	1	Zeiler 2007
		Late Roman/Early Med.	rural	1	
Tiel-Oude Tielseweg	Gelderland	AD 270-350	rural	1, 2	Groot 2008a
Tiel-Passewaaijse Hogeweg	Gelderland	AD 270-350	rural	1, 2	Groot 2008a

Tab. 4.13 Essential information on the Lower Rhenish assemblages selected from the literature. Data type: 1: species frequency, 2: biometry. c.: centuries.

CHAPTER 5

Methods

The methodological choices adopted in this study are described below along with their original references. Related methods have been grouped under the same subheading (e.g. NISP, MNI, MNE and MAU are described individually under the subheading ‘Quantification’).

All traditional zooarchaeological analyses provide essential information to the research question of this study. However, the significance of livestock improvement in the Roman period and its continuity, demise or other development in post-Roman Britain implied a major focus on biometrical data and analyses, which have been developed accordingly.

5.1 Recording

This section describes the facilities used and methodologies adopted for the taxonomic identification of animal remains and for their recording.

5.1.1 Taxonomic identification

The identification of recordable fragments relied primarily on comparisons with the zooarchaeological reference collections held at the University of Sheffield (UK) and University of Leiden (The Netherlands). The animal bone atlases by Schmid (1972) and Barone (1976) were also consulted.

Recordable elements were identified to species-level whenever possible; however, for a number of fragments this was not possible and higher taxonomic ranks had to be assigned. This is typically the case for sheep (*Ovis aries*) and goat (*Capra hircus*), whose remains are often difficult to separate (see below). In some cases, the work by Prummel (1988) was used for separating cattle (*Bos taurus*) from red deer (*Cervus elaphus*); when this was not possible, the broader category ‘CB’ (*Cervus*/*Bos*) was used. Similarly, ‘OCC’ (*Ovis*/*Capra*/*Capreolus*) was used when it was not possible to identify a specimen as either caprine (sheep/goat) or roe deer (*Capreolus capreolus*). The methods used to attempt the identification of closely related taxa are described below for each group of animals.

5.1.1.1 Caprines

The distinction between sheep and goat was attempted on a defined set of anatomical elements (following Albarella and Davis 1994) (Tab. 5.1). The distinction was based on Boessneck (1969), Kratochvil (1969) and Zeder and Lapham (2010) for post-cranial bones and on Payne (1985), Halstead et al. (2002) and Zeder and Pilaar (2010) for mandibular premolars. Maxillae, mandibular teeth other than premolars, and unfused bones were directly assigned to the sub-family Caprinae, as were all the other specimens which could not be assigned to one of the two species. Additional measurements were taken on caprine post-cranial bones according to Salvagno (pers. comm.) and Salvagno and Albarella (2017), in order to allow an estimation of the proportion of sheep and goat remains on the basis of biometrical analyses.

horncore	distal metacarpal
posterior cranium	distal tibia
mandible (when at least one of these teeth was present: dP$_3$, dP$_4$, P$_3$, P$_4$)	astragalus
dP$_3$, dP$_4$, P$_3$, P$_4$ (loose)	calcaneum
proximal radius	distal metatarsal
distal humerus	1st, 2nd and 3rd phalanges

Table 5.1 Elements on which separation between sheep and goat was attempted; countable elements underlined.

5.1.1.2 Equids

It is difficult to separate between the remains of horse (*Equus caballus*), donkey (*Equus asinus*) and their hybrids (mules and hinnies). The separation was attempted on mandibular premolars and molars, according to Davis' (1980) criteria, and on fused first phalanges, according to Davis' (1982) biometrical criteria. All other elements were more generally assigned to the genus *Equus*.

5.1.1.3 Domestic mammals and wild forms

The wild boar (*Sus scrofa*, the ancestor of domestic pigs) was present in both Britain and Continental north-western Europe during antiquity and the Early Middle Ages, while the aurochs (*Bos primigenius*, the ancestor of domestic cattle) had already gone extinct in Britain.

With very few exceptions, the remains of pig and cattle cannot be distinguished from their wild forms on the basis of morphological criteria. Biometrical data were analysed in order to verify the presence and incidence of wild animals in suids and bovines. In particular, Wright (2016) was consulted in order to isolate aurochs remains in the assemblages from the lower Rhineland.

5.1.1.4 Galliformes

The atlas by Tomek and Bochenski (2009), as well as the available reference collections, were consulted to attempt the separation of close galliform species. The identification of chicken (*Gallus gallus*) remains from archaeological sites is hindered by the existence in Europe of morphologically similar species of the order Galliformes. In particular, it is sometimes difficult or impossible to separate chicken from some species of the family Phasianidae based on bone morphology. The black grouse (*Tetrao tetrix*) is an endemic species from the family Tetraonidae, and also very similar to other galliforms; females are slightly smaller in size than the common pheasant (*Phasianus colchicus*), which is native to Asia. Populations of this latter species became established in Europe after it was introduced in the late Middle Ages. However, the Romans imported pheasants to the north-western provinces as exotic animals, although stable populations likely failed to establish (Hill and Robertson 1988). The helmeted guineafowl (*Numida meleagris*), native to Africa, is also osteologically similar to chicken. Its presence in Europe is testified by artistic reproductions and literary sources since the Roman period; however, its osteological identification is limited to only one case (Castellammare di Stabia, Sicily, Italy; Masseti 2015). In sum, both the pheasant and the helmeted guineafowl would have been very rare, if not at all absent, in the regions and periods here considered; in addition, the black grouse can be distinguished from chicken on the basis of size and morphology. Therefore, medium-sized galliform remains from the analysed assemblages are most likely to belong to domestic chicken. However, bones from this taxon have been cautiously assigned to the broader category ‘GNP’ (*Gallus*/*Numida*/*Phasianus*), with the exception of those few elements on which separation can be attempted. In particular, separation between chicken and pheasant remains was attempted on a defined set of elements, which present clearer diagnostic features than others (Tab. 5.2).

proximal coracoid
proximal scapula
distal humerus
ulna
proximal femur
tarsometatarsus

Table 5.2 Elements on which separation between chicken, pheasant and helmeted guineafowl was attempted.

5.1.2 The 'Diagnostic Zone Method'

Zooarchaeologists have to deal with a very small selection of the original amount of animal remains deposited in a site; such selection is the result of a number of natural and human-mediated filters which are at play before the remains enter the archaeological context, during the long post-depositional period and, finally, in the very moment of excavation and recovery itself. These taphonomic processes impact differently and to different extent on the preservation of faunal assemblages. Therefore, the degree of preservation of zooarchaeological assemblages is highly diverse and depends upon a wide range of often unpredictable variables. As a consequence, a diversity of recording strategies may be suited to different assemblages. It is important to consider the diverse extent and type of biases which affect an assemblage, as these will influence comparisons between different sites. Other potential biases are introduced during the process of recording and analysis itself, as researchers with differing experience have to face different research conditions, producing better or more detailed results than others. Table 5.3 lists the variables affecting the study of faunal assemblages, and the potential biases deriving from such variables.

VARIABLES	POTENTIAL BIASES
preservation • degree of fragmentation • degree of surface erosion • other modifications (e.g. gnawing, butchery, burning)	• larger species over-represented as they produce more and larger identifiable fragments (more likely to be recovered) • different elements and portions of elements fragment to different extents (biasing body part distribution, ageing) • different degrees of preservation in different phases/contexts or at different sites (biasing comparisons)
excavation and recovery • excavation methods • recovery strategy for animal remains • sieving method (dry, wet, or none) • lighting conditions, weather • soil (matrix, humidity, colour) • psycho-physical condition of workers • post-excavation storage conditions	• damage from excavation tools (‘fresh breakages’ and further fragmentation) and/or storage conditions • elements from smaller species are more easily missed (under-representation of these species) • smaller elements from the same species more easily missed (under-representation of these elements)
research conditions • researcher’s experience • time and funds available • facilities (physical space, light, reference collection etc.)	• quantitative and qualitative variability in recording (unrepeatable results, problematic comparisons) • higher error margins • over-representation of species which can be more easily identified from smaller or less diagnostic parts of the bone

Table 5.3 Variables affecting zooarchaeological assemblages and their analysis, and potential biases deriving from them.

The consequence of all these conditions is that the final results of a zooarchaeological study depend upon a wide range of varying taphonomic processes and subjective, case-specific variables. Recording methods that ignore such problems and rely on unpredictable variables lack any substantial methodological basis, and inevitably produce biased, unrepeatable results. One way of counteracting these problems is defining exactly what has to be recorded (the unit of analysis) and what should instead be discarded, rather than vaguely considering every single fragment as potentially recordable (as in traditional recording methods).

The recording system adopted for this study is the ‘Diagnostic Zone Method’. The diagnostic zone recording system is conceived as a set of methodological principles and, as such, it can be purposely adapted to meet the needs of individual faunal assemblages. Introduced for the first time by J. P. N. Watson in the late 1970s (Watson 1979), the method was updated and improved and is now more widely employed in Europe; the recording protocol adopted in this study is an adapted version of the one developed for the assemblage of West Cotton by Albarella and Davis (1994). The protocol is based on the selection of a restricted set of body parts which are highly diagnostic at the anatomical and taxonomic level; these include the proximal and/or distal diaphyses and epiphyses of most long bones, along with most of the bones from the extremities and part of the elements from the axial skeleton (Tables 5.4 and 5.5). All fragments which are not part of this selection were excluded from recording.

However, a most important aspect of such recording method is the distinction between countable and non-countable specimens. The formers contribute to quantitative data (e.g. the frequency of species) and originate from no more than one or two diagnostic zones per anatomical element (usually, those from the most robust part of the bone, which is more likely to survive in the archaeological record). The second category includes fragments which are not used in quantification, but contribute to qualitative analyses, such as the presence of rare species or peculiar butchery practices on otherwise non-recordable fragments. In sum, non-countable specimens include a number of diagnostic zones and any other fragment which is worth recording for specific reasons. The consideration of specific cases within the non-countable fragments ensures that no important qualitative data are ignored and, therefore, that potentially important information is not lost.

The selection of countable and non-countable diagnostic zones is given in Tables 5.4 and 5.5. These were recorded only when more than half of the zone was present, in order to avoid over-counting the same specimen, but also to establish a threshold for recording. Of course, a considerable number of fragments was excluded as a consequence of the selection of body parts and of the 50% preservation threshold. This, however, applies to all species and mitigates the usual underestimation of smaller or less identifiable taxa.

Altogether, the application of the Diagnostic Zone Method allows minimising most of the biases related to taphonomic processes and the subjective conditions of the researcher. The different degrees of fragmentation are eluded and over-counting is limited, while the process of identification is accelerated and adapted to research conditions. This methodological approach produces repeatable results and more reliable datasets, which can confidently be compared with those from other sites.

horncore (complete transversal section, cattle and caprines only)	vertebrae (present/absent)
upper teeth (occlusal surface, pig only)	ribs (present/absent)
maxilla (with at least one tooth)	pelvis (ischial part of acetabulum)
lower teeth (occlusal surface)	proximal femur (head)
mandible (with at least one tooth)	distal femur
zygomaticus	proximal tibia
atlas	distal tibia
axis	astragalus (lateral half)
scapula (glenoid cavity)	calcaneum (sustentaculum)
proximal humerus (head)	scafocuboid
distal humerus	distal metatarsal (only III, IV or III+IV)
proximal radius	distal metapodial (only III, IV or III+IV)
distal radius	proximal 1st phalanx
proximal ulna (articulation)	proximal 2nd phalanx
C3 or C2+3	proximal 3rd phalanx
distal metacarpal (only III, IV or III+IV)	

Table 5.4 Diagnostic zones recorded for all mammal species; countable elements underlined.

scapula (articular end)	vertebrae (present/absent)
proximal coracoid	ribs (present/absent)
distal coracoid	proximal femur
proximal humerus	distal femur
distal humerus	proximal tibiotarsus
distal radius	distal tibiotarsus
proximal ulna	proximal tarsometatarsus
proximal carpometacarpus	distal tarsometatarsus
sternum (anterior articulation)	

Table 5.5 Diagnostic zones recorded for galliforms; countable elements underlined.

5.2 Quantification

The frequency of species, namely the relative proportions of taxa, was calculated using the number of identified specimens (NISP) and the minimum number of individuals (MNI). The minimum number of anatomical units (MAU), obtained from the minimum number of elements (MNE), was used for the analysis of body part distribution.

5.2.1 Number of Identified Specimens (NISP)

The NISP quantifies every countable element in the dataset, producing species frequencies which are based on raw fragment counts. The method presents a number of limitations. Differences in skeletal complexity between species are overseen; as a consequence, taxa with a higher number of bones per individual are over-estimated (though this can easily be corrected). In addition, larger species produce more and larger (i.e. more easily recovered and identifiable) fragments, leading to an over-estimation of these animals. Finally, the NISP is biased by the problem of interdependence, whereby fragments originating from the same animal are all counted (Grayson 1984; Lyman 2008).

To some extent, these problems are mitigated by the application of the Diagnostic Zone Method: the same selection of anatomical elements is applied to all species, and over-counting is further limited by the application of the 50% threshold of integrity. As a result, the NISP obtained from this recording method becomes closer to the results of the MNI, although the drawbacks typical of the latter (see below) are avoided.

In this study, only assemblages with NISP ≥ 100 were analysed.

5.2.2 Minimum Number of Elements (MNE) and Minimum number of Animal Units (MAU)

The MNE is the minimum number of elements represented by the remains recorded for each taxon. Calculations of the MNE vary according to the definition of 'element', the unit of analysis of this quantification method (Lyman 2008). In this study, the recording of a limited set of diagnostic zones (only recorded when more than 50% of the zone is present) and the presence of only one countable zone per element make calculations of the MNE straightforward. For example, the presence of 17 cattle distal humeri would give an MNE of 17 for cattle humeri.

The MAU is calculated from the MNE, which is adjusted according to the frequency of each element in the skeleton of each taxon (Lyman 2008). For example, the 17 cattle humeri would give a MAU of 9. In this study, the MAU was used in the analyses of the distribution of anatomical elements.

5.2.3 Minimum Number of Individuals (MNI)

The MNI calculates the minimum number of animals for each taxon, on the basis of the most frequent anatomical element. The MNI is the highest MAU obtained for each taxon. Also this method presents a number of advantages and drawbacks.

Difference in skeletal complexity between taxa and, to some extent, recovery biases are overcome, as the unit of analysis is the whole animal rather than individual elements. However, the method tends to an overestimation of rare or less frequent species (even only one countable fragment equals to one individual); this is particularly enhanced in small assemblages. In addition, the MNI varies substantially with different aggregations of archaeological contexts (i.e. by applying the same calculations to a whole site-period, or to smaller clusters of contemporary contexts, or even separately to each context) (Grayson 1984; Lyman, 2008). Finally, using individual animals as the unit of analysis presents the same problem as quantifications based on weight estimation: it is assumed that whole animals (complete carcasses) entered the site and the archaeological record, while it is possible that animal exploitation focussed on processed carcasses and portions, and food waste disposed of in different ways (Binford 1978).

Comparisons between species frequencies calculated by NISP and MNI can provide important information on the nature of faunal assemblages. Moreover, a similarity between the NISP and the MNI would suggest that the species frequency is not excessively compromised by the biases of the two methods and by taphonomic processes.

In this study, the MNI was calculated disregarding differences in age, sex and size.

5.3 Taphonomy

The observation of human and non-human taphonomic alterations provides information on the quality of the material analysed, hence on the reliability of the data collected. In addition, it allows inferring practices of animal consumption and waste disposal.

5.3.1 Recovery bias

The incomplete recovery of all animal remains from an archaeological excavation is the result of a number of variables (see Tab. 5.3). Typically, smaller fragments tend to be missed, especially when sieving is not implemented. Most zooarchaeological analyses are biased by incomplete recovery. For this reason, it is important to be aware of the impact that recovery bias had on the integrity of a faunal assemblage. In this study, estimations of the recovery bias relied on calculations of the proportions between associated elements of different size, and on comparisons of the results between large and smaller species. In particular, the analyses included the proportions between distal tibiae and astragali, distal metapodials and phalanges, and mandibles and loose mandibular teeth in cattle, caprines and pig. Differences in the proportions of these elements (typically, proportionally fewer small elements recorded for smaller species), allow to estimate the extent of the impact of the recovery bias, and comparing it between sites. Although differences in the recovery bias between assemblages can partly affect some comparisons (e.g. species frequency, distribution of anatomical elements), other types of analyses are less affected (e.g. biometry – the main focus of this research project).

5.3.2 Surface preservation

Surface preservation was recorded by assigning each fragment to one of the three levels of degradation listed below (Tab. 5.6). The use of descriptive criteria for assigning different levels of surface preservation mitigates the biases derived from subjective judgments on preservation.

Although the degree of fragmentation of the material impacts on the quantity and quality of data recorded, it is not part of this specific analysis.

Grade	Definition of surface preservation
G (good)	clearly visible surface morphology, localised surface erosion with only slight surface penetration
M (medium)	part of the surface eroded and some details masked by erosion, but general bone profile maintained
B (bad)	entire surface eroded, heavy penetrating erosions, modified morphology (identification compromised or incomplete as a consequence)

Table 5.6 Grades of surface preservation assigned to all recorded fragments.

5.3.3 Gnawing

Carnivore and rodent gnawing marks were recorded as present/absent on each recordable element. Gnawing marks can provide information on practices of waste disposal and on-site scavenging caused by commensal species (mainly carnivores – e.g. dogs – and rodents).

5.3.4 Butchery

Butchery marks were described as cut marks, chop marks, saw marks, and/or hook marks. The presence, distribution and proportion of different types of butchery marks may be indicative of different practices of carcass processing. Specialised butchery practices are recorded and discussed separately.

5.3.5 Burning

Evidence of burning included burnt (black, shiny colouration on all or most of the surface), singed (localised black areas on the part of the fragment exposed to fire), or calcined (white or light grey colouration) fragments.

The presence of specific burning patterns can provide information on cooking practices. Complete burning and calcination cause shrinkage and deformations which can potentially compromise taxonomic identification and bias morphometric data. Elements affected by such modifications were excluded from certain analyses.

5.3.6 Distribution of anatomical elements

The analysis of body parts distribution relies on calculations of the minimum number of anatomical units (MAU), which is obtained from the minimum number of anatomical elements (MNE). The use of the MAU rather than raw fragment counts provides a more reliable representation of those body parts which are present in the skeleton in different numbers. Only diagnostic zones were considered for this analysis, and only when $\mathrm{MAU} \geq 20$. The codes employed in the bar charts are explained in Table 5.7.

The distribution of anatomical elements provides information on butchery practices and waste disposal. Primary butchery consists in the initial preparation of dressed carcasses, while secondary butchery reduces the cuts to smaller portions for consumption. The distribution of anatomical elements reveals whether such practices occurred on the same place or on different locations, and can shed light on the degree of specialisation in animal exploitation.

HC	horn-core	**dMC**	distal metacarpal
Zyg	zygomatic bone	**PE**	pelvis (ischial part of the acetabulum)
Max	maxilla (including loose teeth)	**pFE**	proximal femur
Mand	mandible (including loose teeth)	**dFE**	distal femur
AT	atlas	**pTI**	proximal tibia
AX	axis	**dTI**	distal tibia
SC	scapula (glenoid)	**AS**	astragalus
pHU	proximal humerus	**CA**	calcaneum
dHU	distal humerus	**SCU**	scaphocuboid
pUL	proximal ulna	**dMT**	distal metatarsal
pRA	proximal radius	**P1**	1st phalanx
dRA	distal radius	**P2**	2nd phalanx
C3	3rd carpal	**P3**	3rd phalanx

Table 5.7 Codes employed in the bar charts of the distribution of anatomical elements.

5.4 Ageing

The age-at-death of animal remains was assessed by analysing tooth eruption and wear stages, as well as the epiphyseal fusion of post-cranial bones.

5.4.1 Mandibular and maxillary wear stages

Ageing methods which employ animal teeth rely on the fact that different teeth erupt at different times, and that distinctive wear patterns can be recognized as an animal ages (e.g. Payne 1973; Grant 1982). The conformation of premolars and molars (the teeth usually analysed for ageing in zooarchaeology) in most domesticates is more elaborated than in humans, with layers of enamel and dentine forming structures which are specific for different taxa. As a tooth starts wearing down and the upper enamel cover wears away, the dentine underneath is exposed; the pattern created by the enamel and the dentine on the occlusal surface of a tooth changes as a tooth wears down. This process allowed the development of sequential recording methods, where wear patterns are organised in defined sets of tooth wear stages. Following the procedures outlined by most scholars (e.g. Payne 1973; Grant 1982), tooth wear stages (TWS, the wear stage recorded on each tooth) and eruption stages (if applicable) from one mandible are analysed to assign a mandibular wear stage (MWS), which represents the estimated age group for that animal.

Ageing with teeth presents a number of advantages and drawbacks, which are mainly related to husbandry practices, environmental conditions, and taphonomy. Teeth (and mandibles) tend to survive well in the archaeological record; in addition, teeth provide more detailed information on the age-at-death of animals than the analysis of epiphyseal fusion, and allow ageing animals after these have reached skeletal maturity. However, the timing of tooth eruption and wear can be affected by nutrition and pathologies, which can vary according to husbandry practices and environmental conditions. In addition, abnormal or unconventional wear patterns are sometimes observed, especially in case of malocclusion or overcrowding (a recurrent condition in domestic animals). Finally, age estimations are less precise for older animals, as the last tooth wear stages cover a much wider timespan of an animal's life than the earliest stages.

In this study, cattle and pig mandibular tooth wear stages were determined following Grant (1982), while Payne (1973) was employed for caprine mandibles. In addition to Grant's (1982), a new method for recording wear stage on pig mandibular and maxillary teeth was employed (Wright and Albarella 2010; Wright et al. 2014). The method relies on schematic descriptions of the wear stage rather than visual illustrations as in Grant (1982). This proves more practical and applicable to the recording of pig tooth wear, which is much more variable than in other species and tends to differ often from the restricted set of illustrated wear stages. The inclusion of this method will allow comparing the results from two different methods of recording pig mandibular tooth wear (Grant 1982 and Wright et al. 2014), as well as comparing the results from mandibles and maxillae.

Mandibular wear stages were determined using O'Connor (1988) for cattle and pig (O'Connor 1988 was also used for pig maxillary wear stages) and Payne (1973) for caprines. When the furthest tooth in the jaw was not present or could not be recorded, the complete tooth wear stage sequence was reconstructed using the correlation tables elaborated by Grant (1982), Wright *et al*. (2014), and Harvey (2019). Mandibular and maxillary wear stages were estimated only for jaws with at least two recordable teeth. Kill-off patterns were reconstructed when the number of available mandibular/maxillary wear stages was ≥ 15.

5.4.2 Epiphyseal fusion and bone ossification

Due to the different ways in which mammals and birds reach skeletal maturity, the two groups of animals have been treated separately in this section.

5.4.2.1 Mammals

The stage of bone epiphyseal fusion was recorded as unfused, fusing (when the fusion line is still visible) or fused. Ageing methods which analyse the epiphyseal fusion of post-cranial bones rely on the fact that fusion of the epiphysis to the diaphysis occurs at different times for different bones, and even for different epiphyses of the same bone. Studies on modern animal populations allowed reconstructing the timing and order in which the various bones fuse (e.g. Silver 1969). This has allowed the development of ageing methods which elaborate epiphyseal fusion data from zooarchaeological assemblages. For analytical purposes and to increase sample size, all fusion events were organised into three groups according to Silver (1969) (Tab. 5.8); the percentage of fused bones within each fusion stage was then calculated.

The ageing evidence from the analysis of epiphyseal fusion can provide complementary or additional information to husbandry practices at a given site-period. In particular, it becomes essential when the assemblage being analysed is mainly the product of secondary butchery, where body extremities (including the head – hence the mandibles) have already been removed and disposed of elsewhere.

This ageing method, however, presents some drawbacks which are related to the biological process of skeletal growth and taphonomy. Indeed, the unfused bones from immature animals (and even more those from neonatal individuals), are rather fragile and more affected by taphonomic processes, and therefore tend to be underrepresented in relation to the fully ossified fused elements (the same applies, but to a lesser extent, to immature mandibles and maxillae) (Brain 1981). In addition, the representation of age stages in the three fusion groups is uneven and incomplete: the early fusing stage, for example, includes neonate to immature/sub-adult animals. At the same time, ageing with epiphyseal fusion provides no further information on the age-at-death of animals which have reached skeletal maturity, as all their bones are fused and there is no other detectable development: as a result, fused elements from the last fusing stage can include early and mid-adult, as well as elderly individuals. Similarly, the estimated ages at which different epiphyses fuse vary between different studies (Moran and O'Connor 1994), and castration also affects the process of epiphyseal fusion (Davis 2000). Finally, the presence of a large number of post-cranial bones per animal usually results in a higher number of fusion data, which can be used for ageing; however, this also increases the over-representation of the same individuals.

In this study fused and fusing bones were combined. In order to avoid the over-representation of unfused elements, unfused diaphysis, but not epiphyses, were considered.

Early fusing	**Middle fusing**	**Late fusing**
scapula (glenoid)	distal tibia	proximal humerus
distal humerus	proximal calcaneum	proximal ulna
proximal radius	distal metapodials	distal radius
pelvis (acetabulum)		proximal femur
proximal 1st phalanx		distal femur
proximal 2nd phalanx		proximal tibia

Table 5.8 Epiphyseal fusion event groups for cattle, sheep, goat and pig (adapted from Silver 1969).

5.4.2.2 Chicken

With the exception of a few elements, birds do not develop ossified epiphyses during the process of skeletal maturity. As a consequence, the ageing of chicken remains could only rely on observations of the degree of bone ossification and on biometrical analysis. All recordable elements were identified as 'immature', 'fusing immature' (in the presence of fusing epiphyses), or 'mature' (Corbino in prep.).

5.5 Sexing

An analysis of the sex ratio of domestic populations can provide information on husbandry practices, as a higher incidence of one sex-group usually reflects the main outputs sought through animal exploitation. Assessments of the sex ratio, namely of the relative proportions of males, females and eventual castrates, rely on specific morphometric and physiological features which can be observed on animal remains.

The size of domestic cattle, sheep, goat, pig and chicken is particularly affected by sexual dimorphism, namely by the difference in size between male and female individuals, typically the former being larger than the latter (although in horse sexual dimorphism is almost absent). Sexual dimorphism is more pronounced in the larger wild forms of these species, as the impact of this feature is usually directly proportional to size (McPherson and Chenoweth 2012). Still, depending on sample size, measurements from these domesticates tend to cluster according to sex, although overlapping occurs in most cases. For domestic species, the term ‘sexual polymorphism’ has been introduced as castrates tend to group separately, being larger than females and taller than males; however, the final size of castrate animals depends on a range of variables, including age at castration (Davis 2000). The size and shape of cattle horncores have also been related to sex (Armitage and Clutton-Brock 1976); however, more variables affect horncore morphometry, hence measurements from this element have not been used for sexing. In this study, biometrical analyses were interpreted also in terms of changing sex ratios; in some cases, the more sex-dependent measurements were used separately for investigating such issue.

A number of sex-dependent features were also recorded. Male suids develop particularly large and long canines, which are also morphologically different from those of sows (Schmid 1972). In this study, loose canines were excluded from calculations of the proportion of male *vs* female pig canines, as differential recovery may bias in favour of the larger male teeth. When canines were not present in the jaws, the alveoli were sexed and these data included in the analyses.

Cockerels (as well as the males of a few other bird species) develop a distinctive spur near the distal end of the tarsometatarsus; in the presence of large assemblages of chicken remains, the incidence of the spur can be used to estimate the sex ratio (Sadler 1991) (Tab. 5.9). However, a number of limitations apply. The process of ossification of the spur proceeds from the tip of the spur towards the bone shaft, and fusion is not complete before six months of age, with considerable variations among breeds and under different nutrition régimes, environmental conditions, etc. (Serjeantson 2009); as a consequence, male chickens which are skeletally mature but sexually immature may have not yet developed a spur. In addition, caponisation (i.e. castration) results in a scar on the shaft of the tarsometatarsus, where the spur would have fused (West 1982); similar scars or even reduced spurs are sometimes observed in hens from specific breeds, or with hormonal imbalances (Sadler 1991; De Cupere *et al*. 2005). The sex of chicken (and other bird) remains can be more reliably assigned by verifying the presence of medullary bone, a temporary reserve of calcium deposited by hens within their long bones and which is used for the production of egg shells; as a consequence, it is found in females shortly before and during the laying season (Bloom *et al*. 1958; Hodges 1974). In the case of domestic chicken, which have been selected by humans to have a prolonged laying period, medullary bone is almost constantly present in the long bones of hens, though in varying quantities (Corbino in prep.). The presence or absence of the medullary bone was recorded in femurs and tibiotarsi, where it occurs in larger quantities, as well as in tarsometatarsi, in order to compare the results from spur and medullary bone analyses (Tab. 5.9). To this end, the bones were drilled with a vitrified grinding wheel polishing drill, removing only a wedge of bone and thus avoiding the separation of the bone in two pieces (Corbino *et al*. 2017; Corbino in prep.). The analysis of medullary bone was only performed when permission for destructive analysis was granted by the curator.

Presence of spur in tarsometatarsi	**Presence of medullary bone**
P (present)	PF (present, full cavity)
R (reduced)	PK (present, thick layer – ca. 2 mm)
S (scar)	PN (present, thin layer – ca. 1 mm)
A (absent)	PT (present with traces)
	A (absent)

Table 5.9 Codes used for the recording of spur in tarsometatarsi and of medullary bone in femurs, tibiotarsi and tarsometatarsi (Corbino in prep.).

5.6 Biometry

Biometric data were analysed to explore variations in the size and shape of domestic animals, to assess the proportion of male, female and castrate individuals, to assist separation between closely related species, and to provide complementary ageing information. These analyses allow addressing research questions which are fundamental for this study, such as the dynamics and conditions of animal improvement in the Late Roman period, and the development of animal management in the early medieval period.

Measurements from post-cranial bones and teeth were taken according to von den Driesch (1976), Payne and Bull (1988), Davis (1992; 2002), Albarella and Payne (2005) and Salvagno and Albarella (2017). Measurements were selected according to the research question and from a defined set of diagnostic zones, which are more likely to survive in the archaeological record and whose state of maturation (i.e. epiphyseal fusion stage) can be assessed. The complete set of measurements is listed in Tables 5.10 and 5.11.

In unfused bones, only the greatest length (from proximal to distal end of the unfused diaphysis) and smallest diameter of the diaphysis (SD) were measured, as well as the smallest length of the collum scapulae (SLC) in mammals; 'light' or porous (i.e. immature) astragali and scaphocuboids were separated from the fully ossified (i.e. mature) ones.

The comparison of biometric data between different periods and sites relied on the analysis of scatter plots and histograms, as well as on statistical tests which aimed to support the results from the visual observation of graphs. The statistical significance of differences between groups of data is traditionally assessed relying on fixed thresholds (e.g. $p < 0.05$); in this study, however, it was preferred to directly comment on the lower or higher values of p resulting from the comparisons of different groups of data, overcoming the arbitrary use of such thresholds. The statistical test used in this study is the Student's t-test. This test is usually used for normally distributed measurements (as is the case for most of the groups of data analysed in this study); however, the Student's t-test is considered a robust test, it is little affected by variance (Simpson *et al.* 1960), and has been used in this study also for non-normally distributed groups of data. The statistical tests were performed using SPSS Statistics.

Scatter plots or histograms with specific measurements from individual elements were preferred whenever possible. The preference accorded to the analysis of individual measurements derives from the fact that each element (and even different measurements within individual elements) reacts differently to ageing and sex differences or to external stimuli (Payne and Bull 1988). Depending on sample size, however, it is not always possible to have a statistically relevant number of biometric data from the same element. In addition, it is even more unlikely this to occur for the same element in different site-periods, hence compromising comparisons.

element	lengths	widths/depths	*element*	lengths	widths/depths
horncore	GL	maxD, minD	*scaphocuboid*		GB
atlas	H	BFcr	*metatarsus*	GL	SD, BatF, BFd, Dd, WCM, WCL, DEM, DVM, DIM, DEL, DVL, DIL
scapula		SLC, GLP	*1st phalanx*	GL	SD, Bp, Dp, Bd, Dd
humerus	GL	SD, Bd, BT, HTC, BE, BEl			
radius	GL	SD, Bp, BFp, Dp	P_2	L_1	W_a
ulna		BPC, DPA, SDO	P_3	L_1	W_a
metacarpus	GL	SD, BatF, BFd, Dd, WCM, WCL, DEM, DVM, DIM, DEL, DVL, DIL	P_4	L_1	W_a
pelvis		LA, LAR	dP_4	L	WP
femur	GL	SD, DC	$M_{1,2}$	L, L_1	WA, WP, W_a, W_d
tibia	GL	SD, Bd, Dd, Ddb	M_3	L, L_1	WA, WC, WP, W_a, W_d
calcaneum	GL	GD, c, d, DS, B	$M^{1,2}$	L	WA, WP
astragalus	GLl, GLm, H, GH, LmT	Bd, Dl, GB, BFd	M^3	L	WA, WC, WP

Table 5.10 Set of measurements taken on mammal remains for this study. Some measurements were taken only for some taxa (see complete protocol in Appendix 1).

element	lengths	widths/depths	*element*	lengths	widths/depths
coracoid	GL, Lm		*femur*	GL, Lm	SC, Bp, Dp, Bd, Dd
humerus	GL	SC, Bp, Bd	*tibiotarsus*	GL, La	SC, Dip, Bd, Dd
ulna	GL	SC, Bp, Dip	*tarsometatarsus*	GL	SC, Bp, Bd
carpometacarpus	GL	Bp			

Table 5.11 Set of measurements taken on galliform remains for this study. All measurements were taken according to von den Driesch (1976).

In order to allow comparisons between site-periods and to counteract small sample size, measurements from different bones were merged by use of a size index scaling technique. This technique compares each measurement to a standard, producing a series of relative values which can be plotted on the same scale. The choice of a proper standard against which to compare archaeological data is an essential prerequisite for any size index scaling technique. In particular, the proportions of measurements from the various anatomical elements of the standard must reflect as much as possible that of the archaeological population being analysed. For this reason, traditional animal breeds are usually preferred as a standard, as they most closely resemble ancient animals. If possible, the mean of measurements from an archaeological population is preferable. The standards employed in this study are listed in Table 5.12.

The technique which calculates the decimal logarithm of the ratio between each measurement and the standard (also known as ‘log ratio’) was used in this study, since it is easier to calculate, it provides a better visual representation and is widely employed in the literature (Meadow 1999; Albarella and Payne 2005). Scaling index techniques allow to increase the size of otherwise unserviceable faunal assemblages, as well as to compare biometrical data from different site-periods. However, the use of measurements from bones which react differently to different variables may compromise the resolution of the final results, whereby patterns related to changes in size, ageing or sex ratio are either masked or over-emphasised (Meadow 1999; Albarella 2002). Specific measurements can be excluded to mitigate these problems; still, the dearth of data from small-sized samples does not always allow being particularly selective in the measurements to use.

Cattle	the means of the measurements of cattle bones and teeth from Early Anglo-Saxon contexts at the site of West Stow, Suffolk (Appendix 2)
Caprines	the means of the measurements of caprine bones and teeth from Early Anglo-Saxon contexts at the site of West Stow, Suffolk (Appendix 3)
Suids	the means of the measurements of suid bones and teeth from the late Neolithic site of Durrington Walls (Wiltshire) (Albarella and Payne 2005)
Equids	the means of the bone measurements of three female Mongolian ponies from the collection at the Museum für Haustierkunde, collected as part of Hagenbeck's expedition to Mongolia in 1901 (Johnstone 2004)
Chicken	the bone measurements of a three-years-old hybrid Harco hen, raised in Campofreddo (Tursi, province of Matera, Italy) (Corbino in prep.)

Table 5.12 Standards employed in this study for the production of log ratio histograms.

In this study, some arrangements have been made to minimise the problems arising from the combination of different measurements. In particular:

- it is essential to analyse post-cranial bones and teeth separately, since these elements can react very differently to selective pressures. Indeed, teeth tend to be conservative in terms of size changes within a population; as a consequence, abrupt variations in their size or shape suggest the introduction of a new genotype (Payne and Bull 1988);
- the smallest breadth of the diaphysis of long bones (SD) and the smallest length of the collum scapulae (SLC) were excluded, due to the influence of age in these measurements;
- in some cases, sex-dependent bones were separated from those which are less affected by sexual dimorphism, producing histograms where the issues of changing sex-ratios and size increase could be independently pursued.

Where possible, length and width/depth measurements were analysed separately, since dimensions lying on different axes can react differently to size change. By doing this, it is possible to verify the occurrence of shape changes between two or more animal populations (Davis 1996; Meadow 1999). Depending on sample size, bone length and width/depth measurements had to be combined; in particular, this was often the case for the less common species, such as horse, chicken and pig. However, the biometrical analyses of postcranial bones and teeth were always carried out separately.

5.7 Pathologies and non-metric traits

Dental and skeletal pathologies have been recorded and discussed. Pathologies related to animal management which leave clear marks on animal remains, such as splayed metapodials, spavin, eburnation on joints, and enamel hypoplasia on pig teeth, have been consistently recorded and analysed. In particular, the incidence of pathologies potentially related to traction, such as splayed cattle metapodials, is compared between site-periods; in this case, morphological observations are complemented by biometrical analyses, which take into consideration the abnormal swelling of the distal end as well as the proportion between medial and lateral condyles (as in Johnstone and Albarella 2015), providing a more solid base for interpretation.

Non-metric traits and their incidence can provide useful complementary information for the presence or introduction of genetically distinct animal populations (e.g. Argant *et al*. 2013). These traits have been recorded and their incidence discussed.

CHAPTER 6

Results

The results from the analyses of assemblages recorded for this study are presented separately for each study-region (Suffolk, Cambridgeshire, Oxfordshire, and the Lower Rhineland). Within each section, results from different types of analyses are presented together for the sites belonging to the study-region being considered. The zooarchaeological evidence is briefly summarised at the end of each section.

Complementary data from the literature are presented in § 6.5, along with summary graphs with species frequencies and biometrical data from all assemblages.

6.1 Suffolk

The assemblages analysed for Suffolk were collected from the sites of Pakenham, Icklingham, (Late Roman period), and West Stow (Early Anglo-Saxon period) (§ 4.2).

6.1.1 Preservation and recovery bias

The analysis of surface preservation presented in Fig. 6.1.1 shows an overall good preservation of the material from the three assemblages, with very few fragments recorded with a medium or bad level of preservation. This allowed a proper anatomical and taxonomical identification of most recordable fragments; only in a few cases a low degree of surface preservation hindered the identification of butchery marks or gnawing marks, or prevented taking measurements.

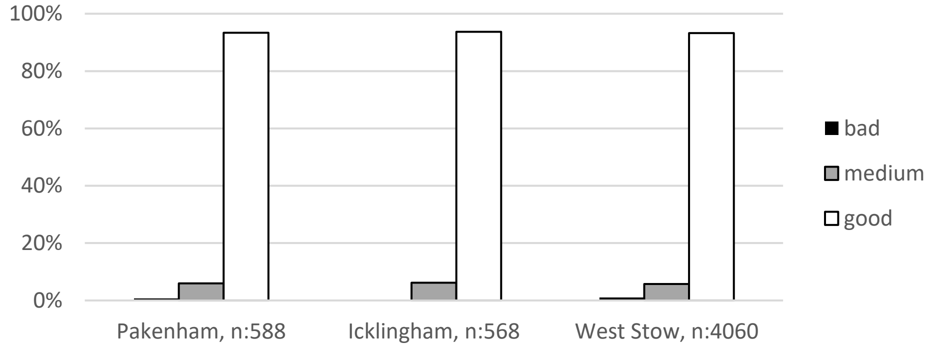


Fig. 6.1.1 Incidence of categories of surface preservation (§ 5.3.2, Tab. 5.6) in the recorded material.

The analysis of the recovery bias relied on the proportions between distal tibiae and astragali, and between distal metapodials and 1st phalanges in cattle and caprines (Figs. 6.1.2 and 6.1.3). As a result of the three assemblages having been hand-collected, they are all clearly affected by a recovery bias, whereby smaller elements and elements from smaller species are underrepresented. However, West Stow seems less affected than Pakenham and Icklingham; this may contribute to the greater relative abundance of caprines (and suids) in the Early Anglo-Saxon assemblage from West Stow (§ 6.1.2).

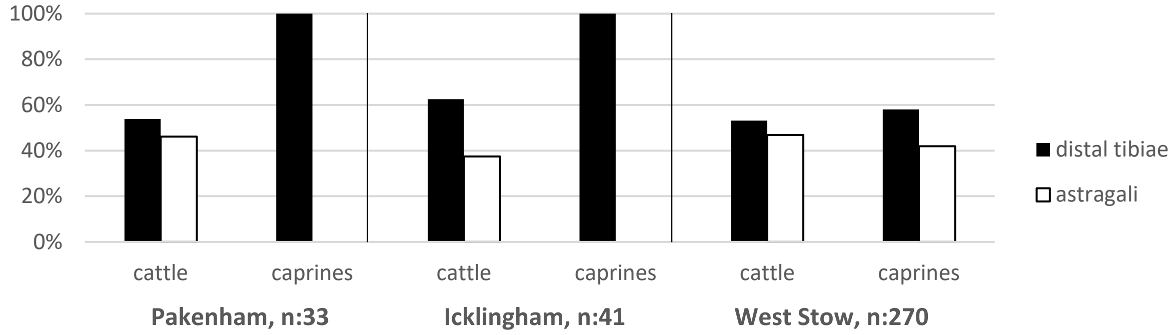


Fig. 6.1.2 Recovery bias analysis: proportions of distal tibiae *vs* astragali for cattle and caprines in the recorded assemblages (natural proportion: 1:1).

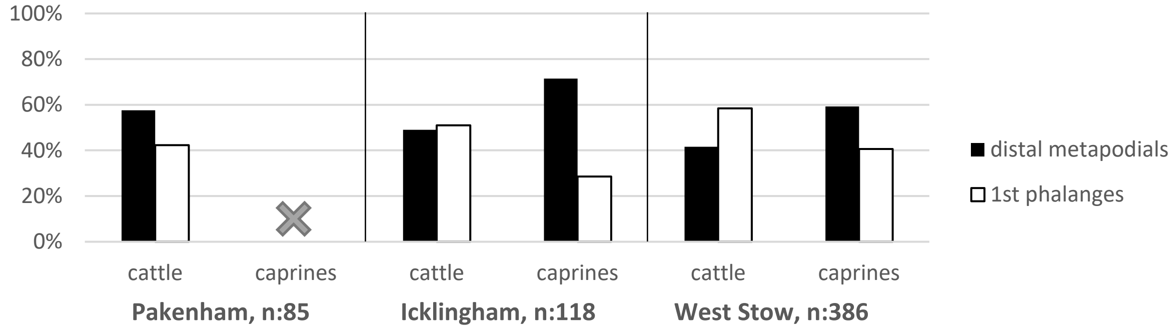


Fig. 6.1.3 Recovery bias analysis: proportions of distal metapodials *vs* 1st phalanges for cattle and caprines in the recorded assemblages (natural proportion: 1:2).

6.1.2 Species frequency

NISP frequencies highlight a much higher proportion of cattle in the Late Roman assemblages from Pakenham and Icklingham in comparison to Early Anglo-Saxon West Stow. In the latter site, caprines are relatively much more abundant (over 40% of all countable fragments), and suids make up over 20% of the assemblage (Fig. 6.1.4). Tooth and postcranial bone biometrical analyses suggest the vast majority of suids were domestic pigs (§ 6.1.7.3). Morphological observations and biometrical analyses of caprine remains suggest most of them, if not all, belonged to sheep (Figs. 6.1.5 and 6.1.6). As mentioned above, the relatively higher frequency of cattle in the Late Roman assemblages may be emphasised by the higher recovery bias detected for these sites; the difference in the relative frequencies of cattle and caprines, however, is large enough to suggest a genuine decrease in the frequency of cattle, and is confirmed by MNI estimations. The MNI frequencies confirm the trend suggested by the NISP, although displaying slightly different proportions (Fig. 6.1.7). This is important as the MNI is less affected by recovery bias (§ 5.2.2) and, indeed, in all three sites, cattle are less well-represented according to this quantification method. Therefore, we have a confirmation that the higher frequency of cattle at the Roman sites is not only a consequence of differential recovery.

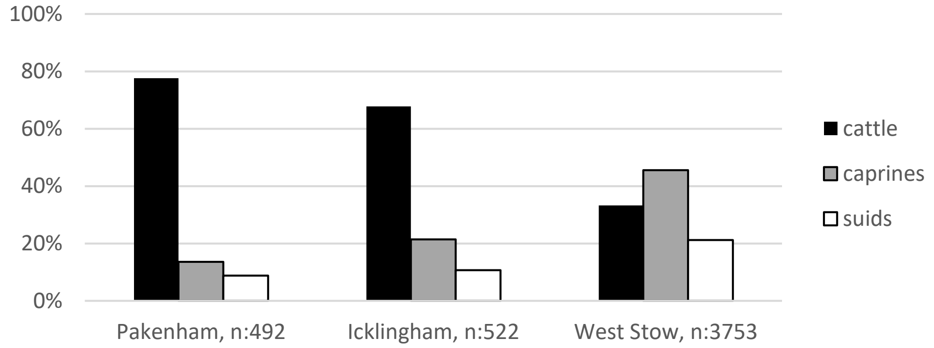


Fig. 6.1.4 NISP species frequencies for cattle, caprines, and suids.

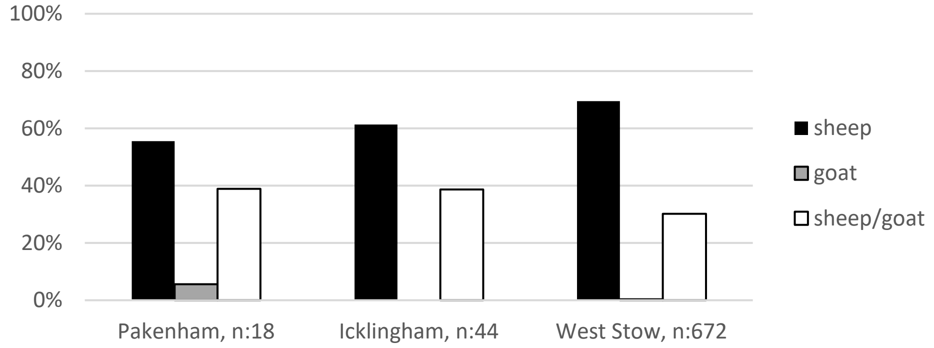


Fig. 6.1.5 Proportions of caprine remains recorded as sheep, goat, and sheep/goat, calculated using the set of selected elements on which the sheep-goat distinction is attempted.

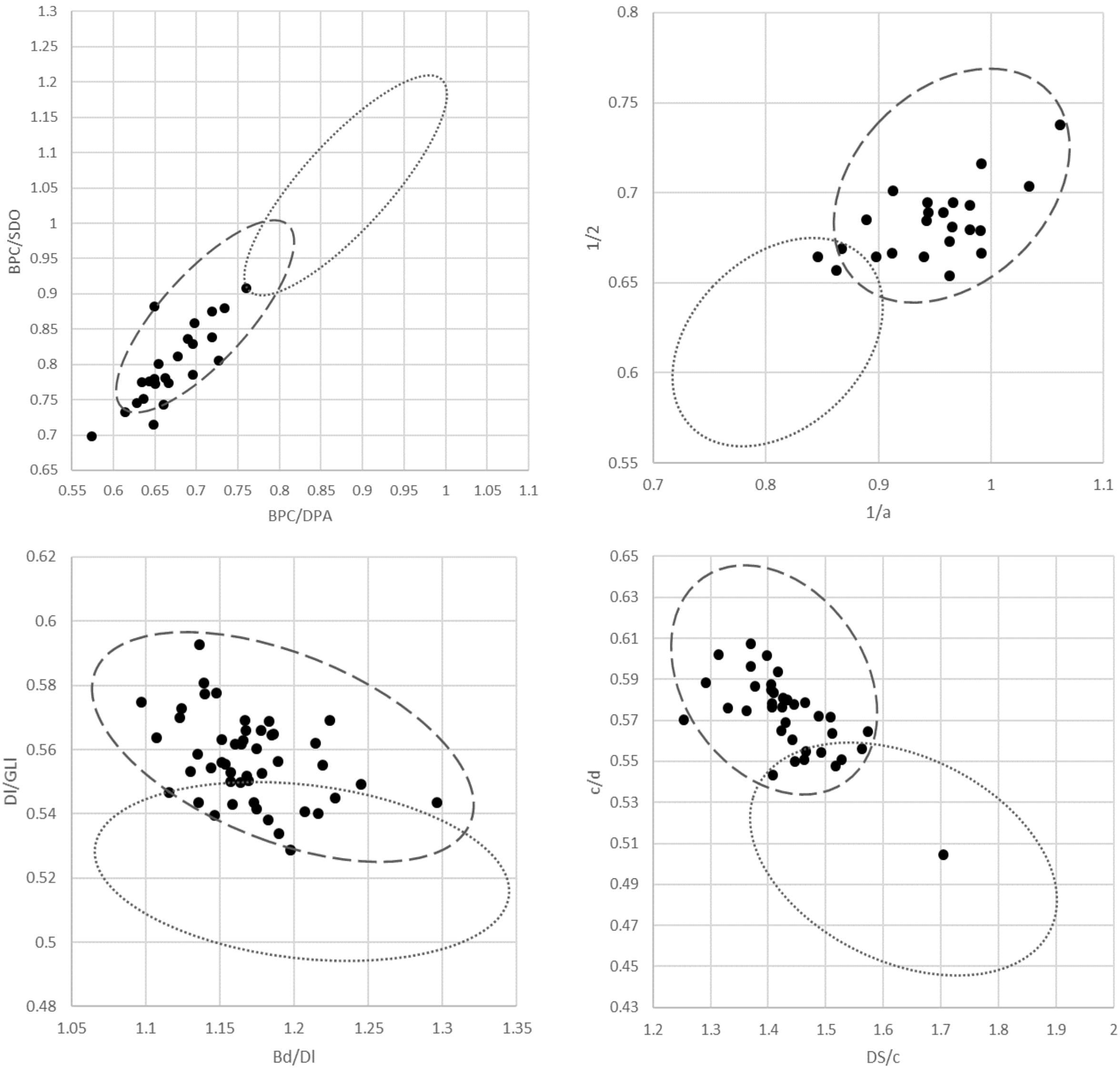


Fig. 6.1.6 Biometrical shape analyses of caprine bones against the approximate distributions of sheep (dashed line) and goat (dotted line) modern values from Salvagno and Albarella (2017). The scatter plots include values from Pakenham, Icklingham, and West Stow.

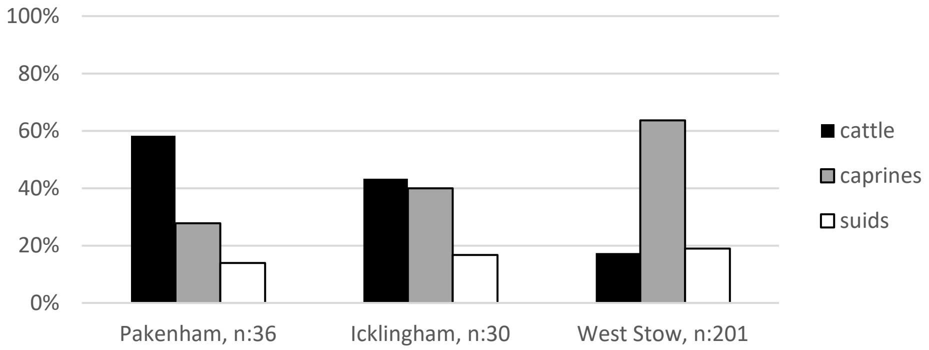


Fig. 6.1.7 MNI species frequencies for cattle, caprines, and suids.

At the same time, the high incidence of caprine mandibles (the most resistant body part, and more likely to survive with recordable fragments than cattle mandibles) in comparison to other elements (§ 6.1.5) contribute to high estimated MNIs for this taxon; this holds particularly true for West Stow, while in the Late Roman sites the disproportionately high frequency of cattle scapulae further contributes to enhance difference between the two periods (§ 6.1.5 and 6.1.6). For this reason, it was decided to include calculations of the MNI which exclude caprine mandibles and cattle scapulae, but this further confirms the overall trend (Fig. 6.1.8).

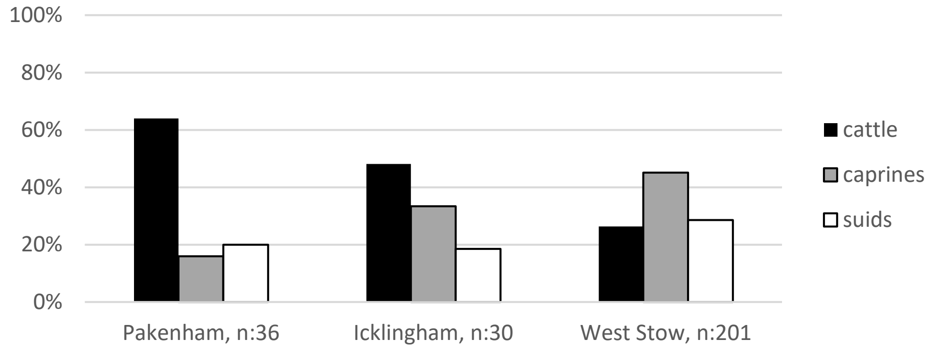


Fig. 6.1.8 MNI species frequencies for cattle, caprines, and suids without cattle scapulae and caprine mandibles.

At West Stow, species frequencies in the four subphases indicate a gradual increase in the frequency of caprines, which stabilises in the 6th century AD (Fig. 6.1.9). Suids are much more abundant in the first subphase (5th century AD), where they account for over 30% of the main domesticates, while in the following phases they drop to below 20%. Cattle frequency fluctuates, but remains between 30 and 40%.

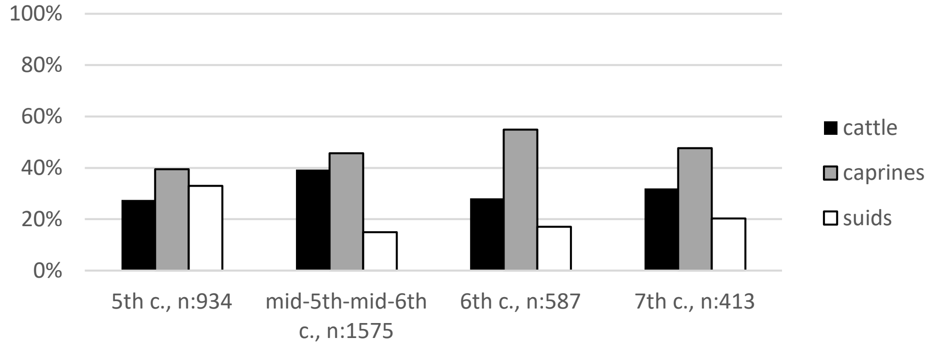


Fig. 6.1.9 West Stow, NISP species frequencies for cattle, caprines, and suids in the four subphases.

6.1.3 Ageing

The reconstruction of culling profiles for cattle, caprines and suids relied on the analyses of mandibular wear stages and epiphyseal fusion stages of postcranial bones. However, in some cases, data from Pakenham and Icklingham and from the subphases at West Stow had to be combined to provide large-enough datasets for reliable comparisons. Perinatal remains of cattle and, especially, caprines and suids, were recovered in large quantities at West Stow, while only one perinatal suid remain has been recorded for Late Roman Icklingham. While these finds indicate that domesticates were bred on-site, they have been excluded from the analyses of postcranial epiphyseal fusion presented below, as they represent natural losses rather than deliberate culling.

Cattle mandibular wear stages from the Late Roman sites of Pakenham and Icklingham, as well as from the four subphases at West Stow were combined. At the Late Roman sites, cattle were mainly culled as adult and elderly animals, while at Early Anglo-Saxon West Stow younger individuals are also represented (Fig. 6.1.10). Results from the analysis of postcranial epiphyseal fusion confirm that, in the Late Roman sites, very few animals were culled at a young age, with a large majority (60-80%) surviving into adulthood. Slightly more young animals were culled at Early-Anglo Saxon West Stow, but also at this site most animals survived to older ages (Fig. 6.1.11). When the four subphases from this site are considered individually, some differences can be observed (Fig. 6.1.12). In the earliest period of settlement (5th century AD), many more young individuals were culled (early and middle fusing stage), with ca. 50% surviving into adulthood. Therefore, the difference from culling profiles reconstructed for Late Roman assemblages seems more pronounced in the phase of establishment at the site. In the following phase, there seems to be a shift towards the survival of more animals into older ages which, however, is reversed twice in the second and final phase.

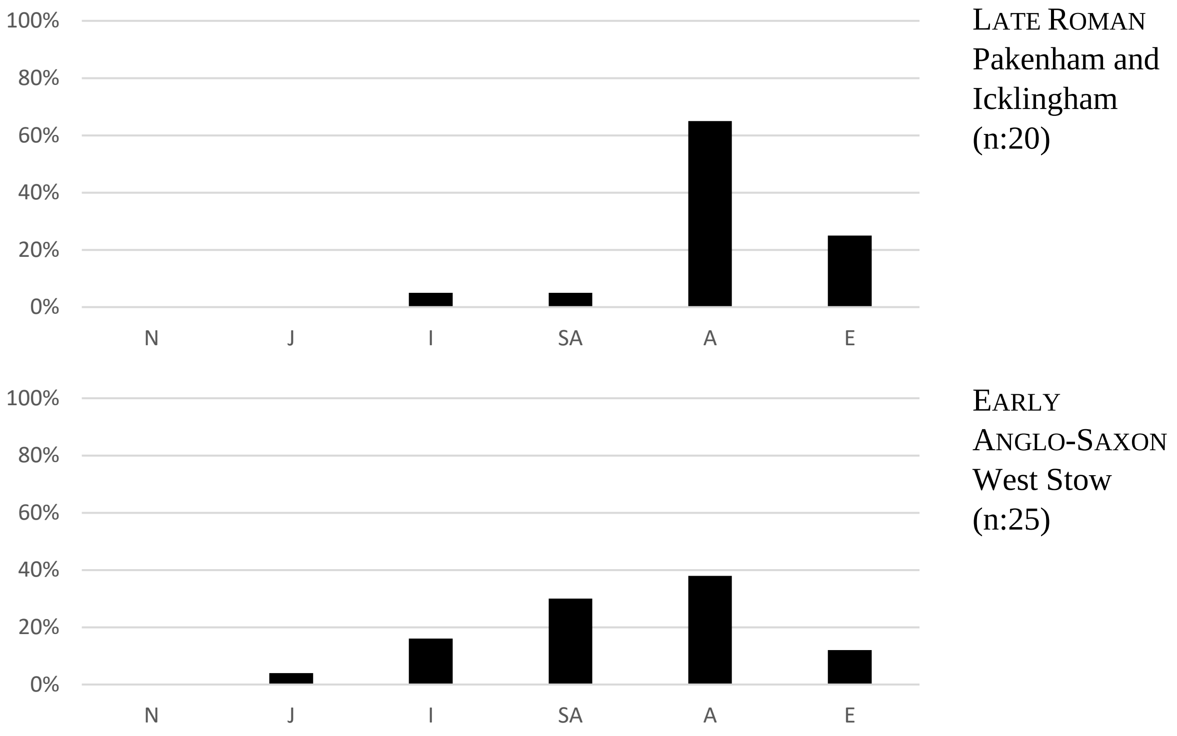


Fig. 6.1.10 Distribution of cattle mandibular wear stages in the age groups devised by O'Connor (1988) at Pakenham and Icklingham (top, n:20) and West Stow (bottom, all subphases combined, n:25). N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

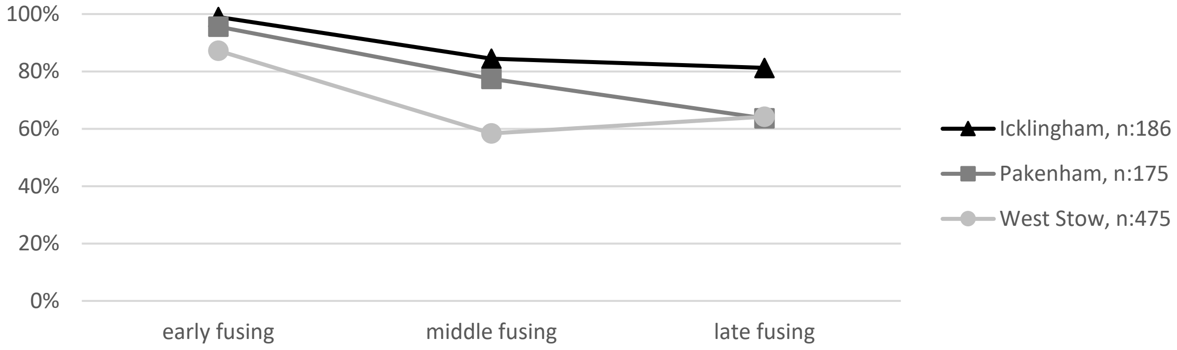


Fig. 6.1.11 Incidence of cattle fused elements in the three fusing stages proposed by Silver (1969) at Pakenham (n:186), Icklingham (n:175), and West Stow (n:475).

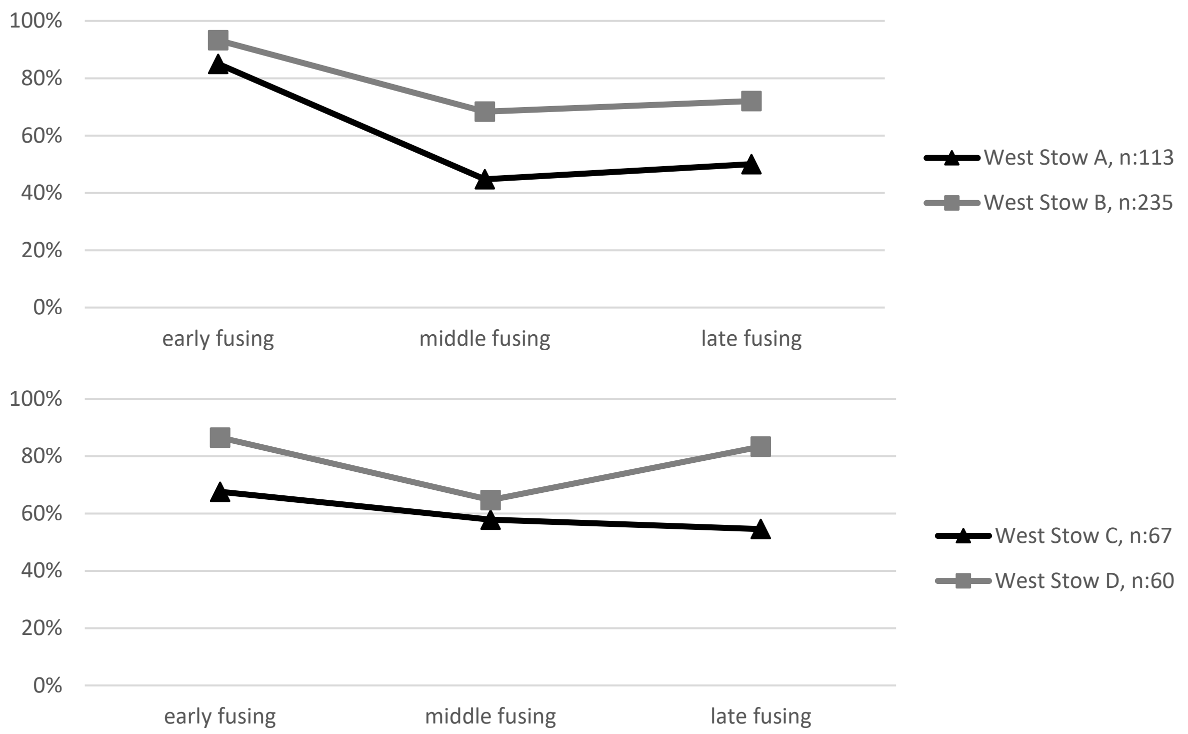
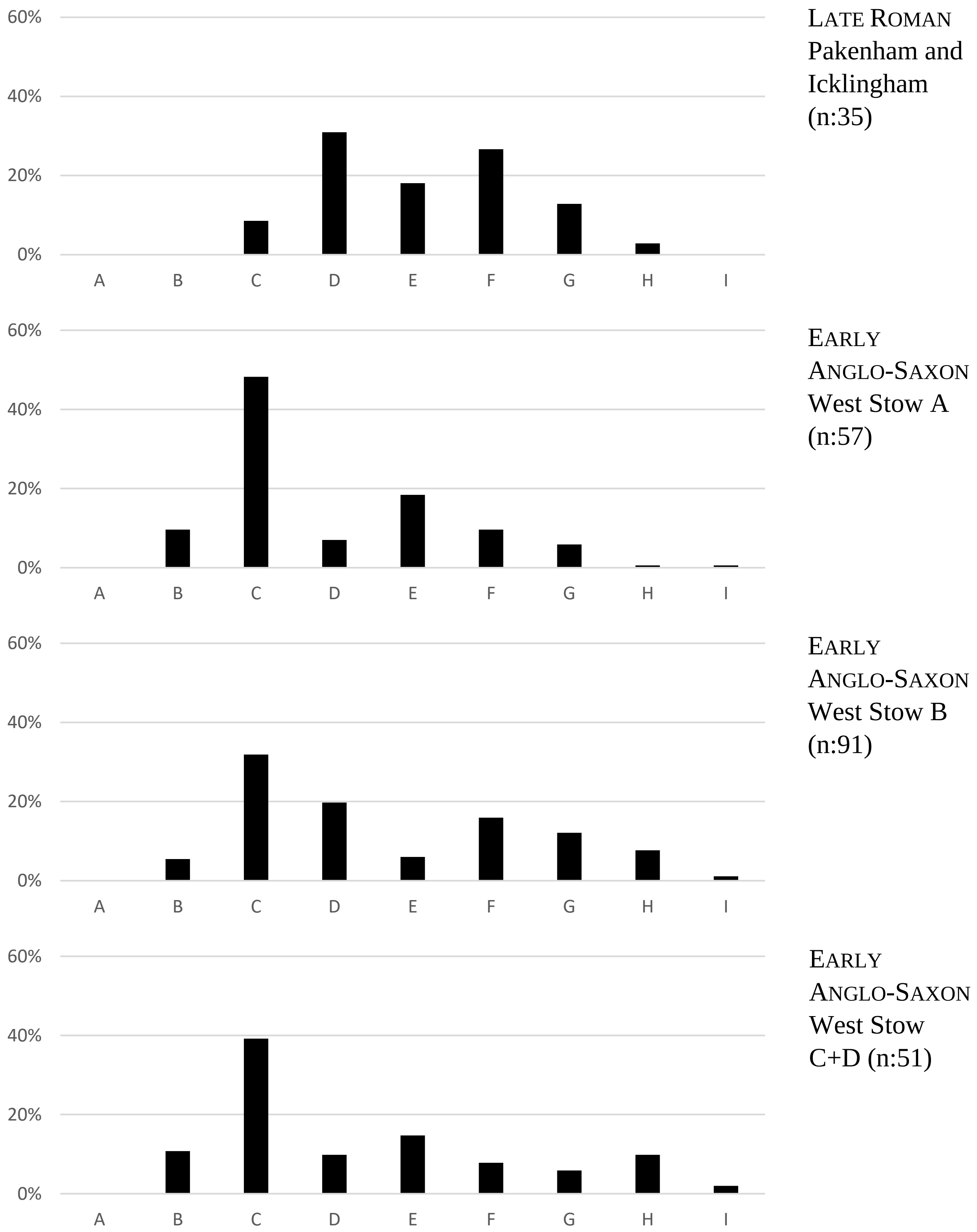


Fig. 6.1.12 Incidence of cattle fused elements in the three fusing stages proposed by Silver (1969) at West Stow (subphase A – 5th century AD, n:113; subphase B – mid-5th-mid-6th centuries AD, n:91; subphase C – 6th century AD, n:67; subphase D – 7th century AD, n:60).

Differences in the culling profiles of caprines between the Late Roman and Early Anglo-Saxon assemblages are more pronounced. The analysis of mandibular wear stages of sheep indicate that these animals were mainly kept for meat and wool production at Pakenham and Icklingham (whose data had to be combined), with very few individuals culled in early ages (Fig. 6.1.13). On the contrary, in all subphases from West Stow (and especially in the first one – 5th century AD) a large number of individuals were culled as lambs (ca. 35-60% individuals younger than one year), with fewer culls of sub-adult/early adult animals and a relatively small group of sheep surviving into late adulthood. As a result, the mandibular wear stages at West Stow suggest a major culling of excess lambs for meat production and milk exploitation, as well as for practical reasons related to animal management in the winter season; at the same time, the presence of animals from all age ranges suggests all caprine products were being exploited at the site. Contrary to cattle, the analysis of epiphyseal fusion of postcranial caprine bones does not reflect the changes observed in the distribution of mandibular wear stages (Fig. 6.1.14). While the prevalence of subadult and adult animals is confirmed for the Late Roman sites, a shift towards the culling of younger animals at West Stow is not evident, nor are the alternating fluctuations highlighted by dental ageing; rather, there seems to be a barely perceptible, gradual move towards the culling of younger sheep, especially in subphases C and D (6th-7th centuries AD). Phase A (5th century) in particular, when dental ageing shows a 60% of animals culled before the first year of age, indicates a very low amount of culled lambs, a low number of culled subadults/early adults, and over 30% of the sheep surviving into later adulthood; most of culling events occur by the late fusing stage (ca. half of the culls), much later than suggested by dental ageing. Considering the higher fragility of bones from immature individuals, such inconsistency may be the result of preferential taphonomic destruction and therefore of the underrepresentation of young animals in the epiphyseal fusion analyses.



LATE ROMAN
Pakenham and
Icklingham
(n:35)

EARLY
ANGLO-SAXON
West Stow A
(n:57)

EARLY
ANGLO-SAXON
West Stow B
(n:91)

EARLY
ANGLO-SAXON
West Stow
C+D (n:51)

Fig. 6.1.13 Distribution of caprine mandibular wear stages in the age groups devised by Payne (1973) at Pakenham and Icklingham (n:35), West Stow – subphase A (5th century AD, n:57), West Stow – subphase B (mid-5th-mid-6th centuries AD, n:91), and West Stow – subphases C+D (6th-7th centuries AD, n:51).

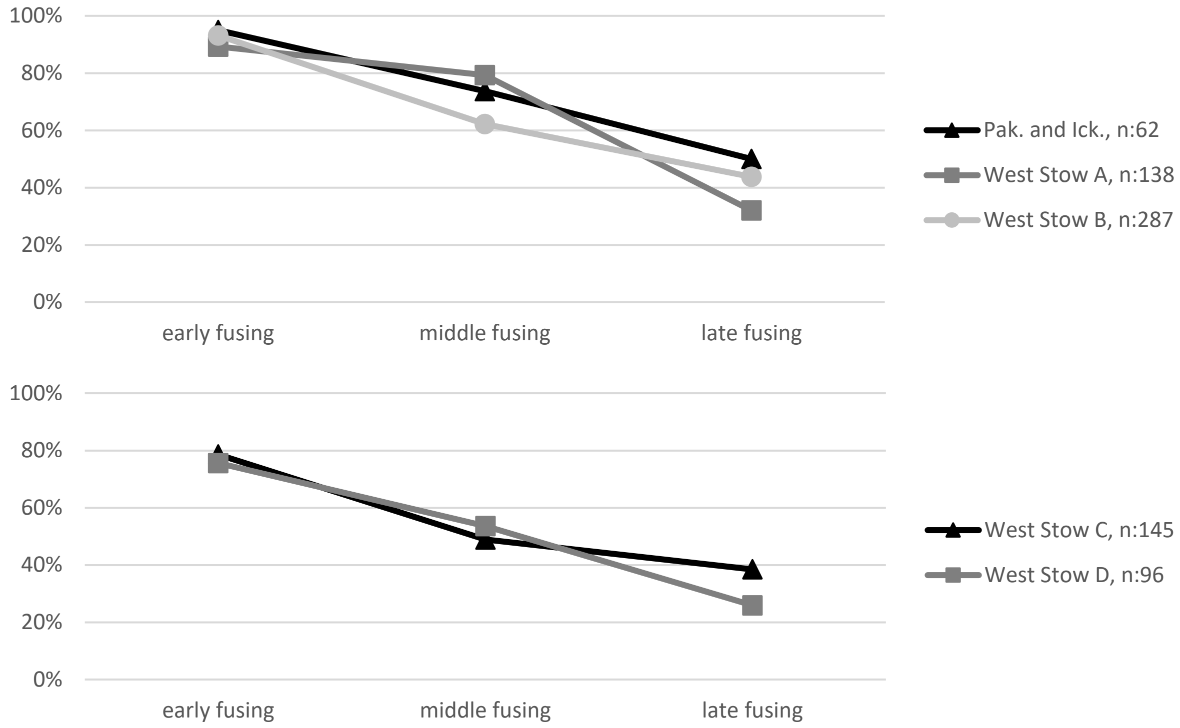


Fig. 6.1.14 Incidence of caprine fused elements in the three fusing stages proposed by Silver (1969) at Pakenham and Icklingham (n:62), and West Stow (subphase A – 5th century AD, n:138; subphase B – mid-5th-mid-6th centuries AD, n:287; subphase C – 6th century AD, n:145; subphase D – 7th century AD, n:96).

At West Stow, suid culling does not seem limited to subadults and adults, but is spread more equally to include immature individuals. This is consistently reflected in the four subphases when the analysis of postcranial epiphyseal fusion is considered; ageing data from Pakenham and Icklingham reveal a similar trend to West Stow (Fig. 6.1.16). The relatively high incidence of pig culled as adult individuals in Early Anglo-Saxon West Stow suggests animals reached their optimum weight relatively late.

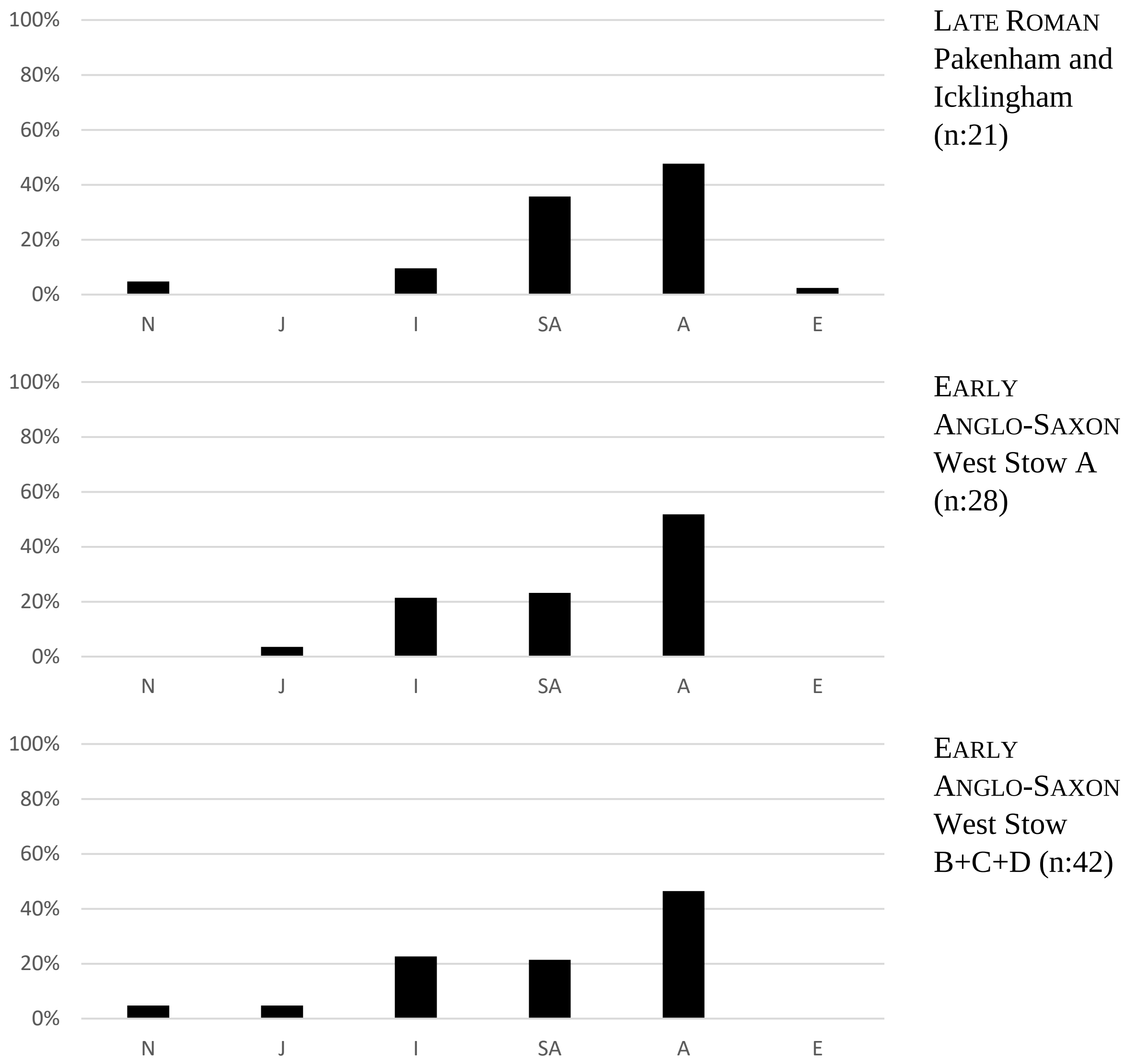


Fig. 6.1.15 Distribution of suid mandibular and maxillary wear stages in the age groups devised by O'Connor (1988) at Pakenham and Icklingham (n:21), West Stow – subphase A (5th century AD, n:28), and West Stow – subphases B+C+D (mid-5th-7th centuries AD, n:42). N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

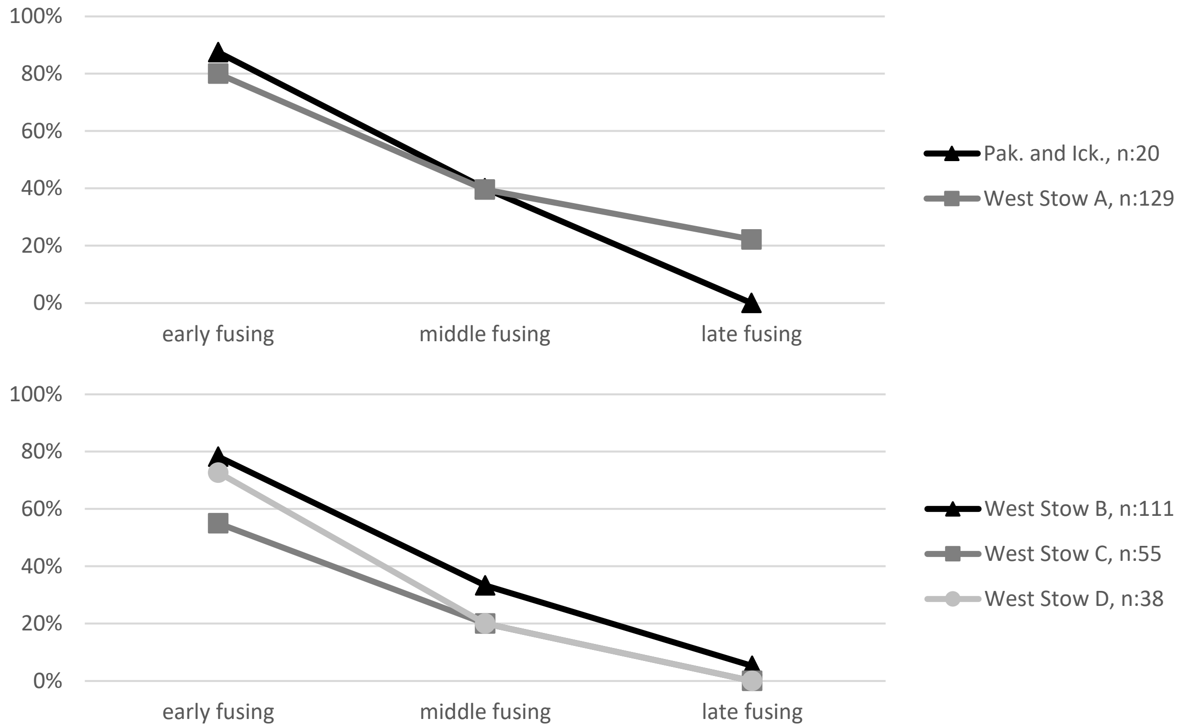


Fig. 6.1.16 Incidence of suid fused elements in the three fusing stages proposed by Silver (1969) at Pakenham and Icklingham (n:20), and West Stow (subphase A – 5th century AD, n:129; subphase B – mid-5th-mid-6th centuries AD, n:111; subphase C – 6th century AD, n:55; subphase D – 7th century AD, n:38).

6.1.4 Sexing

Sexing analyses on the material from the Suffolk sites relied on biometrical analyses of highly sexually dimorphic bones (cattle and caprines), and on canine morphology (suids).

Cattle horncore measurements were used to attempt a separation between cows, oxen, and bulls. Due to the lack of horncore lengths, the analysis could only rely on the minimum and maximum diameters of the base (Fig. 6.1.17). Values from Late Roman Pakenham cluster in two groups of similar dimensions, most likely representing cows and oxen; the three outliers could represent bulls. At Icklingham, most values cluster with the smaller measurements from Pakenham; again, the few larger outliers may represent bulls or large oxen. As some female individuals could also be hornless, there seems to be a slightly higher frequency of females. In order to investigate further the sex composition of the cattle populations, the more sex-dependent measurements were plotted in log ratio histograms (Fig. 6.1.18). The measurements from Pakenham support the observations made for Fig. 6.1.17: the polymodal distribution of values, which is very much diluted when the less sex-dependent measurements are included (§

6.1.7.1) may reflect the presence (and different incidence) of cows, oxen, and bulls. A similar assumption cannot be made for Icklingham and West Stow, where it is impossible to identify potential sex groups; the right-hand tail, however, may represent a small number of males, hence indicating a prevalence of cows. At Icklingham at least, the main group of values corresponds to that of cows from Pakenham, potentially supporting the prevalence of females at this site suggested by Fig. 6.1.17.

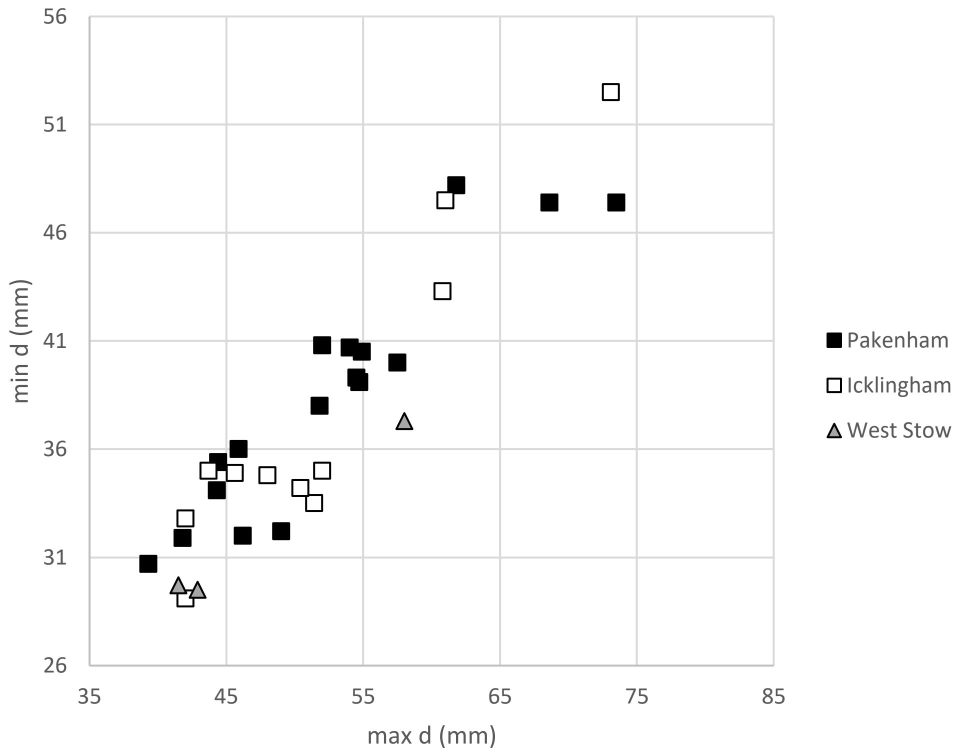


Fig. 6.1.17 Scatter plot of measurements from cattle horncores (maximum diameter *vs* minimum diameter) from Pakenham, Icklingham, and West Stow.

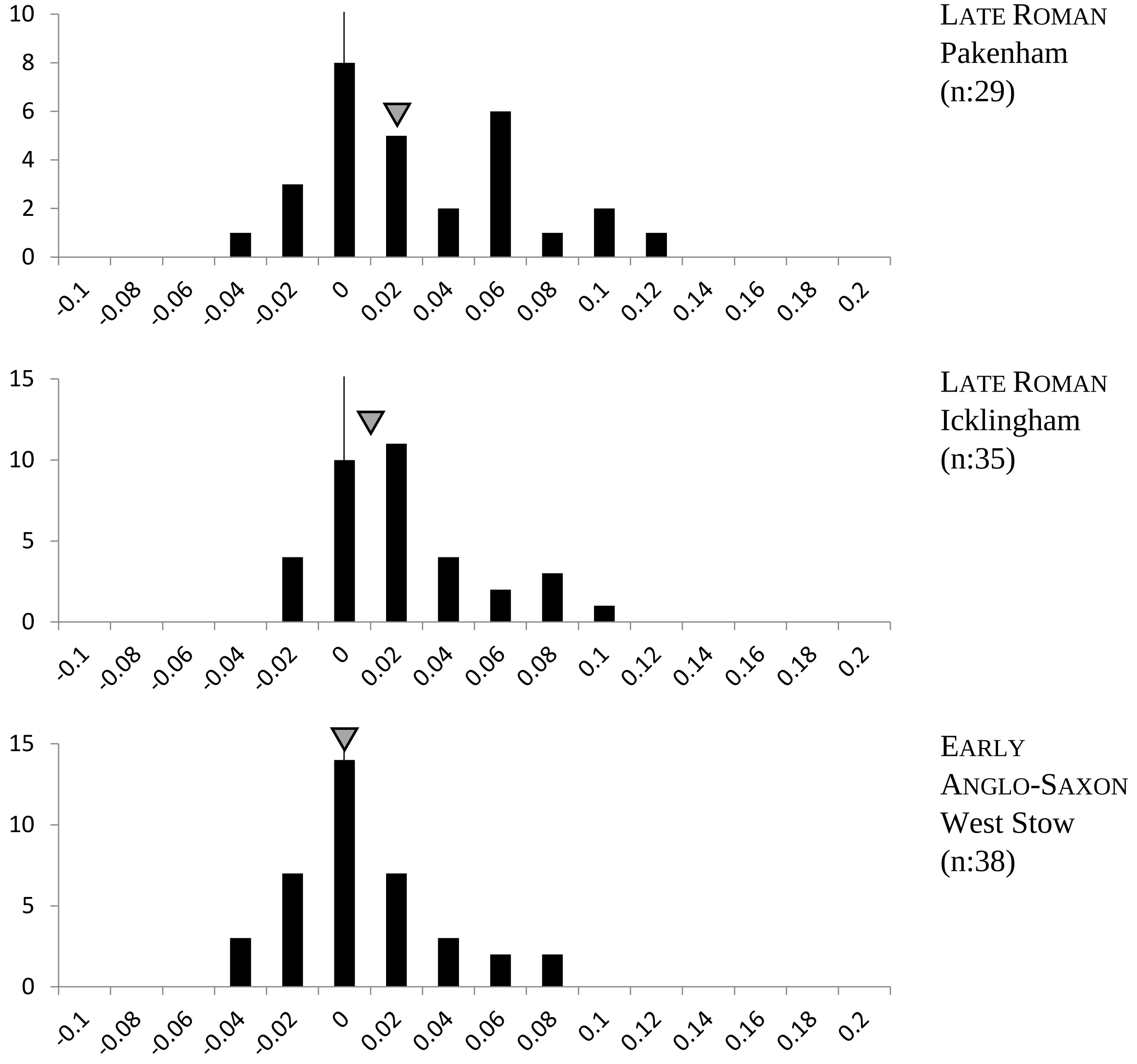


Fig. 6.1.18 Distribution of log ratio values of a selection of cattle bone widths (only the more sex-dependent measurements) from Pakenham, Icklingham, and West Stow.

Considerations on the sex ratio of caprine populations could only be made for West Stow, due to the small sample size from the Late Roman sites. Values from the distal humerus cluster in two main groups in the first and second subphases; in both cases, the group of smaller values has more specimens, possibly suggesting a prevalence of ewes and the presence of wethers and rams (Fig. 6.1.19). The higher incidence of females could indicate a focus on the exploitation of milk, as well as of meat.

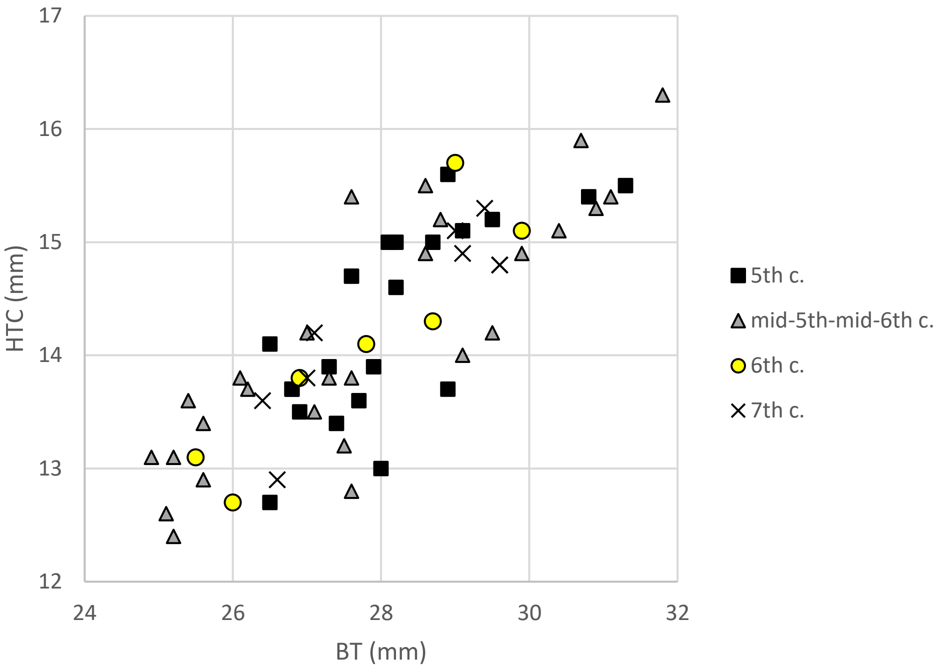


Fig. 6.1.19 Scatter plot of measurements from caprine humeri (BT *vs* HTC) from the four subphases at West Stow.

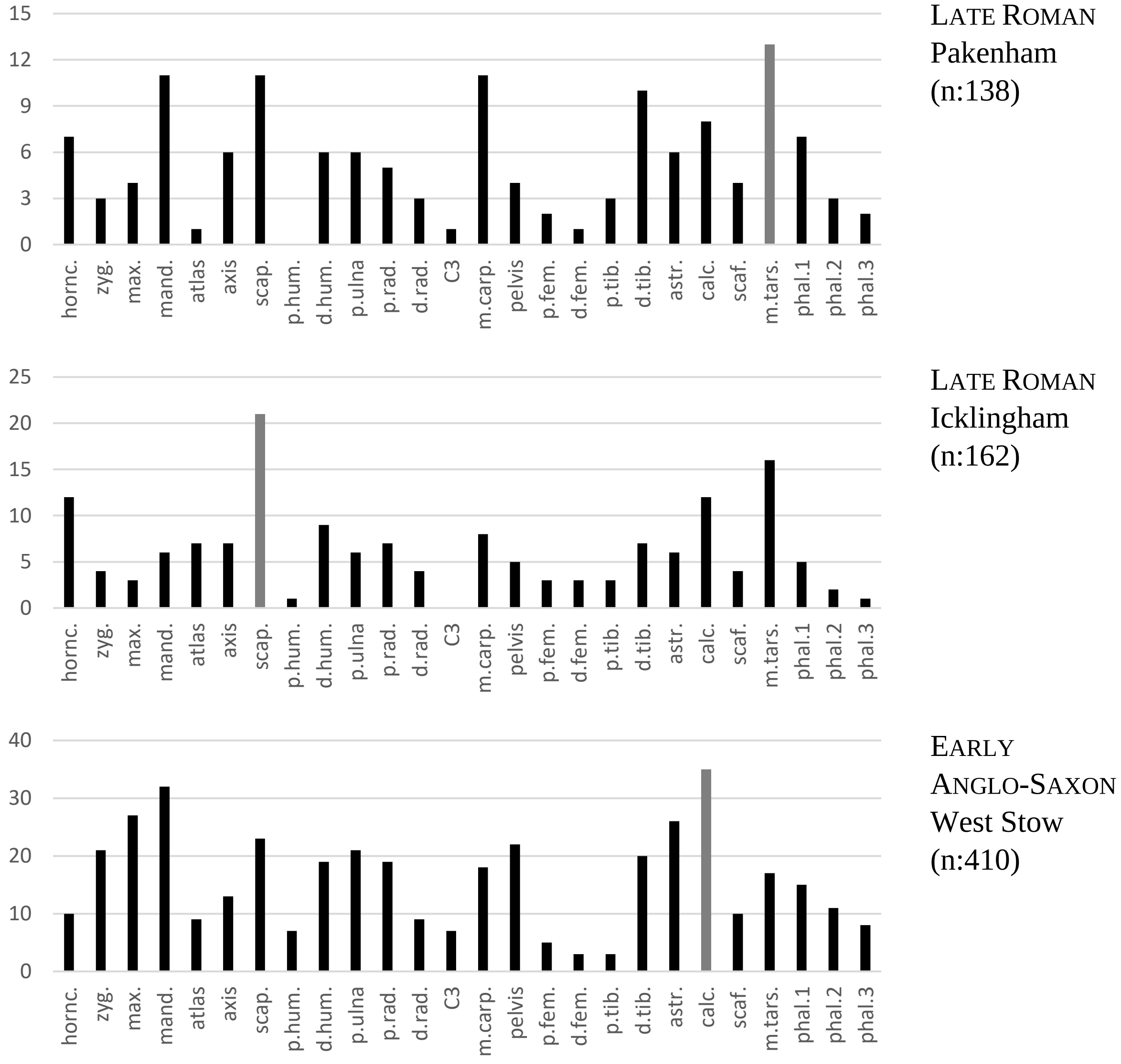
The proportion of pig male and female canines/alveoli indicates an equal presence of sows and boars at Early Anglo-Saxon West Stow (Tab. 6.1.1). As biometrical analyses suggest the vast majority of suids were domestic, and the number of boars should be kept to a minimum in domestic populations, it is possible that some of the male pigs were castrated individuals.

	n	% males and females
MALE CANINES/ALVEOLI	13	**52%**
FEMALE CANINES/ALVEOLI	12	**48%**
TOTAL	*25*	

Tab. 6.1.1 Presence and proportions of pig male and female canines/alveoli at West Stow. Only canines in jaws (and jaws with identifiable canine alveoli) were used in this analysis.

6.1.5 Distribution of anatomical elements

The distribution of cattle anatomical elements at Pakenham, Icklingham and West Stow is inevitably affected by taphonomic biases (Fig. 6.1.20). Those elements which fuse late, and with less dense and thinner cortical bone (mainly proximal humeri, distal radius, femurs, proximal tibiae), are either absent or underrepresented in all the three sites, as a result of preferential destruction in archaeological deposits; smaller elements, such as the 3rd carpal and phalanges, are also underrepresented, as their presence is affected by a recovery bias (§ 6.1.1). At both Pakenham and Icklingham, primary butchery waste and meat-bearing parts are well represented. Scapulae are particularly abundant; these are among the most resistant parts of the bovid skeleton. However, the consistent occurrence in specific contexts of large numbers of scapulae, characterised by standardised butchery patterns, suggests the consumption of cured beef shoulders (§ 6.1.6, 7.1). At Early Anglo-Saxon West Stow, meat-bearing, lower limb, and cranial elements are equally represented, suggesting the butchery and consumption of whole carcasses.


LATE ROMAN
Pakenham
(n:138)

LATE ROMAN
Icklingham
(n:162)

EARLY
ANGLO-SAXON
West Stow
(n:410)

Fig. 6.1.20 Distribution of anatomical elements (MAU) for cattle at Pakenham (n:138), Icklingham (n:162), and West Stow (n:410).

Preservation and recovery biases clearly affected the distribution of caprine and suid anatomical elements as well (Figs. 6.1.21 and 6.1.22). The more fragile elements are either absent or scarce in comparison to others, and the smaller bones (e.g. phalanges) are underrepresented; the high incidence of mandibles is probably a result of such preservation biases. In addition to this, the sample sizes for the two Late Roman sites (Pakenham and Icklingham) are very small, preventing reliable comparisons with Early Anglo-Saxon West Stow. In general, however, lower limb, cranial, and the more meat-bearing elements are all represented, suggesting the butchery and consumption on site of whole carcasses.

In all three sites, vertebrae and ribs from large- and medium-sized mammals have been recorded, confirming the overall trends.

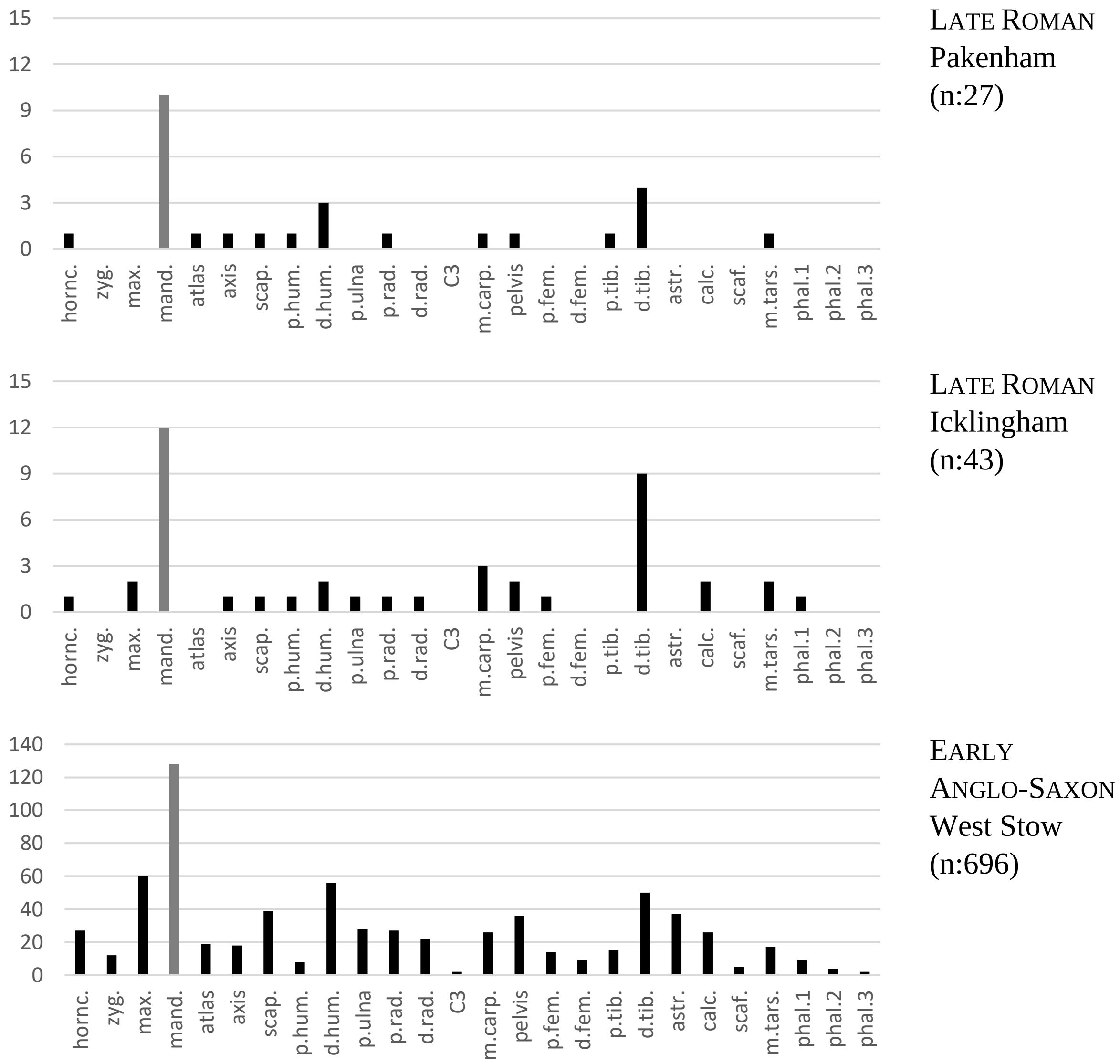


Fig. 6.1.21 Distribution of anatomical elements (MAU) for caprines at Pakenham (n:27), Icklingham (n:43), and West Stow (n:696).

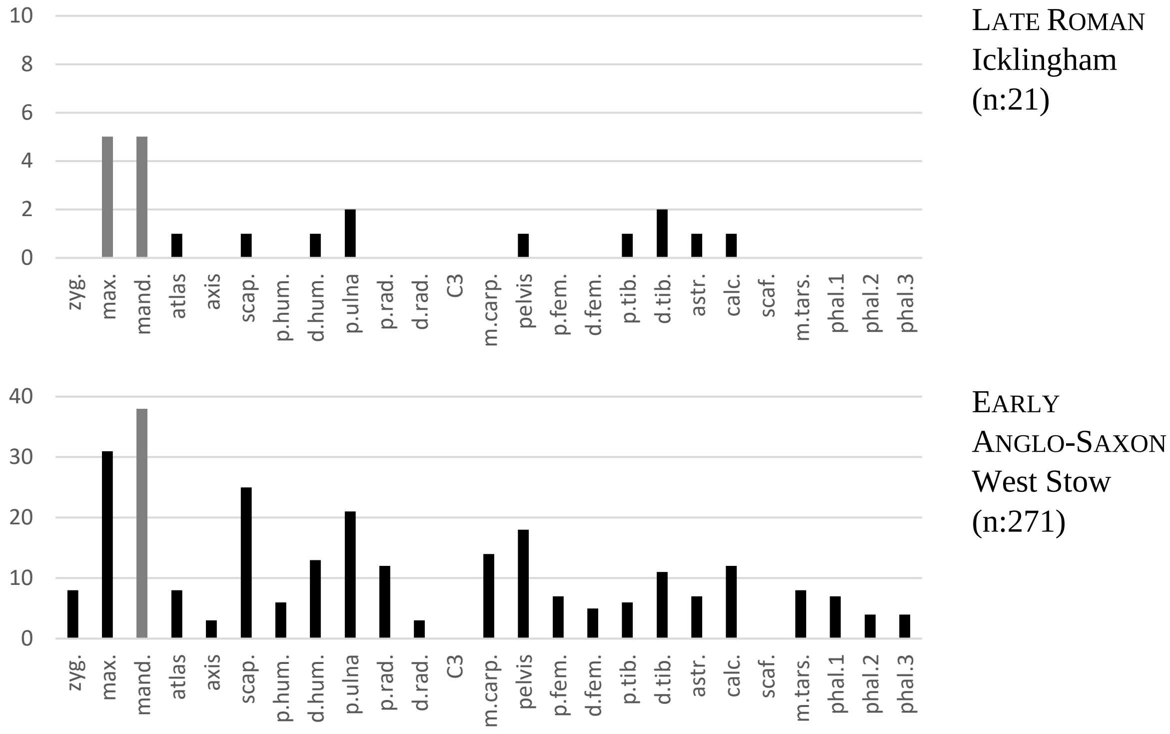


Fig. 6.1.22 Distribution of anatomical elements (MAU) for suids at Icklingham (n:21), and West Stow (n:271).

6.1.6 Butchery

The incidence of butchered countable elements is higher at the Late Roman sites (Pakenham and Icklingham) for the three main domesticates, although most of the butchery evidence was recorded on cattle remains (Fig. 6.1.23). This is largely the result of cattle carcasses being larger than those of caprines and suids, and therefore requiring more effort to be divided into sizeable portions. However, such higher incidence of butchered cattle elements also reflects the standardised, large-scale butchery and distribution of cattle of Roman times. This is supported by the analysis of butchery marks on cattle remains (Fig. 6.1.24). In the Late Roman assemblages, differently from Early Anglo-Saxon West Stow, the large majority consist of chop marks, possibly reflecting a more consistent practice of intensive butchery where carcasses could be quickly processed by chopping through the joints. At West Stow, the more equal representation of cut and chop marks suggests a less standardised, *ad hoc* butchery of animals, where time allowed to cut through tendons at the main joints and remove meat from the bone in a more careful way. Sheep butchery mark analysis could only be run for West Stow. The incidence of cut marks is higher for this taxon, possibly reflecting the trend seen for cattle; at the same time, the smaller size of caprine carcasses would require less chopping, and the whole butchery process could more easily be performed with smaller tools such as knives.

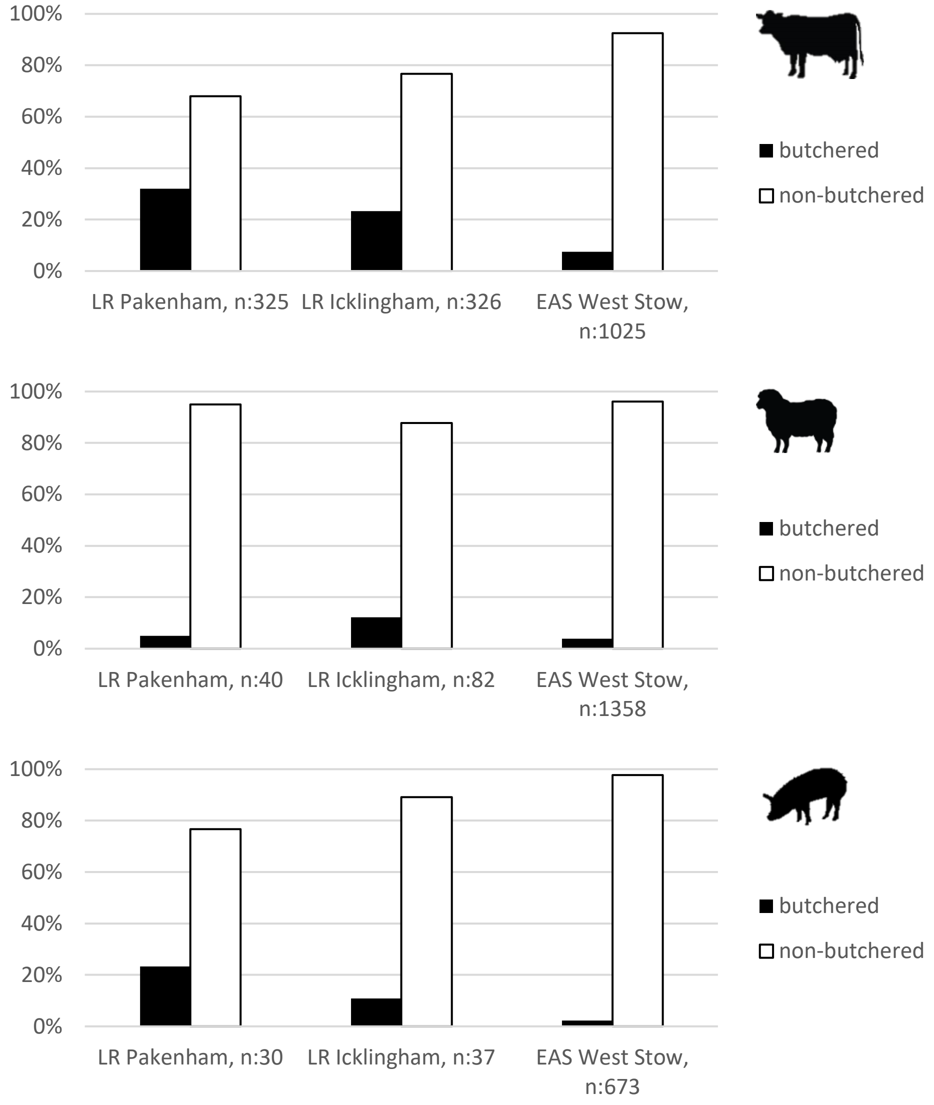


Fig. 6.1.23 Incidence of butchered countable elements for cattle, caprines, and suids at Pakenham, Icklingham, and West Stow.

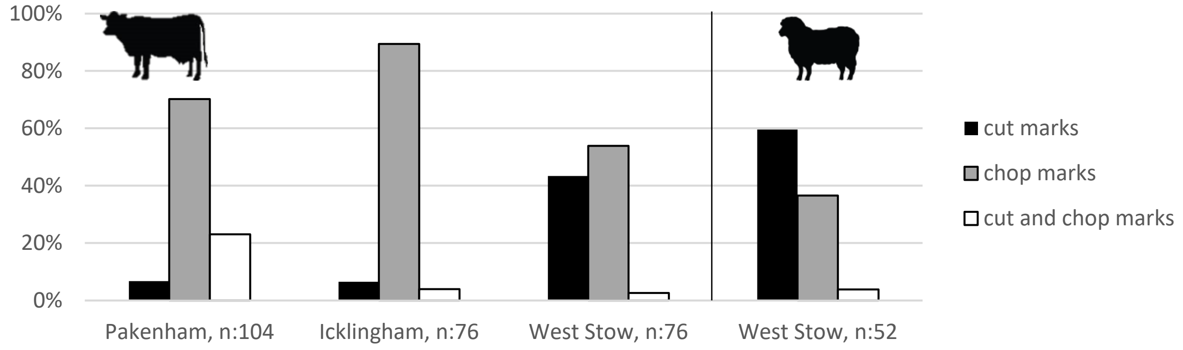


Fig. 6.1.24 Incidence of cut, chop, and cut and chop marks on cattle countable elements at Pakenham, Icklingham, and West Stow, and on caprine countable elements at West Stow.

The trends suggested by quantitative analyses are supported by the presence of specialised butchery products in the Late Roman assemblages, and by their near-complete absence at Early Anglo-Saxon West Stow. At Pakenham and Icklingham, cattle scapulae were among the most frequent elements (§ 6.1.5); almost all of them had been butchered in a very consistent way. The rim of the glenoid cavity was often trimmed, and the coracoid process was also intensively butchered or chopped off altogether; the upper and lower borders usually showed ‘scraping’ marks, while the acromion and the rest of the spine were almost always chopped off at the base; intensive cutting and chopping were also recorded on the neck and on the ventral and dorsal sides of the scapular blade; occasionally, hook marks were present, consisting of irregular holes on the blade. This evidence is consistent with observations made on other Roman assemblages in the north-western provinces of the Empire, and is usually interpreted as the remains of cured beef shoulders (Schmid 1972; Lauwerier 1988; Dobney *et al.* 1996; Seetah 2006; Score *et al.* 2010; Johnstone and Albarella 2015). In addition, at the Late Roman sites many cattle long bones had been longitudinally split, while in other cases the bones had been chopped into small fragments; both practices aimed at the extraction of marrow, a valuable and versatile product. Similarly to cattle scapulae, these butchery practices have been widely recorded at other Roman sites (Schmid 1972; van Mensch 1974; Maltby 2007; Johnstone and Albarella 2015). The significance of these patterns, their origin and distribution, as well as their absence in pre- and post-Roman assemblages, are discussed in Chapter 7.

6.1.7 Biometry

6.1.7.1 Cattle

The scatter plots of cattle bone measurements display a wide range of values for both the Late Roman and the Early Anglo-Saxon assemblages, with small and large animals represented in the two periods. However, Late Roman values seem skewed towards the top-right of most of the graphs, suggesting the presence of on-average larger cattle in this period. Early Anglo-Saxon values concentrate in the range of medium- and small-sized specimens, although a few very large post-Roman values are present in some of the graphs (Figs. 6.1.25-6.1.27).

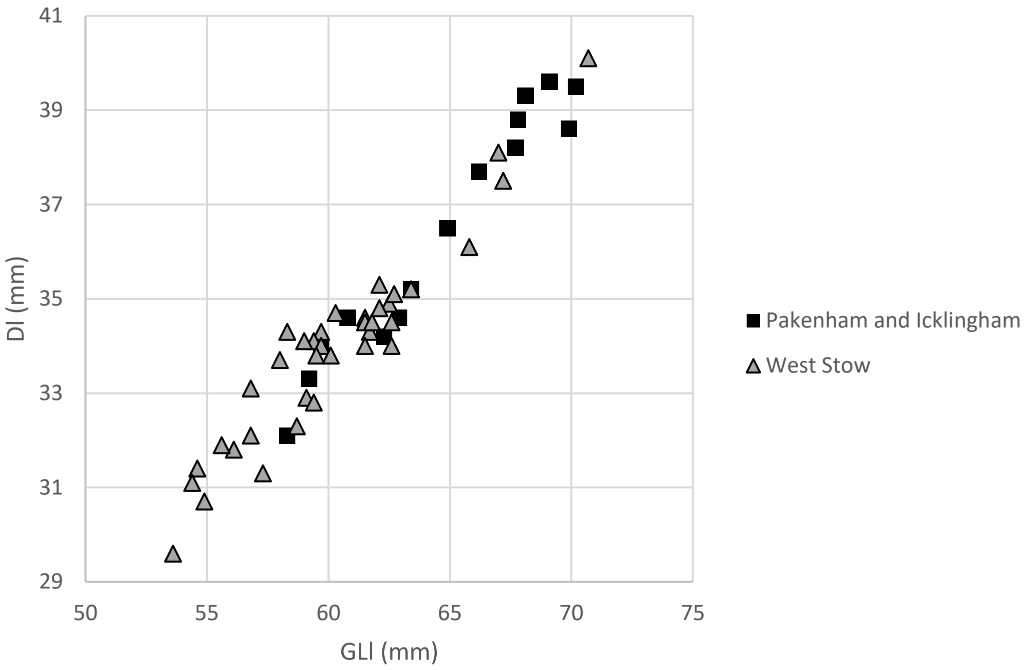


Fig. 6.1.25 Scatter plot of measurements from cattle astragali (GLl *vs* Dl) from Pakenham, Icklingham, and West Stow.

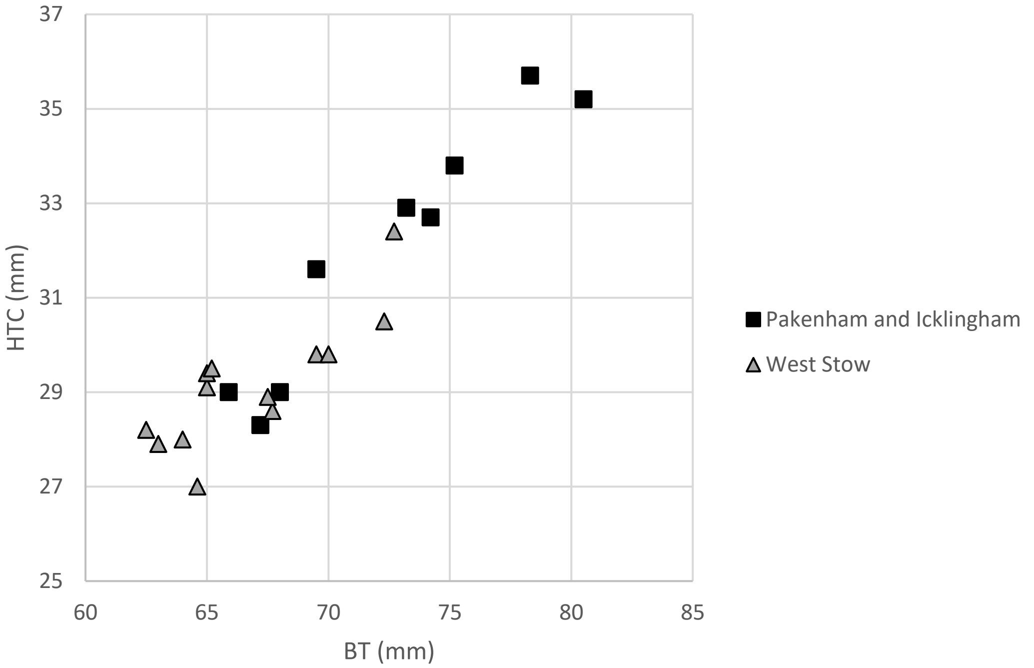


Fig. 6.1.26 Scatter plot of measurements from cattle humeri (BT *vs* HTC) from Pakenham, Icklingham, and West Stow.

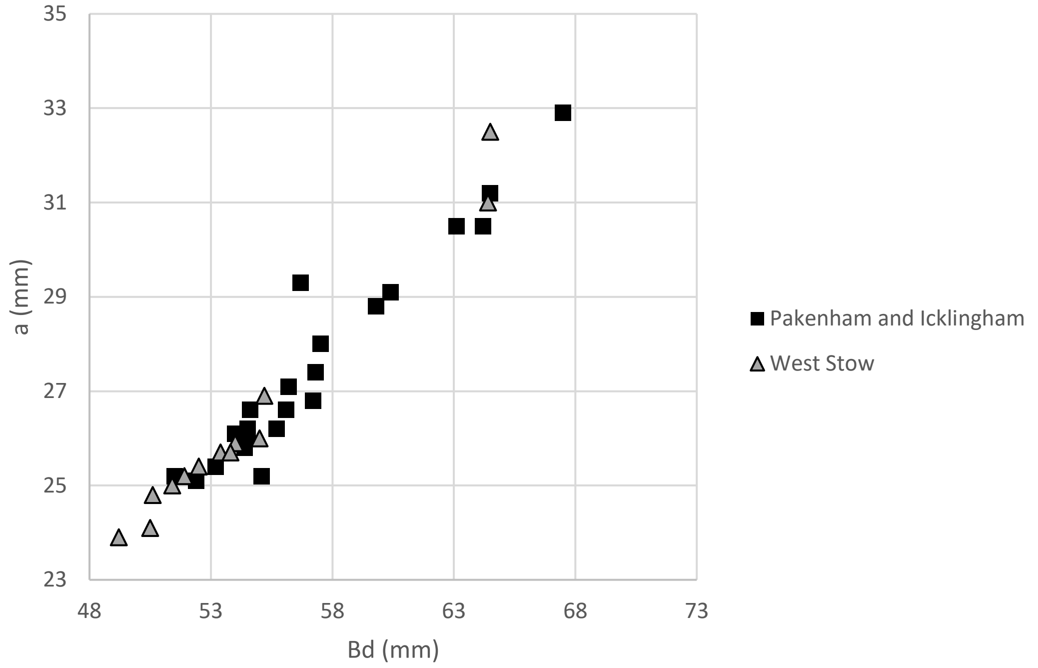


Fig. 6.1.27 Scatter plot of measurements from cattle metacarpals (Bd *vs* a) from Pakenham, Icklingham, and West Stow.

In order to further investigate potential biometrical differences in cattle bones, sets of width, depth, and length measurements were merged into log ratio histograms; this allowed to produce larger samples and to separate observations on measurements lying in the three axes.

Bone widths confirm the presence of larger cattle at the Late Roman sites of Pakenham and Icklingham, although the range of values at West Stow is very similar (Fig. 6.1.28). At the same time, the mean and distribution of values at Icklingham lie in between those from Pakenham and West Stow; sexing analyses highlighted the possibility of a higher incidence of females at Icklingham in comparison to Pakenham (Figs. 6.1.17 and 6.1.18), which could partly impact on the smaller size of cattle at the former site. The results of the Student's t-test confirm that the difference between the group of values from West Stow and those from the Late Roman sites is statistically significant, displaying very low *p* values (Tab. 6.1.2). The larger sample size of width measurements allowed the separate analysis of the subphases at West Stow (Fig. 6.1.29). The means and distributions of values are very similar, with a slight further decrease in the 6th-7th centuries; statistical tests between the subphases confirm these observations (Tab. 6.1.2).

Depth measurements show a similar trend: the values from West Stow concentrate in the range of smaller specimens, although the overall range remains similar and some large cattle are present (Fig. 6.1.30). Length measurements further confirm an overall decrease in the size of cattle (Fig. 6.1.31). Statistical tests for depth measurements only in part support the visual observation of the log ratio histograms, while the result of the Student's t-test comparing cattle bone lengths highlight a highly significant difference (Tab. 6.1.2).

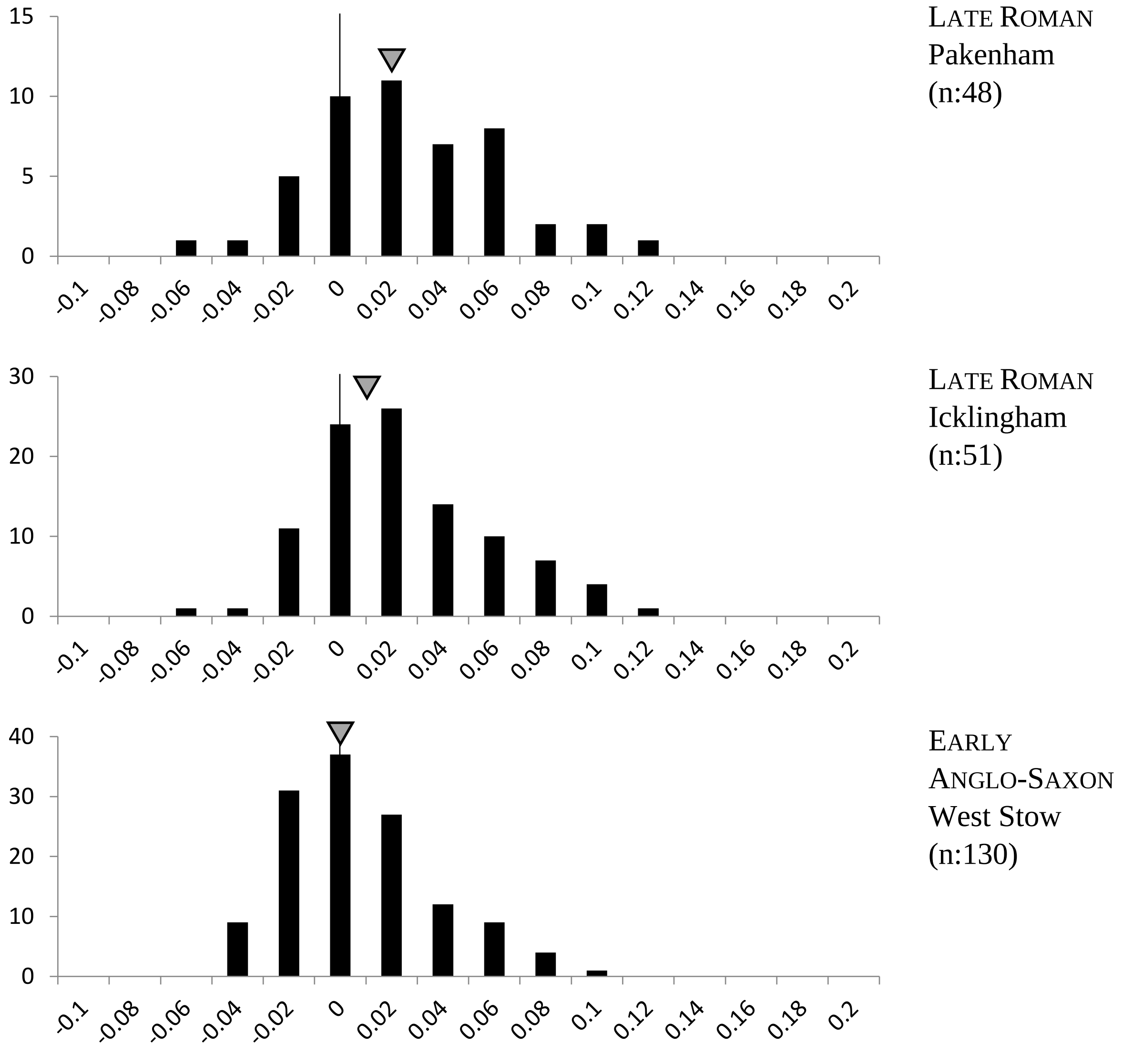


Fig. 6.1.28 Distribution of log ratio values of a selection of cattle bone widths from Pakenham, Icklingham, and West Stow.

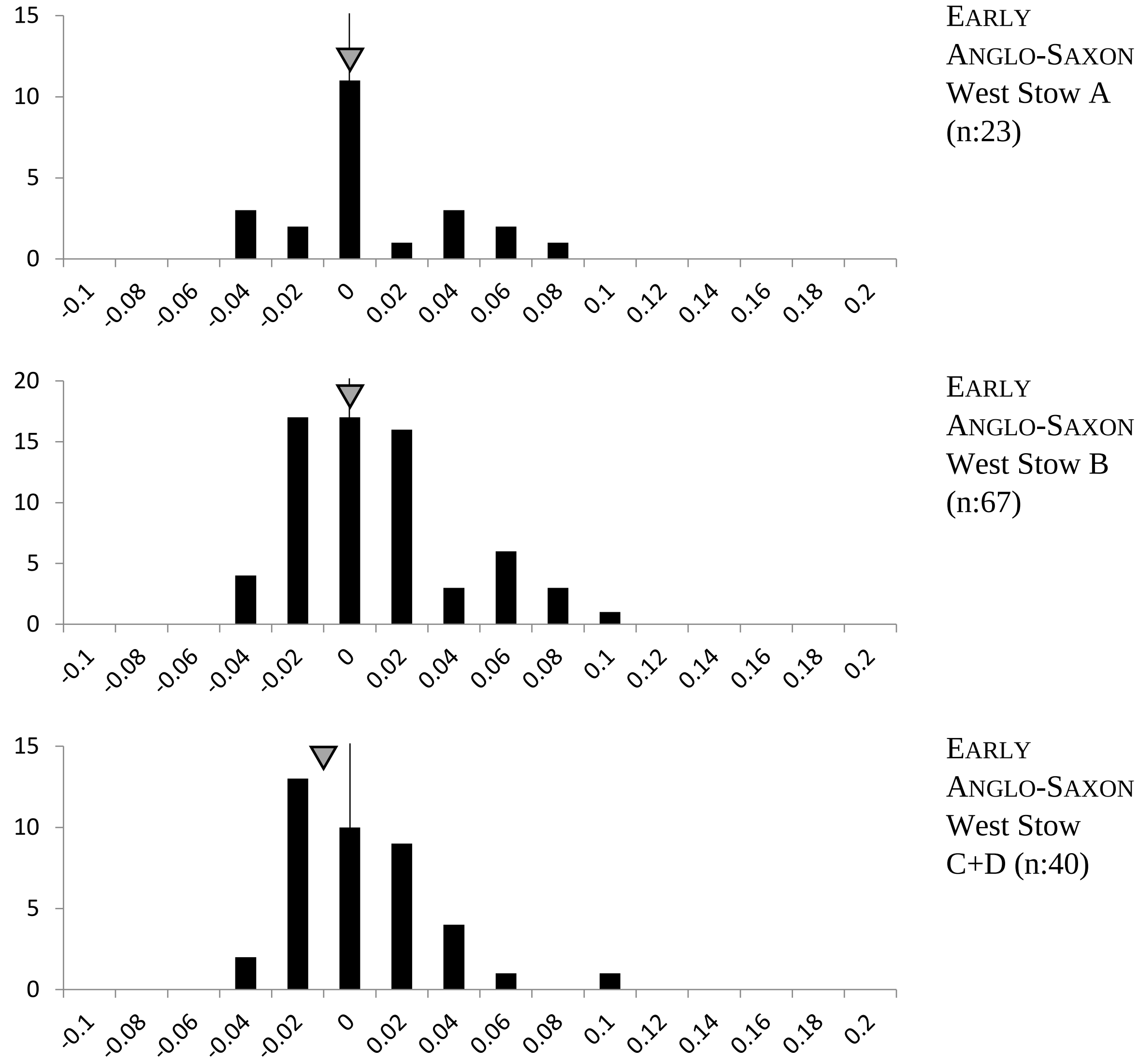


Fig. 6.1.29 Distribution of log ratio values of a selection of cattle bone widths from the subphases at West Stow.

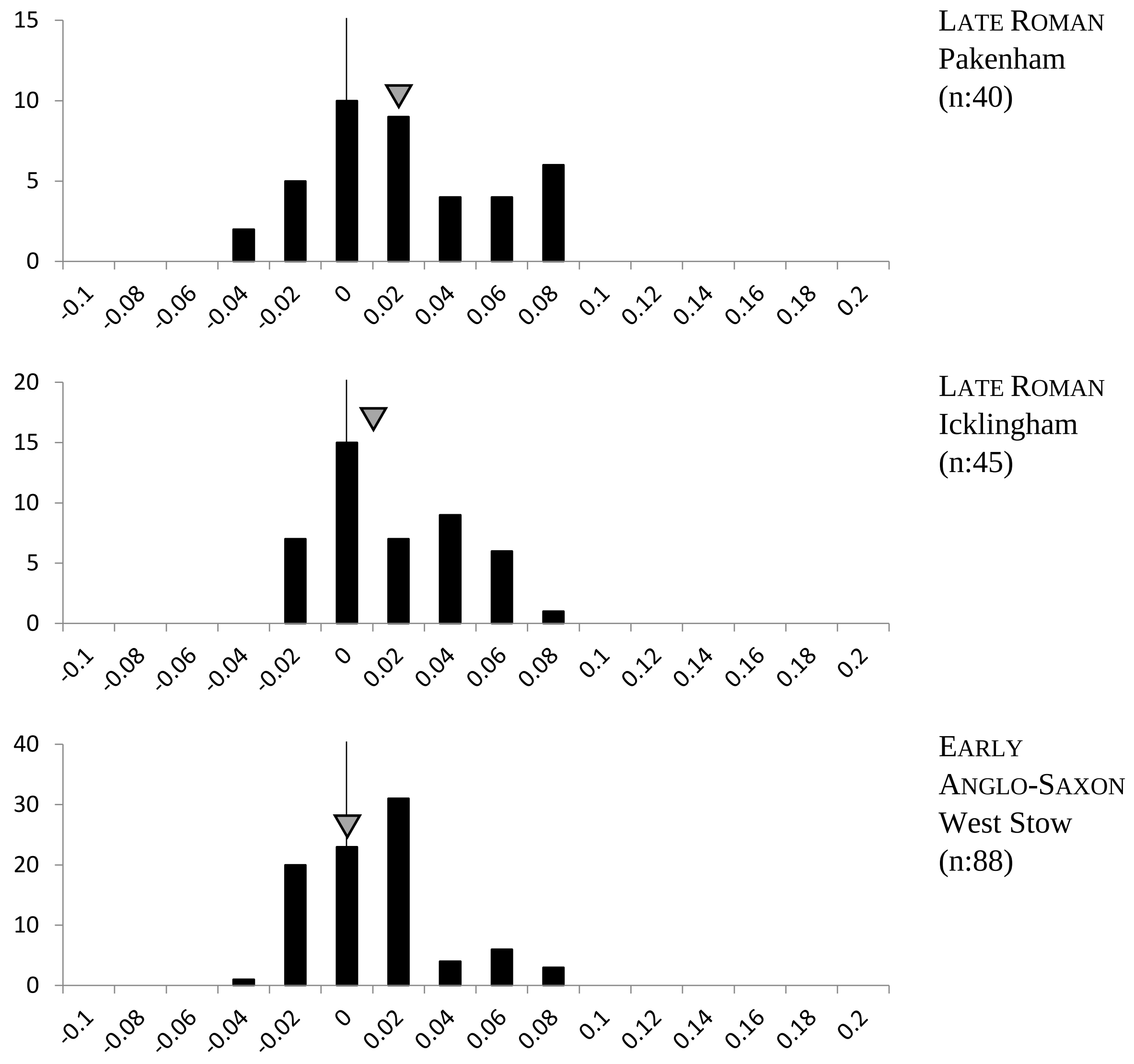


Fig. 6.1.30 Distribution of log ratio values of a selection of cattle bone depths from Pakenham, Icklingham, and West Stow.

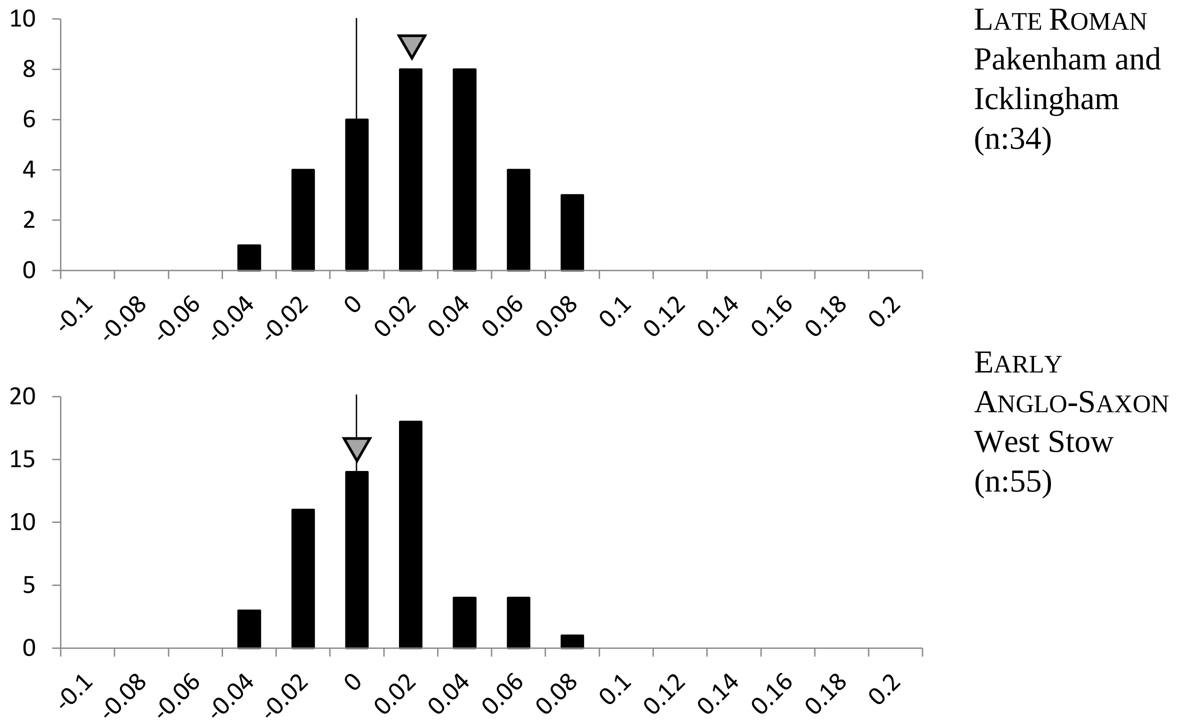


Fig. 6.1.31 Distribution of log ratio values of a selection of cattle bone lengths from Pakenham and Icklingham, and West Stow.

	P w	I w	W w	Wa w	Wb w	Wcd w	P d	I d	Wd	W l
P w	-	0.45	< 0.01	0.03	0.01	< 0.01	-	-	-	-
I w	0.45	-	< 0.01	0.03	0.01	< 0.01	-	-	-	-
W w	< 0.01	< 0.01	-	-	-	-	-	-	-	-
Wa w	0.03	0.03	-	-	0.41	0.32	-	-	-	-
Wb w	0.01	0.01	-	0.41	-	0.19	-	-	-	-
Wcd w	< 0.01	< 0.01	-	0.32	0.19	-	-	-	-	-
P d	-	-	-	-	-	-	-	0.02	0.28	-
I d	-	-	-	-	-	-	0.02	-	0.02	-
W d	-	-	-	-	-	-	0.28	0.02	-	-
P+I l	-	-	-	-	-	-	-	-	-	< 0.01

Tab. 6.1.2 Results of the Student's t-tests for cattle bone measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. P: Pakenham, I: Icklingham, W: West Stow, Wa: West Stow subphase A (etc.), w: widths, d: depths, l: lengths.

Values from tooth measurements show a similar pattern to bones. Lower M3s from the Late Roman sites cluster in the centre and top-right of the scatter plot, while those from West Stow present a wider range, including smaller values (Fig. 6.1.32). Log ratio analyses of tooth widths reflect those from bone widths, with West Stow presenting the smallest values and Icklingham lying in between Pakenham and West Stow (Fig. 6.1.33). This is confirmed by the results of the Student's t-tests, which highlight a higher statistical difference between Pakenham and West Stow than between the latter and Icklingham (Tab. 6.1.3). When the subphases from the Early Anglo-Saxon assemblage are considered, the smaller size of cattle teeth from this site seems the result of a gradual process, with cattle teeth from 5th-mid-6th centuries contexts presenting the same size as those from nearby Late Roman Icklingham, and those from 6th-7th century contexts being smaller (Fig. 6.1.34). According to a Student's t-test the difference between the two subphases is not statistically significant, but this may be due to the relatively small sample size, rather than to a genuine lack of difference between the two groups. A comparison with the Late Roman assemblages reveals a statistically significant difference of the later group from West Stow (subphases C+D), but not of the earlier group (subphases A+B). This confirms the graduality of tooth size decrease at West Stow (Tab. 6.1.3).

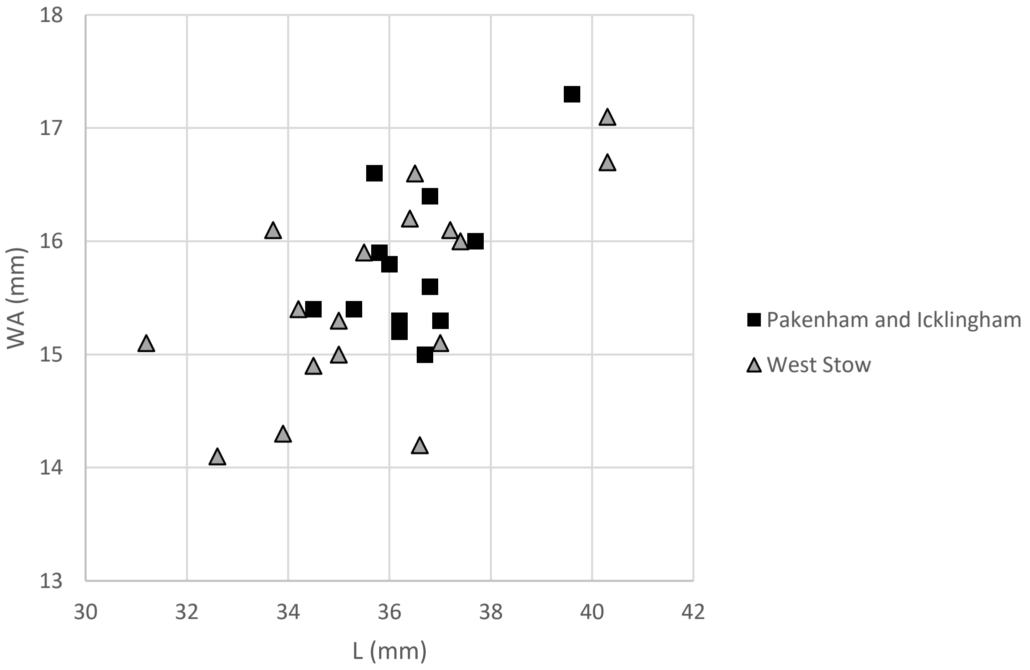


Fig. 6.1.32 Scatter plot of measurements from cattle M_3s (L *vs* WA) from Pakenham and Icklingham, and West Stow.

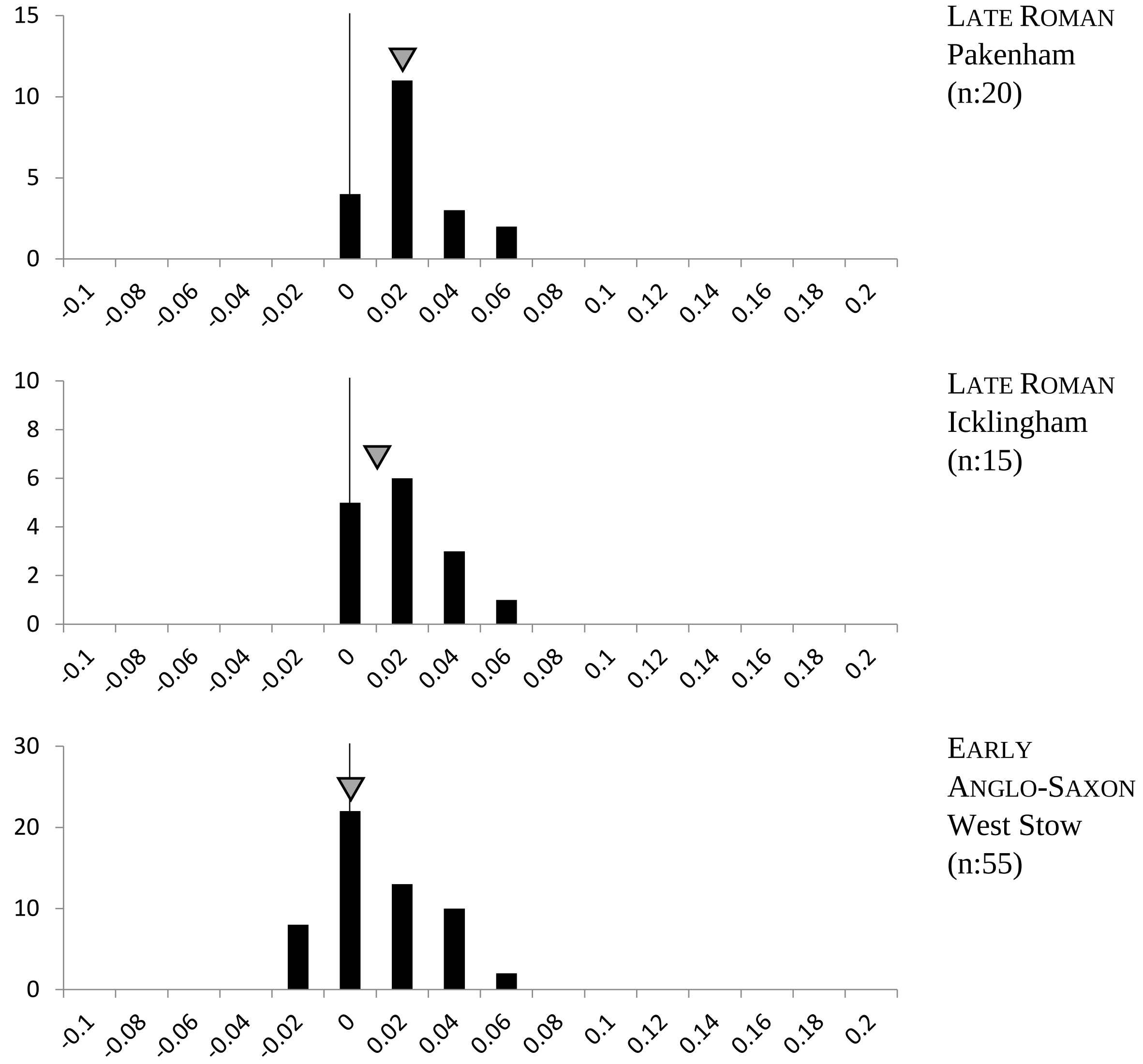


Fig. 6.1.33 Distribution of log ratio values of a selection of cattle tooth widths from Pakenham, Icklingham, and West Stow.

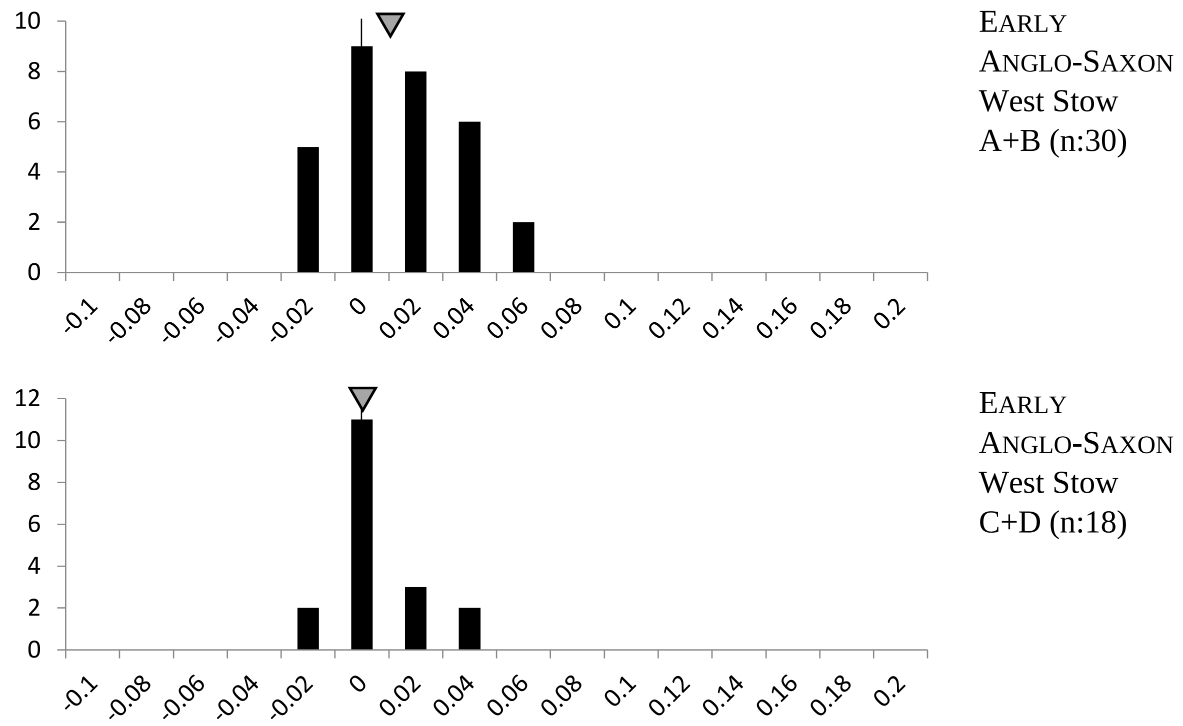


Fig. 6.1.34 Distribution of log ratio values of a selection of cattle tooth widths from the subphases at West Stow.

	P	**I**	**W**	**Wab**	**Wcd**
P	-	0.39	0.02	0.12	< 0.01
I	0.39	-	0.22	0.53	0.05
W	0.02	0.22	-	-	-
Wab	0.12	0.53	-	-	0.21
Wcd	< 0.01	0.05	-	0.21	-

Tab. 6.1.3 Results of the Student's t-tests for cattle tooth width measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. P: Pakenham, I: Icklingham, W: West Stow, Wab: West Stow subphases A and B (etc.).

6.1.7.2 Caprines

The dearth of biometrical data from Pakenham and Icklingham did not allow to investigate caprine size separately at the two Late Roman sites; for this reason, it has been decided to merge values from the two assemblages and compare them with those from West Stow, where caprine remains are much more abundant. Measurements from the tibia do not indicate substantial differences in average size between the Late Roman sites and West Stow; the lower end of the range, however, is mainly occupied by West Stow specimens (Fig. 6.1.35). Measurements from the humerus and the astragalus indicate that the majority of smaller values belong to the later subphases (B, C, and D – mid-5th-7th centuries) (Figs. 6.1.19 and 6.1.36). A potential, though minimal, indication of the smaller size of caprine bones in the earliest subphase at West Stow, compared to the rest of the Early Anglo-Saxon assemblage, could be seen for length and depth measurements of log ratio histograms; however, the overall comparisons between Late Roman and Early Anglo-Saxon values suggest no substantial changes in size in all the three axes (Figs. 6.1.37-6.1.42). In addition, continuity in the size of caprines at West Stow is supported by the fact that the sex ratio was probably skewed in favour of females, which would actually contribute to a higher incidence of smaller values (§ 6.1.4). The results of the Student's t-test confirm the lack of significant statistical difference in all comparisons (Tab. 6.1.4).

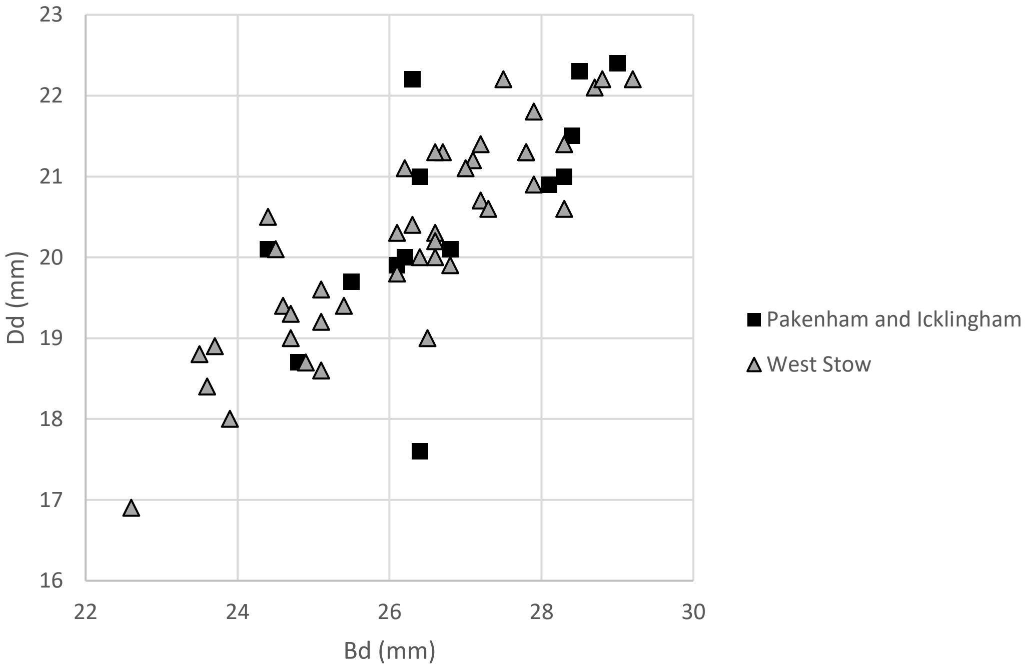


Fig. 6.1.35 Scatter plot of measurements from caprine tibiae (Bd *vs* Dd) from Pakenham and Icklingham, and West Stow.

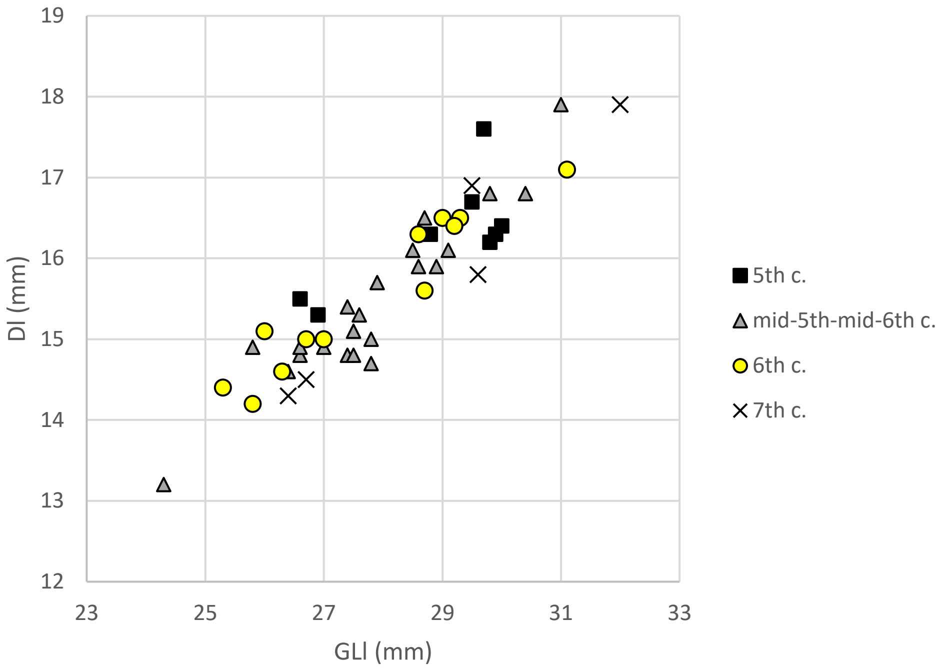


Fig. 6.1.36 Scatter plot of measurements from caprine astragali (GLl *vs* Dl) from the four subphases at West Stow.

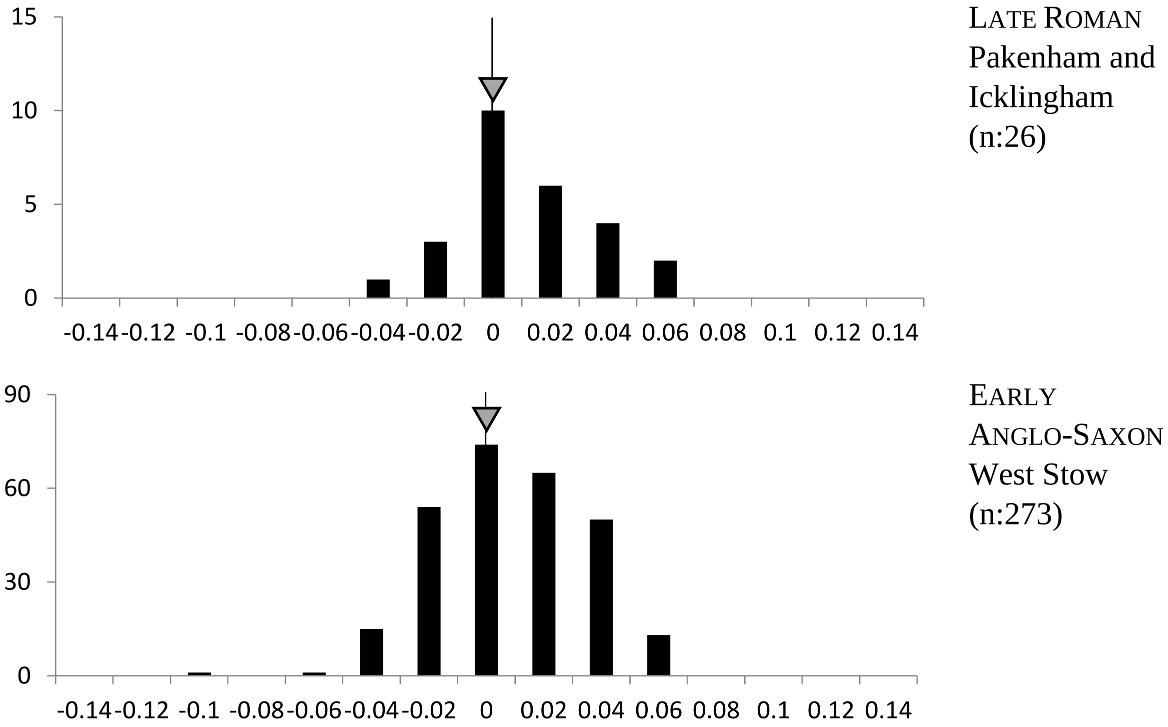


Fig. 6.1.37 Distribution of log ratio values of a selection of caprine bone widths from Pakenham and Icklingham, and West Stow.

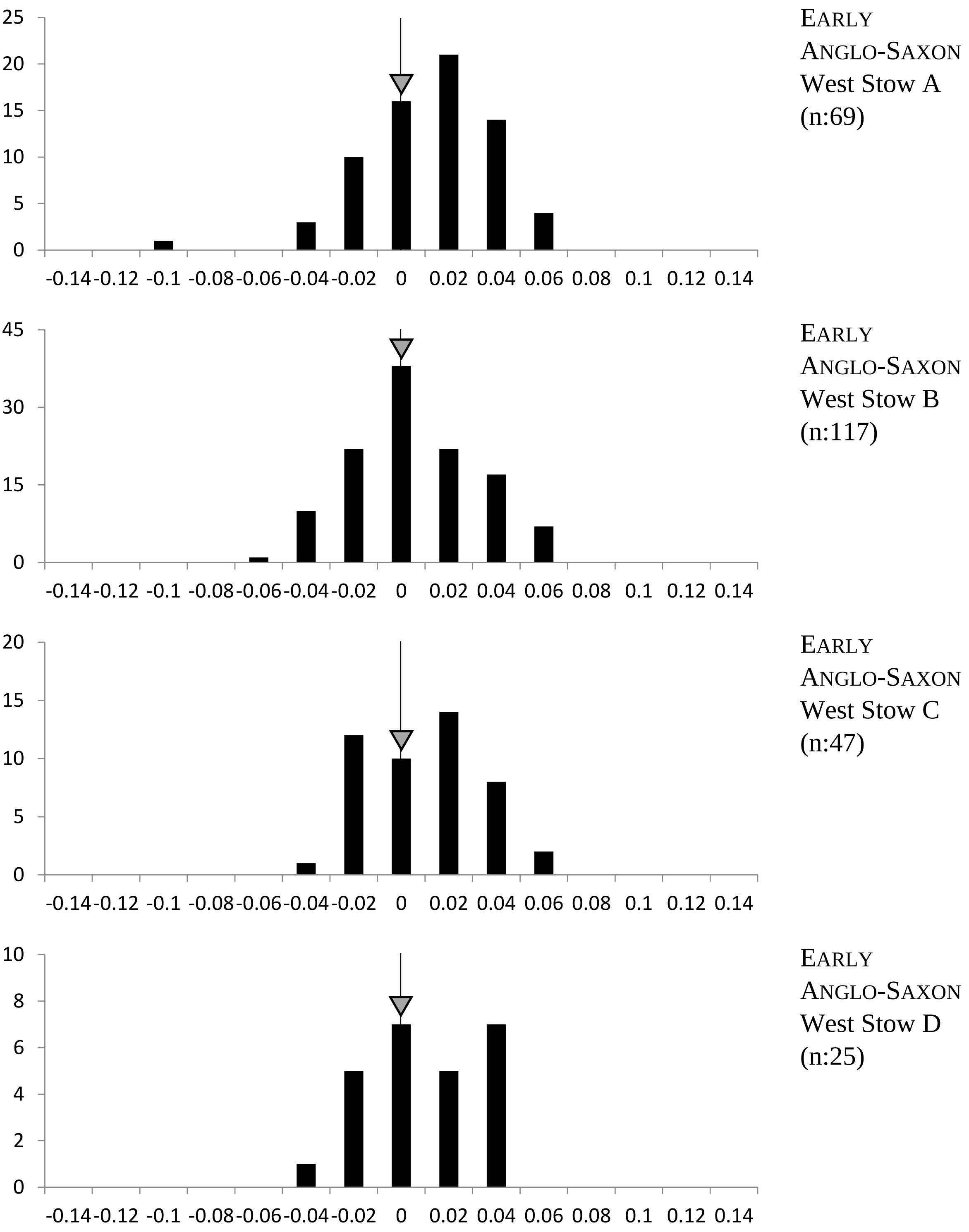


Fig. 6.1.38 Distribution of log ratio values of a selection of caprine bone widths from the subphases at West Stow.

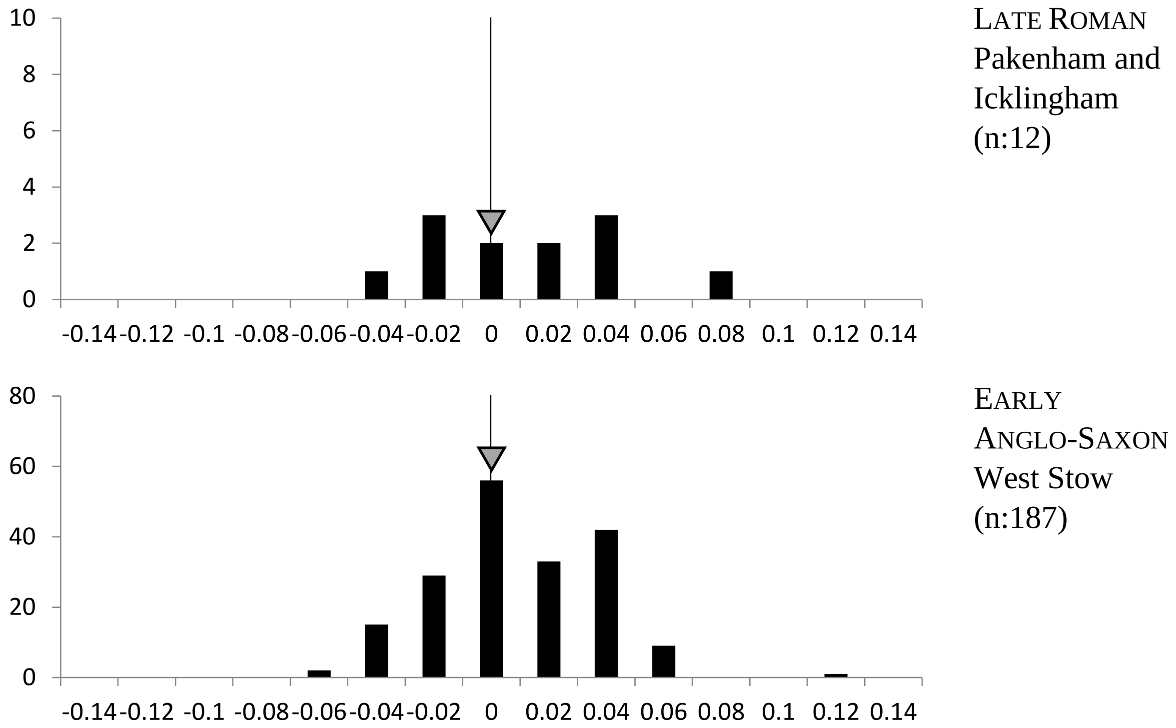


Fig. 6.1.39 Distribution of log ratio values of a selection of caprine bone lengths from Pakenham and Icklingham, and West Stow.

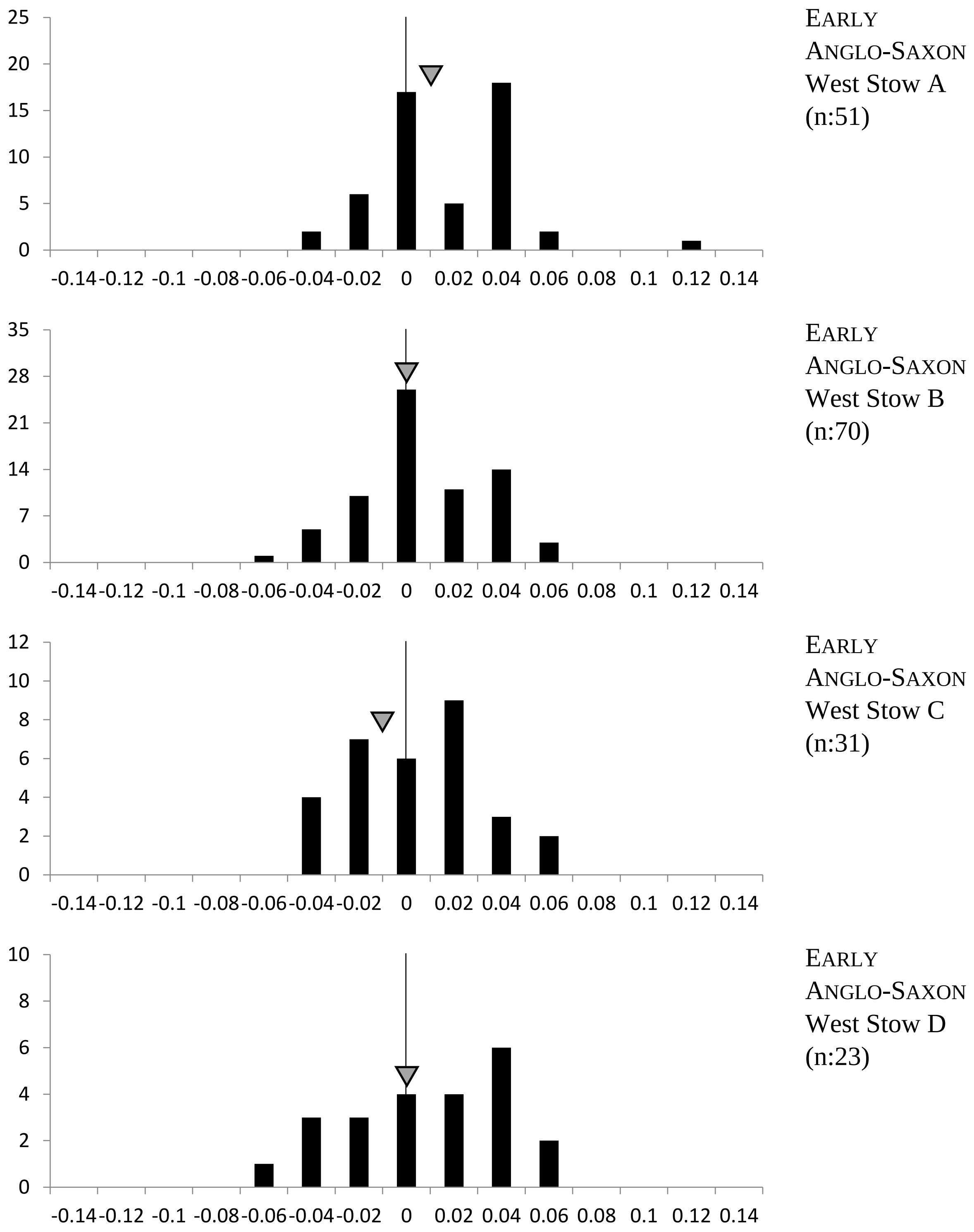


Fig. 6.1.40 Distribution of log ratio values of a selection of caprine bone lengths from the subphases at West Stow.

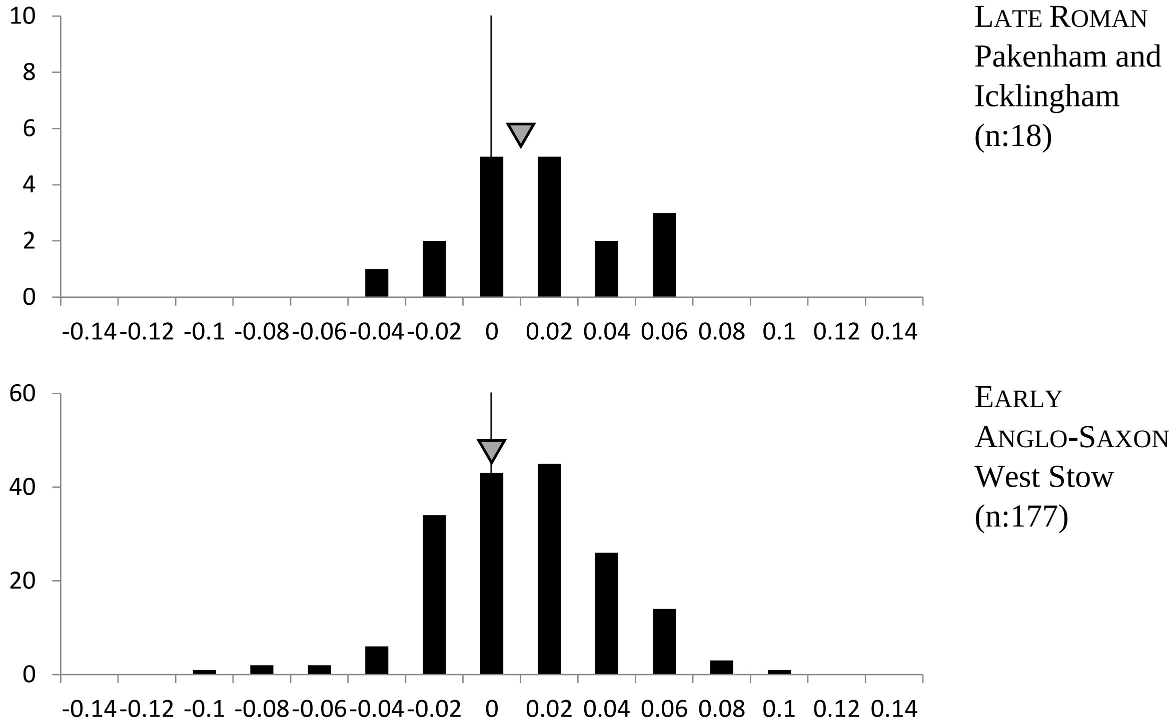


Fig. 6.1.41 Distribution of log ratio values of a selection of caprine bone depths from Pakenham and Icklingham, and West Stow.

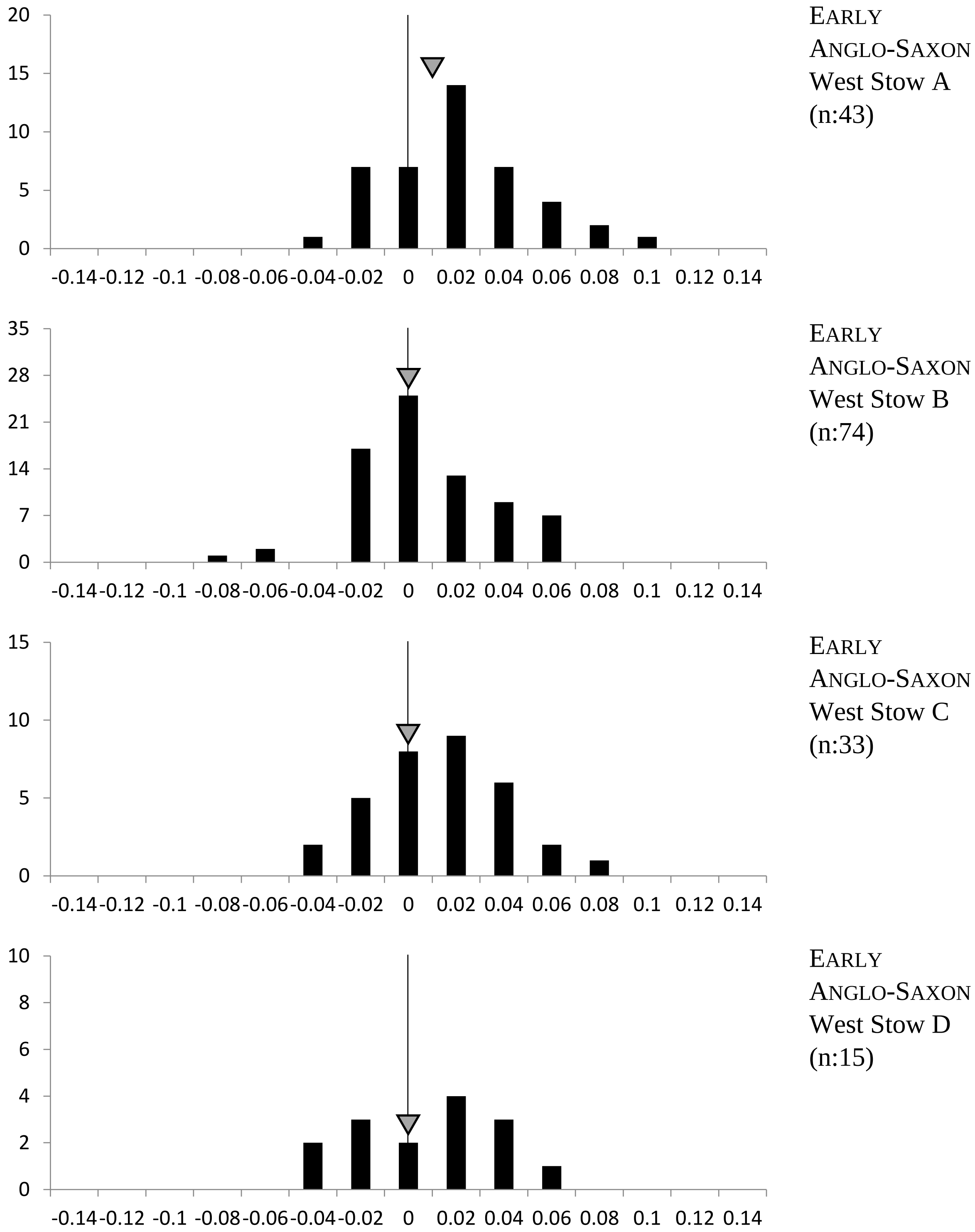


Fig. 6.1.42 Distribution of log ratio values of a selection of caprine bone depths from the subphases at West Stow.

	PI w	W w	Wa w	Wb w	Wc w	Wd w	W d	W l
PI w	-	0.64	0.94	0.41	0.84	0.87	-	-
W w	0.64	-	-	-	-	-	-	-
Wa w	0.94	-	-	0.21	0.73	0.80	-	-
Wb w	0.41	-	0.21	-	0.44	0.53	-	-
Wc w	0.84	-	0.73	0.44	-	0.99	-	-
Wd w	0.87	-	0.80	0.53	0.99	-	-	-
PI d	-	-	-	-	-	-	0.39	-
PI l	-	-	-	-	-	-	-	0.87

Tab. 6.1.4 Results of the Student's t-tests for caprine bone measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. PI: Pakenham and Icklingham, W: West Stow, Wa: West Stow subphase A (etc.), w: widths, d: depths, l: lengths.

Such lack of substantial changes is also supported by the analysis of tooth measurements. The slightly higher incidence of smaller values in M_3 measurements at Early Anglo-Saxon West Stow is less visible than in the analysis of bone biometry, and most of the smallest values belong to the earliest subphase (Figs. 6.1.43 and 6.1.44). Log ratio histograms for tooth width measurements, as well as the results of the Student's t-tests, indicate no differences between the Late Roman and Early Anglo-Saxon assemblages, nor any changes between the subphases at West Stow (Figs. 6.1.45 and 6.1.46) (Tab. 6.1.5).

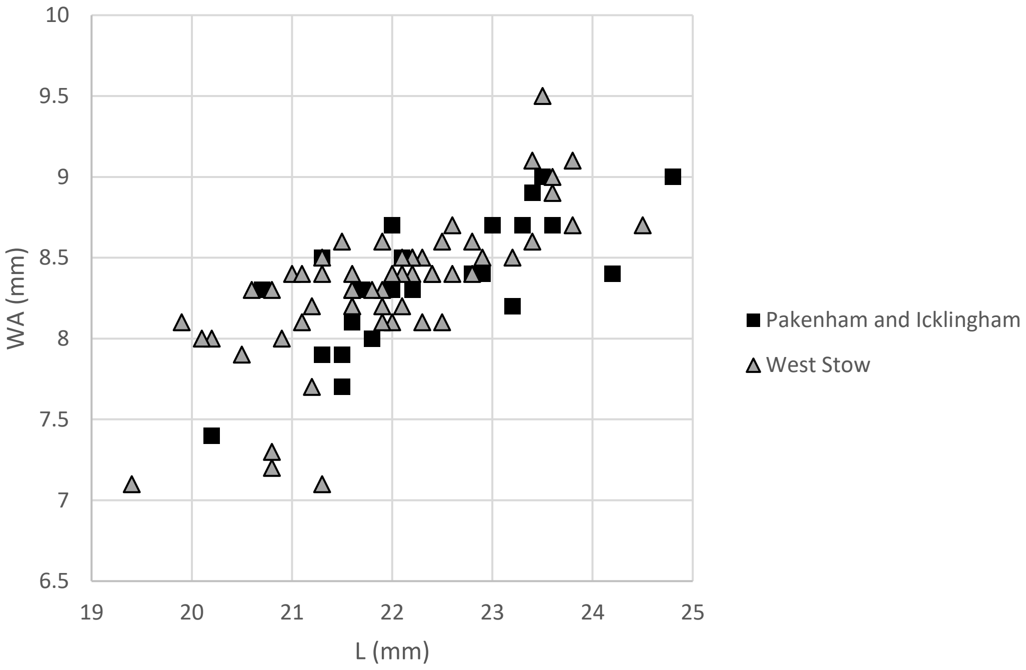


Fig. 6.1.43 Scatter plot of measurements from caprine M_3s (L *vs* WA) from Pakenham and Icklingham, and West Stow.

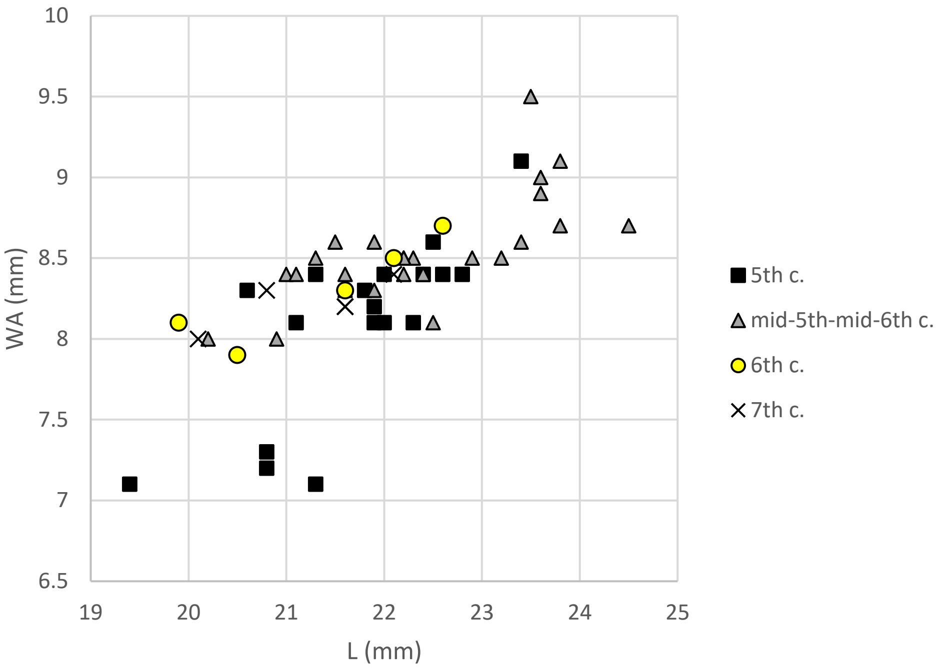


Fig. 6.1.44 Scatter plot of measurements from caprine M_3s (L *vs* WA) from the subphases at West Stow.

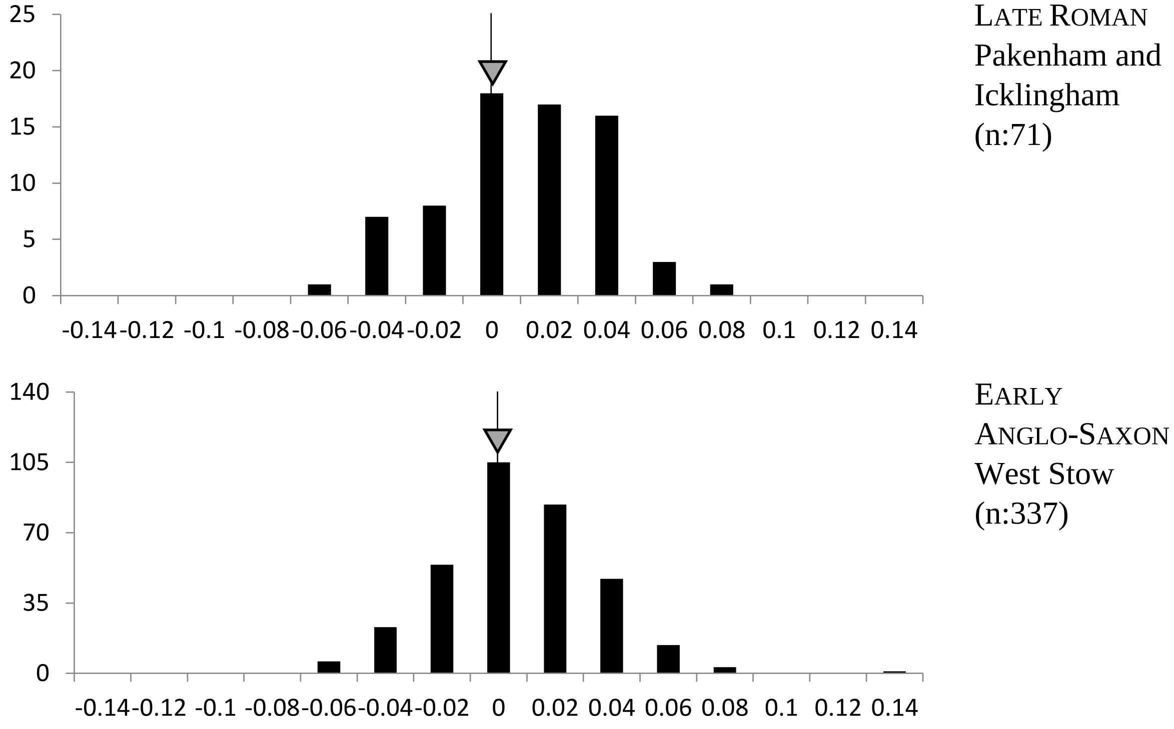


Fig. 6.1.45 Distribution of log ratio values of a selection of caprine tooth widths from Pakenham and Icklingham, and West Stow.

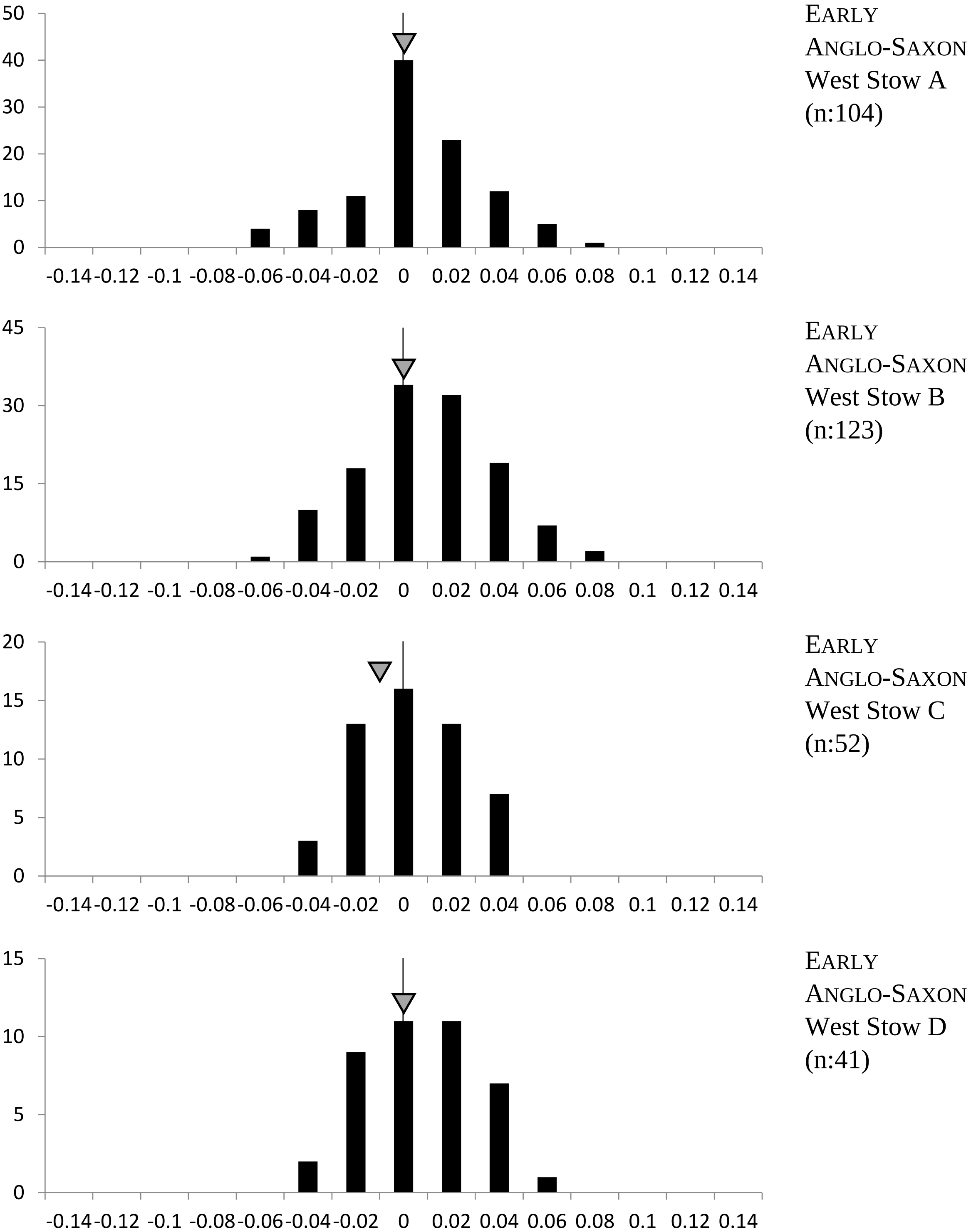


Fig. 6.1.46 Distribution of log ratio values of a selection of caprine tooth widths from the subphases at West Stow.

	PI	W	Wa	Wb	Wc	Wd
PI	-	0.34	0.24	0.66	0.15	0.57
W	0.34	-	-	-	-	-
Wa	0.24	-	-	0.35	0.70	0.66
Wb	0.66	-	0.35	-	0.23	0.80
Wc	0.15	-	0.70	0.23	-	0.41
Wd	0.57	-	0.66	0.80	0.41	-

Tab. 6.1.5 Results of the Student's t-tests for caprine tooth width measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. PI: Pakenham and Icklingham, W: West Stow, Wa: West Stow subphase A (etc.).

6.1.7.3 Suids

Fewer measurements were available for suids in comparison to cattle and caprines. This is the result of both the smaller sample size of suid remains, and the fact that many of them consist of unfused elements (§ 6.1.3).

The dearth of bone measurements from Late Roman Pakenham and Icklingham does not allow drawing conclusions on changes in size at the transition; despite this, the distribution and mean of the few values available hint towards a substantial decrease in size in Early Anglo-Saxon West Stow (Fig. 6.1.47). Such difference is even more evident when Roman values are compared to those from the earliest subphase at West Stow. Intriguingly, there seem to be an increase in average size in the following subphase (Fig. 6.1.48). On the contrary, tooth measurements indicate no substantial changes, with only a very slight increase between the first and second subphases at West Stow (Figs. 6.1.49 and 6.1.50). The few very large values could suggest the presence of wild boar remains in the assemblage; however, this is minimal and unlikely to have affected the overall analysis of the suid assemblage. The results of the Student's t-tests confirm the trends outlined above (Tabs. 6.1.6 and 6.1.7).

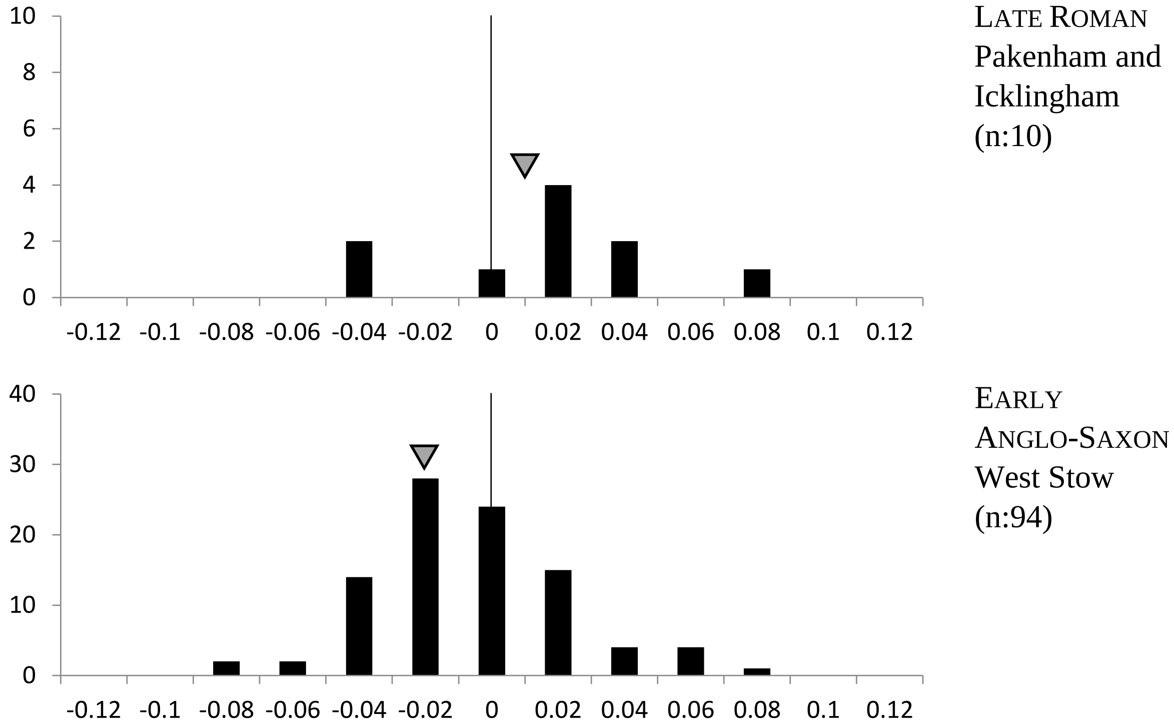


Fig. 6.1.47 Distribution of log ratio values of a selection of suid bone measurements from Pakenham and Icklingham, and West Stow.

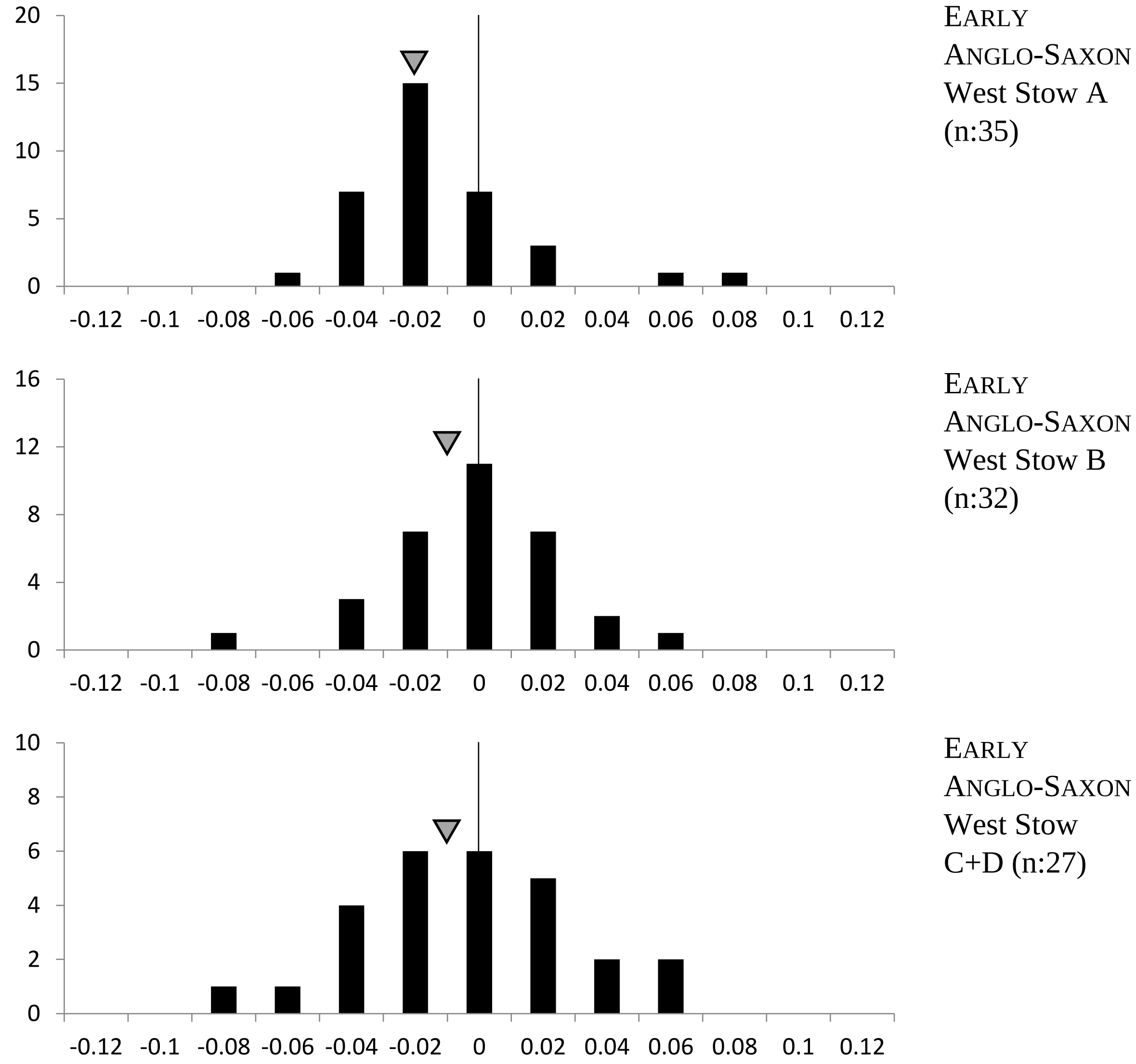


Fig. 6.1.48 Distribution of log ratio values of a selection of suid bone measurements from the subphases at West Stow.

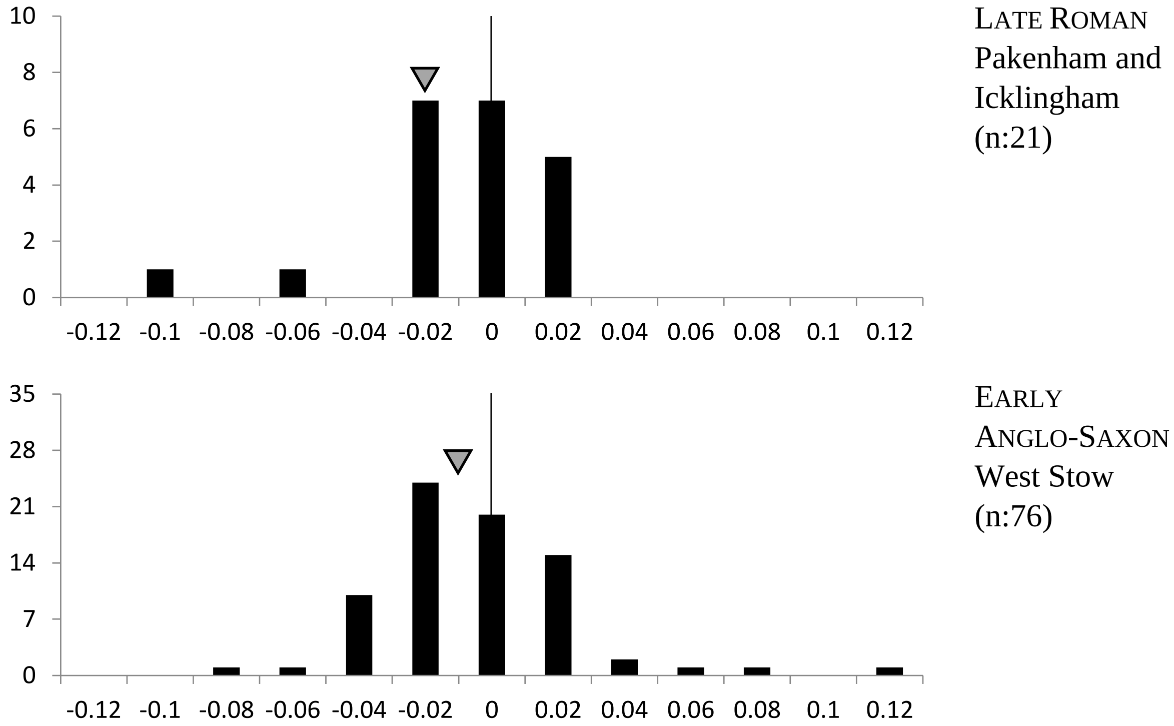


Fig. 6.1.49 Distribution of log ratio values of a selection of suid tooth widths from Pakenham and Icklingham, and West Stow.

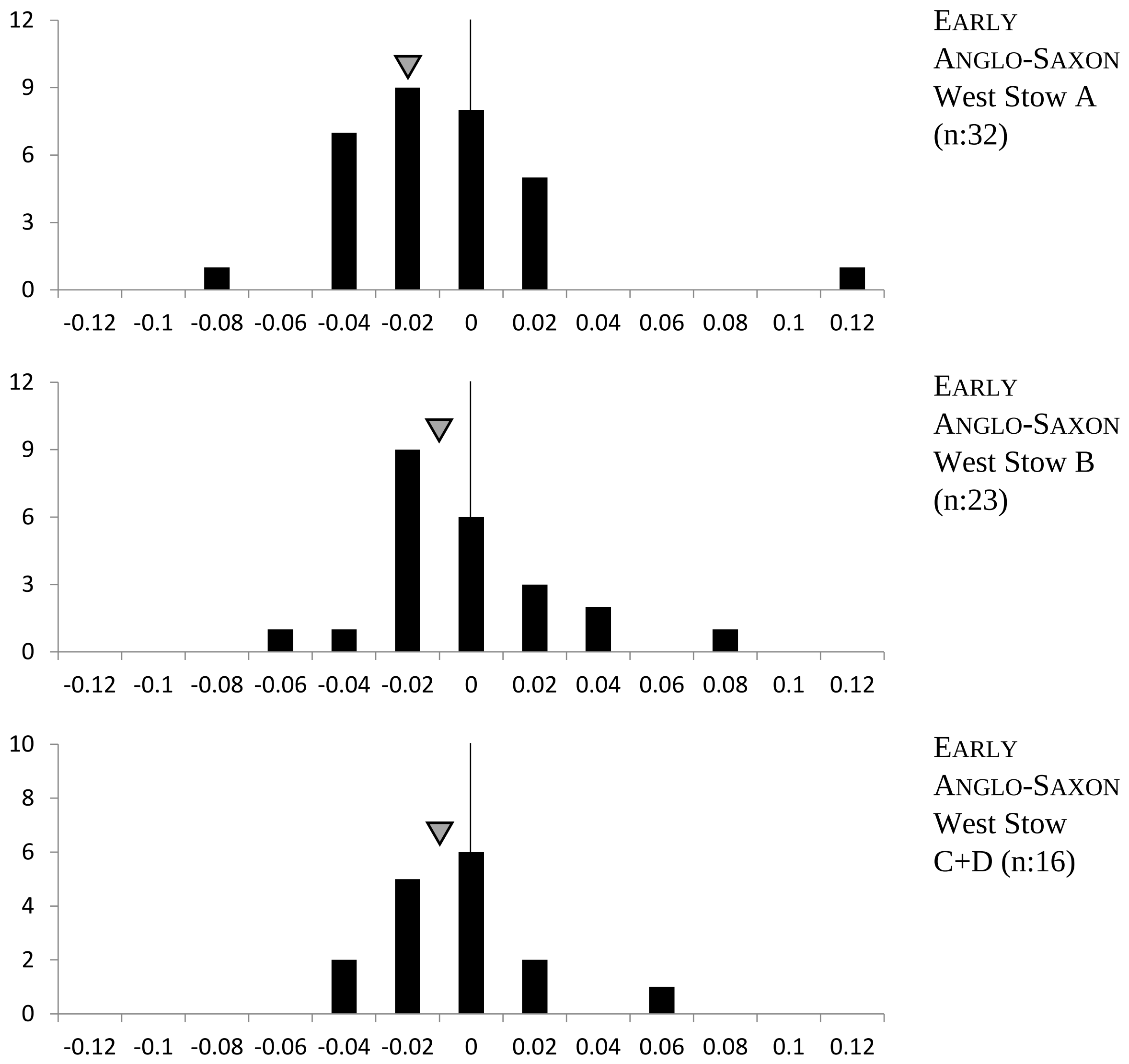


Fig. 6.1.50 Distribution of log ratio values of a selection of suid tooth widths from the subphases at West Stow.

	PI	**W**	**Wa**	**Wb**	**Wcd**
PI	-	0.02	0.01	0.06	0.10
W	0.02	-	-	-	-
Wa	0.01	-	-	0.11	0.22
Wb	0.06	-	0.11	-	0.88
Wcd	0.10	-	0.22	0.88	-

Tab. 6.1.6 Results of the Student's t-tests for suid bone measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. PI: Pakenham and Icklingham, W: West Stow, Wa: West Stow subphase A (etc.).

	PI	**W**	**Wa**	**Wb**	**Wcd**
PI	-	0.63	0.84	0.50	0.70
W	0.63	-	-	-	-
Wa	0.84	-	-	0.38	0.58
Wb	0.50	-	0.38	-	0.79
Wcd	0.70	-	0.58	0.79	-

Tab. 6.1.7 Results of the Student's t-tests for suid tooth width measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. PI: Pakenham and Icklingham, W: West Stow, Wa: West Stow subphase A (etc.).

6.1.8 Pathology and non-metric traits

Pathological evidence on cattle bone remains is mainly represented by conditions on lower limb elements, which are likely related to exploitation of this species for traction. In both the Late Roman and the Early Anglo-Saxon assemblages, a number of distal metapodials were splayed, presenting different extents of deformation and exostosis on their distal ends; the incidences of splayed metapodials do not seem to differ substantially between the two periods, although the small sample sizes do not allow drawing definite conclusions (Tabs. 6.1.8 and 6.1.9). The biometrical visualisation of these deformations tentatively suggests that more metacarpals could have been splayed in the Late Roman assemblages than have been identified morphologically; however, this does not seem to be the case for metatarsals (Figs. 6.1.51 and 6.1.52). Other pathological conditions on cattle remains concentrate on proximal phalanges (exostosis and eburnation) and tarsals (these latter often fused together resembling spavin conditions), again the likely result of prolonged exploitation for traction.

	non-visibly splayed	splayed	total	**% splayed**
Pakenham and Icklingham	26	4	30	**13%**
West Stow	17	3	20	**15%**

Tab. 6.1.8 Presence and incidence of splayed metacarpals at Pakenham and Icklingham, and West Stow.

	non-visibly splayed	splayed	total	**% splayed**
Pakenham and Icklingham	43	3	46	**7%**
West Stow	22	3	25	**12%**

Tab. 6.1.9 Presence and incidence of splayed metatarsals at Pakenham and Icklingham, and West Stow.

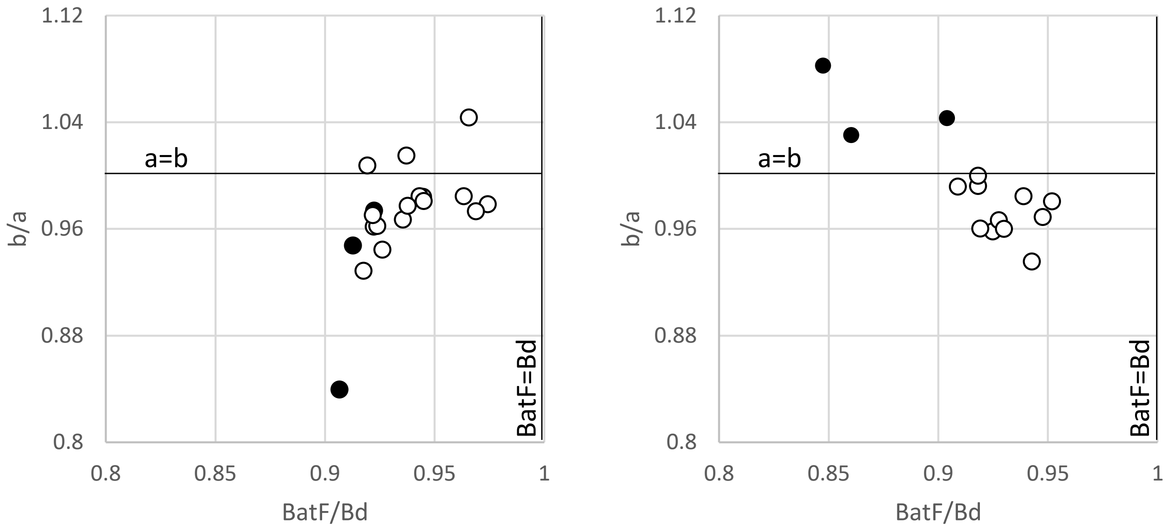


Fig. 6.1.51 Scatter plot of shape indices from cattle distal metacarpals at Pakenham and Icklingham (left) and West Stow (right). Empty circles: morphologically identified as non-splayed; full circles: morphologically identified as splayed. The black lines represent the values at which BatF is the same as Bd, and perfect symmetry occurs between the widths of the two condyles (a=b).

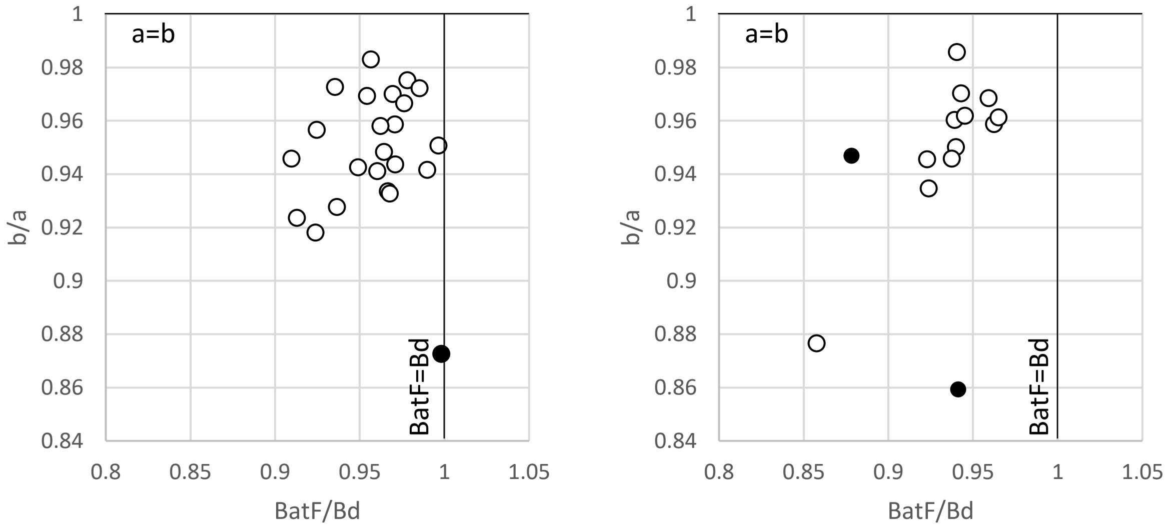


Fig. 6.1.52 Scatter plot of shape indices from cattle distal metatarsals at Pakenham and Icklingham (left) and West Stow (right). Empty circles: morphologically identified as non-splayed; full circles: morphologically identified as splayed. The black lines represent the values at which BatF is the same as Bd, and perfect symmetry occurs between the widths of the two condyles (a=b).

Pathological conditions on the bone remains from other species were rare at Pakenham and Icklingham. Due to the much larger sample size, more conditions were recorded on caprine and suid bones at West Stow; these consisted of well-distributed and rarely severe cases of exostosis at the articulations, which presented no significant patterns. One horse first phalanx and metacarpal presented severe exostosis, likely related to riding/traction.

Caprine dental pathologies included abscesses (including one case from Late Roman Icklingham), periodontal disease, and isolated cases of overcrowding. Enamel hypoplasia on pig teeth was uncommon (one mandibular and one maxillary tooth from Icklingham, and three mandibular teeth from West Stow).

The only non-metric trait recorded in the three assemblages was the absence or reduction of the hypoconulid on cattle lower third molars. In both periods its incidence falls below 1%.

6.1.9 Summary

The results for Late Roman Pakenham and Icklingham, and for Early Anglo-Saxon West Stow highlight a series of similarities and differences in animal exploitation at the two sides of the transition.

The Late Roman assemblages are dominated by cattle remains, which represent both carcasses butchered on site and specific beef products introduced for consumption. Most of the animals survived into adulthood and late adulthood, suggesting a focus on the use of cattle for traction. Once culled, cattle were butchered in a systematic and standardised way, aiming at a full exploitation of the carcass. In Early Anglo-Saxon West Stow, cattle played a secondary role, its exploitation being more generalised and butchery less intensive. Biometrical analyses of bones and teeth indicate that cattle at West Stow were smaller than those from the Late Roman sites, suggesting a decrease in the size of this animal; comparisons among the Early Anglo-Saxon subphases suggest that such decrease may have been gradual.

The animal economy at West Stow focussed on caprines (largely sheep); pig is also well represented, especially in the first subphase, but overall it played a less important role than cattle and sheep. Similarly to cattle, management strategies of sheep seem to change: in the Late Roman sites, subadult and adult sheep were exploited for their meat and wool. At West Stow, the main focus was on meat production from lambs, many of which were culled before their first winter; only in the later subphases culling strategies move slightly towards a more generalised exploitation pattern. The major focus on sheep may explain the retainment of the large size achieved by this animal in Roman times: differently from cattle, bone and tooth measurements indicate almost no change in size from the Late Roman assemblages.

Biometrical data from pig are scarce, but there seem to have been a decrease in size in the first subphase from West Stow, followed by a partial recovery.

6.2 Cambridgeshire

The assemblages analysed for Cambridgeshire were collected from the sites of Cambourne (multiple sites; Late Roman period) and Gamlingay (Early Anglo-Saxon period) (§ 4.3).

6.2.1 Preservation and recovery bias

The material from the two sites presented an overall good level of surface preservation (Fig. 6.2.1). The higher incidence of fragments characterised by a medium and bad level of surface preservation in comparison to other assemblages analysed in this study did not prevent a proper anatomical and taxonomic identification of most of the material. Only in a few cases a low degree of surface preservation hindered the identification of butchery marks or gnawing marks, or prevented taking measurements.

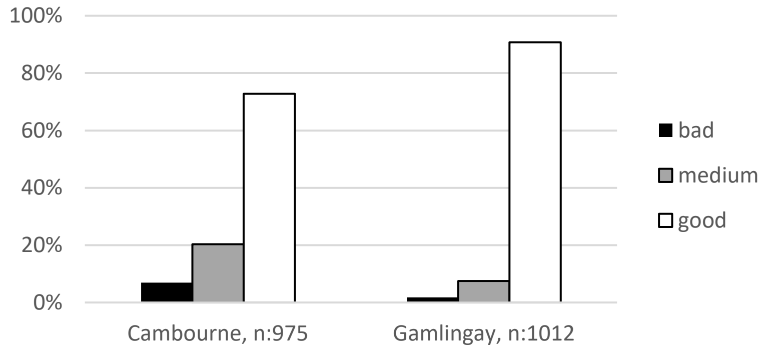


Fig. 6.2.1 Incidence of categories of surface preservation (§ 5.3.2, Tab. 5.6) in the recorded material.

The analysis of the recovery bias relied on the proportions between distal tibiae and astragali, and between distal metapodials and 1st phalanges in cattle and caprines (Figs. 6.2.2 and 6.2.3). As was the case for Suffolk, the results show some variability in the impact that a recovery bias had on the assemblages, both of which were hand-collected. However, the overall lower frequency of smaller elements, especially in caprines, highlights a recovery bias which has to be taken into account in the interpretation of the results from quantitative analyses.

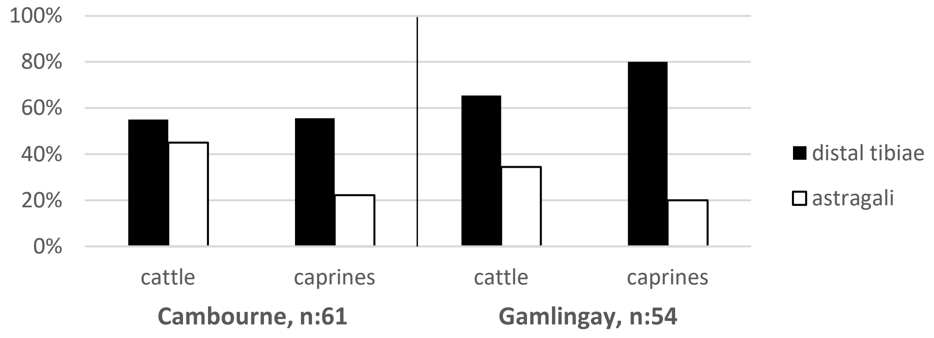


Fig. 6.2.2 Recovery bias analysis: proportions of distal tibiae *vs* astragali for cattle and caprines in the recorded assemblages (natural proportion: 1:1).

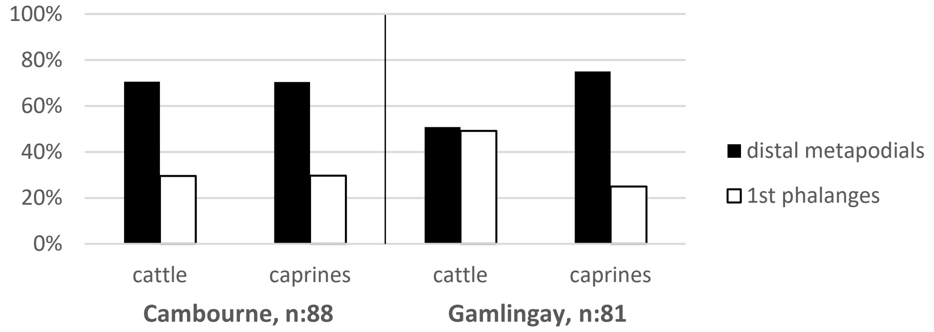


Fig. 6.2.3 Recovery bias analysis: proportions of distal metapodials *vs* 1st phalanges for cattle and caprines in the recorded assemblages (natural proportion: 1:2).

6.2.2 Species frequency

The NISP frequency of cattle is higher at Late Roman Cambourne in comparison to Early Anglo-Saxon Gamlingay. In the latter site, cattle, caprines and suids are more equally represented, all presenting an incidence of between ca. 30 and 40% (Fig. 6.2.4). The biometrical analyses of suid tooth and postcranial bones suggest that, in both sites, the vast majority of suids were probably domestic (§ 6.2.7.3). Morphological observations and biometrical analyses of caprine remains indicate that most of them, if not all, belonged to sheep; goat was present but, as usual, rare (Figs. 6.2.5 and 6.2.6). Although the presence of a recovery bias implies the underrepresentation of caprines (and suids), this is likely to have affected both assemblages more or less equally; relative differences between species frequencies at Cambourne and Gamlingay, therefore, should be considered to be genuine, indicating a greater focus on cattle at Late Roman Cambourne and a more generalised exploitation of domesticates at Early Anglo-Saxon Gamlingay. This is partly confirmed by MNI estimations, where caprines are predominant in both assemblages, with cattle, however, still resulting as more common at Cambourne than Gamlingay (Fig. 6.2.7).

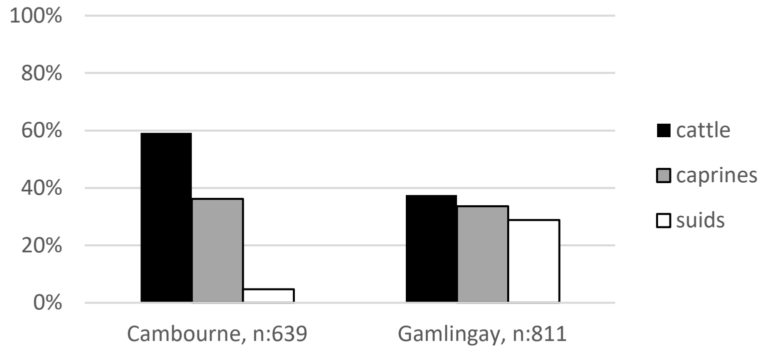


Fig. 6.2.4 NISP species frequencies for cattle, caprines, and suids.

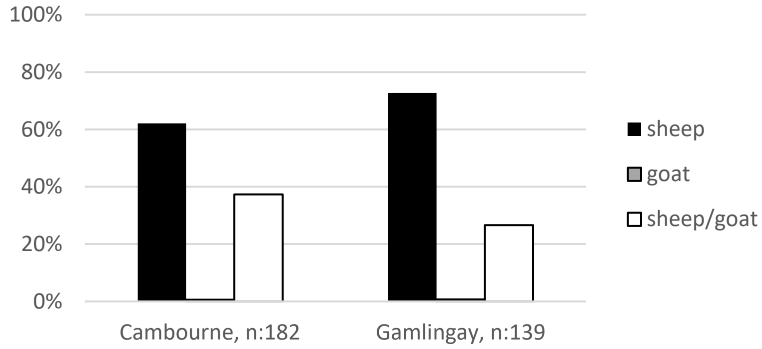


Fig. 6.2.5 Proportions of caprine remains recorded as sheep, goat, and sheep/goat, calculated using the set of selected elements on which the sheep-goat distinction is attempted.

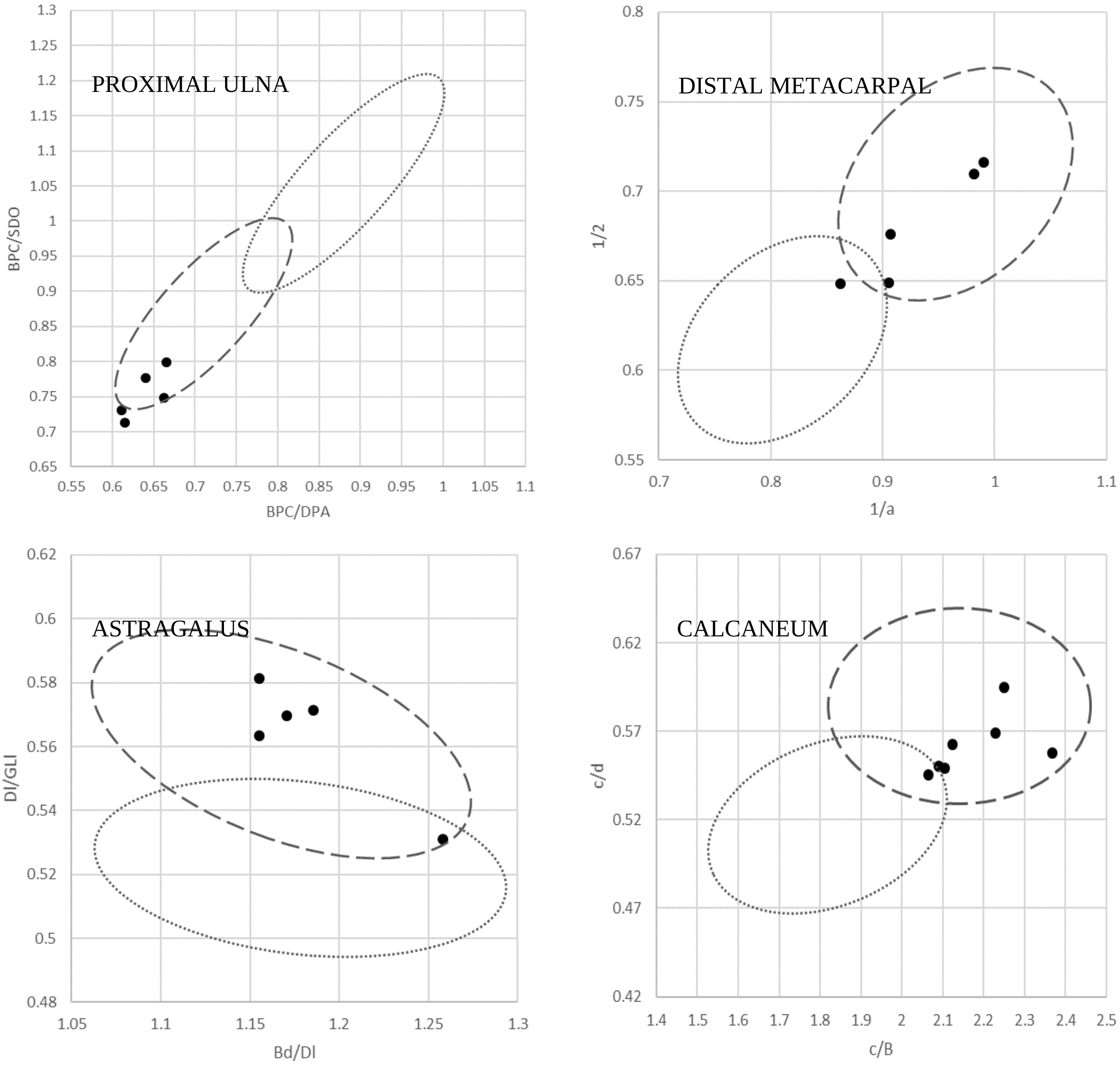


Fig. 6.2.6 Biometrical shape analyses of caprine bones against the approximate distributions of sheep (dashed line) and goat (dotted line) modern values from Salvagno and Albarella (2017).

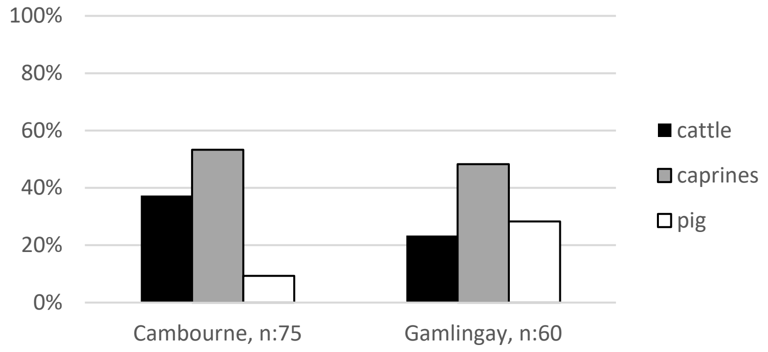


Fig. 6.2.7 MNI species frequencies for cattle, caprines, and suids.

The MNI counting method often results in a higher estimation of smaller taxa, such as caprines, as it allows to mitigate the recovery bias against them (§ 5.2.2); this alone, however, cannot explain the much higher frequency of caprines displayed by MNI counts. The disproportionate high incidence of caprine mandibles (the most resistant body part in caprines, and more resistant than cattle mandibles) in comparison to other elements contributes to high estimated MNIs for this taxon (§ 6.2.5). Fig. 6.2.8 relies on calculations of the MNI where mandibles were excluded; the trend shows a much closer resemblance to NISP frequencies, further confirming the genuine difference in the proportions of the main domesticates suggested above.

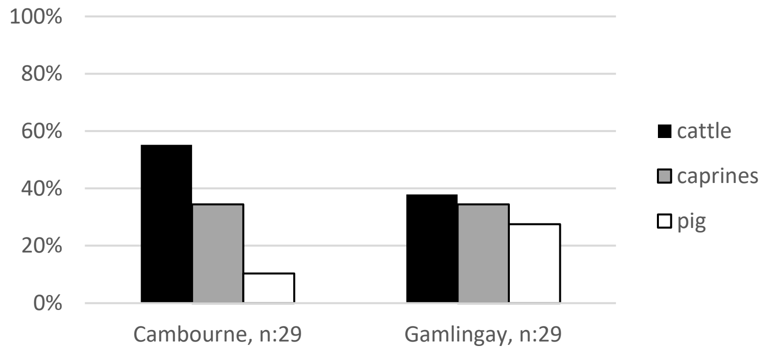


Fig. 6.2.8 MNI species frequencies for cattle, caprines, and suids without cattle, caprine, and suid mandibles, and suid maxillae.

6.2.3 Ageing

The reconstruction of culling profiles for cattle, caprines and suids is based on the analyses of both mandibular wear stages and epiphyseal fusion stages of postcranial bones. The recovery of perinatal remains of cattle and caprines at Cambourne, and of cattle and suids at Gamlingay, suggests that these domesticates were bred on-site; as they most likely represent natural losses rather than deliberate culling, however, they have been excluded from the analyses of postcranial epiphyseal fusion presented below.

The distributions of cattle mandibular wear stages highlight a rather generalised exploitation of this animal, with most age groups well represented in both assemblages (Fig. 6.2.9). In particular, the kill-off pattern from Late Roman Cambourne resembles that from Early Anglo-Saxon West Stow (Suffolk), with a good representation of adult and elderly individuals (ca. 60%), and a number of subadult and immature animals. Although the distribution at Gamlingay is similar, there seem to be a higher incidence of younger individuals, possibly indicating a major interest in beef production. The analyses of postcranial epiphyseal fusion, which rely on larger sample sizes, do not fully support these patterns (Fig. 6.2.10). While at Cambourne the generalised exploitation of cattle is confirmed, with about half of the animals surviving into adulthood (late fusing stage), at Gamlingay this proportion is much higher. These results would suggest a closer similarity of the two culling profiles, the apparent higher incidence of immature in the distribution of mandibular wear stages at Gamlingay being the result of a small sample size.

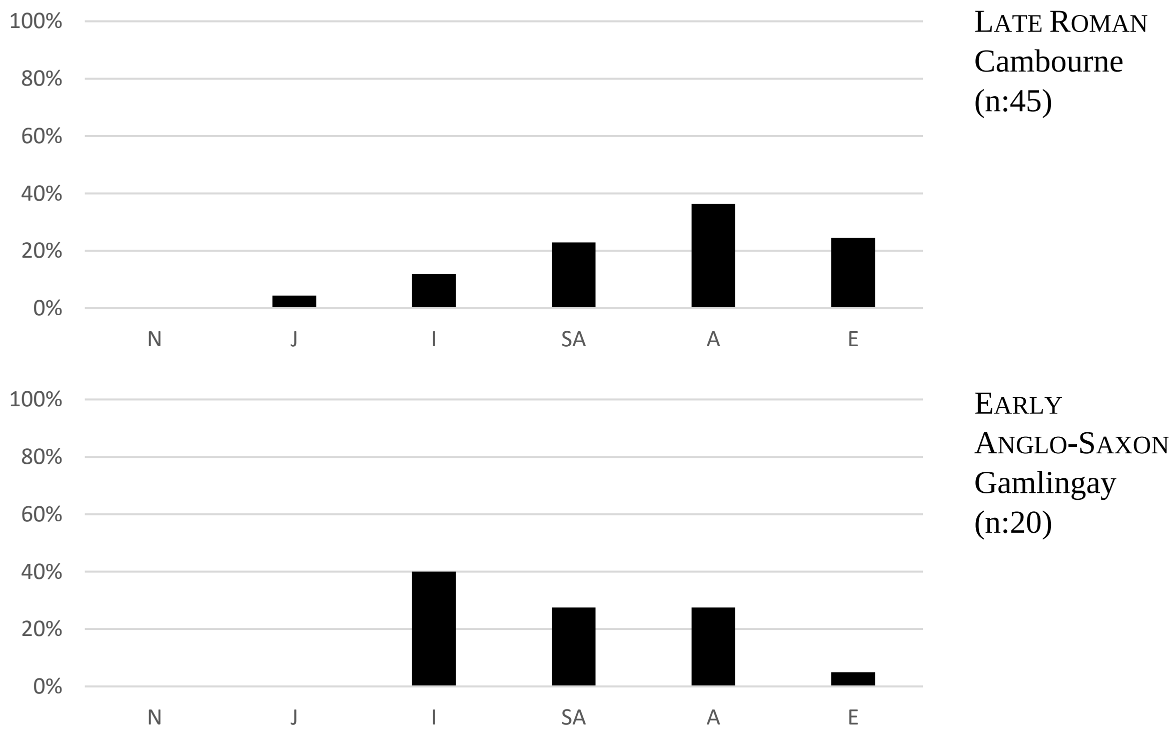


Fig. 6.2.9 Distribution of cattle mandibular wear stages in the age groups devised by O’Connor (1988) at Cambourne (top, n:45) and Gamlingay (bottom, n:20). N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

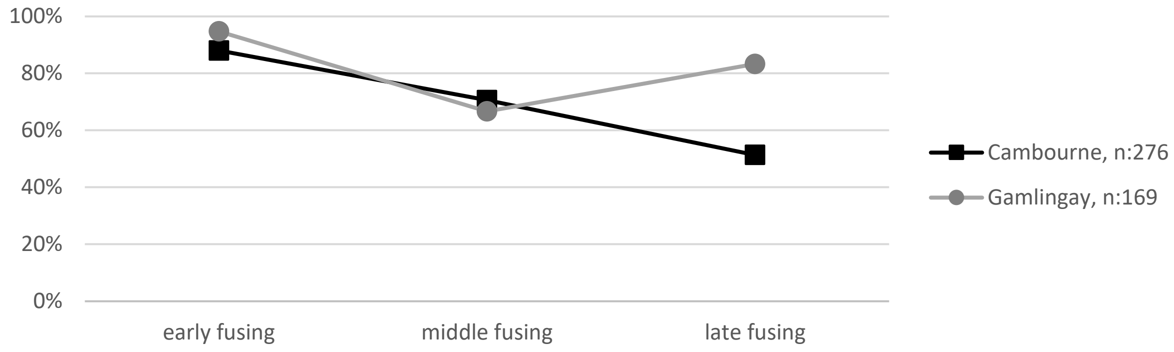


Fig. 6.2.10 Incidence of cattle fused elements in the three fusing stages proposed by Silver (1969) at Cambourne (n:276) and Gamlingay (n:169).

A similar generalised exploitation of animal resources seems to have characterised caprine husbandry practices as well. The distributions of mandibular wear stages show a good representation of subadults and elderly individuals (Fig. 6.2.11). Almost 50% of the sheep from Late Roman Cambourne were reared for meat, being culled just before their first winter (stage C, 6-12 months) or in their second year (stage D); at Early Anglo-Saxon Gamlingay the proportion of sheep culled in these early stages only slightly drops to ca. 40%. Younger lambs, whose culling would have allowed the exploitation of ewe milk, are present but in small numbers; however, preservation biases may have contributed to their lower incidence and, therefore, their presence, though minimal, does still support the existence of a mixed caprine economy in both sites. Results from the analysis of postcranial bone epiphyseal fusion support this hypothesis, showing a gradual culling of animals with ca. 30-40% of the sheep surviving into adulthood (Fig. 6.2.12).

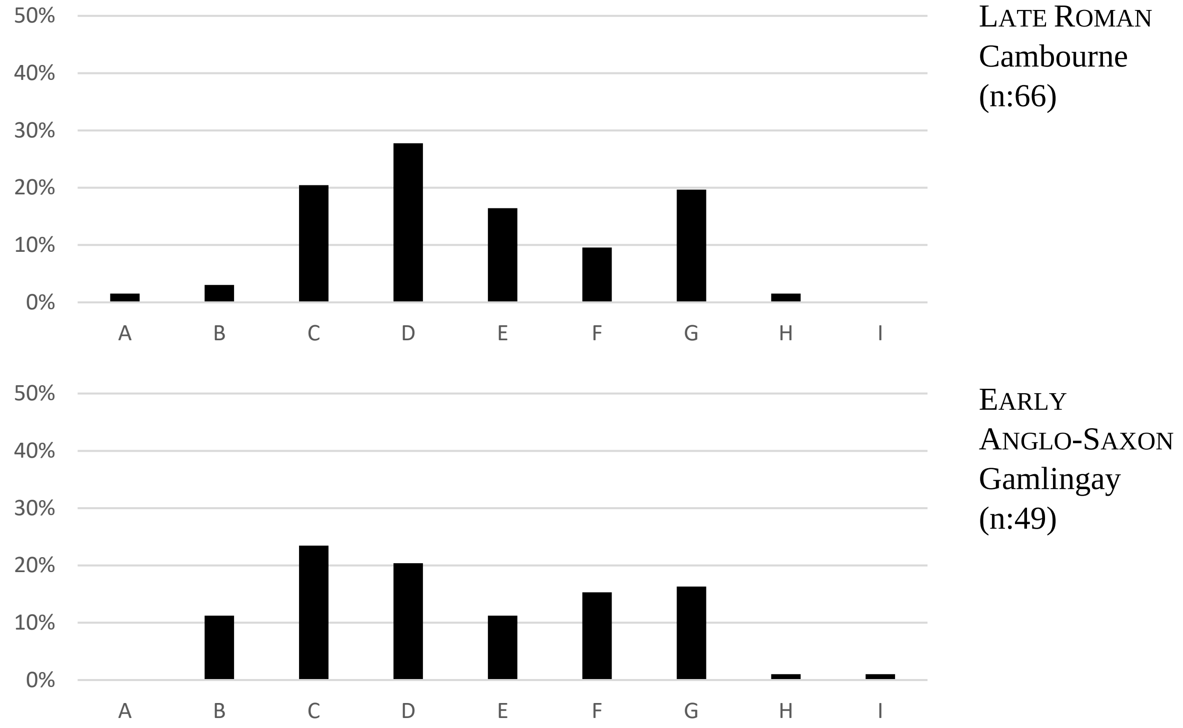


Fig. 6.2.11 Distribution of caprine mandibular wear stages in the age groups devised by Payne (1973) at Cambourne (n:66) and Gamlingay (n:49).

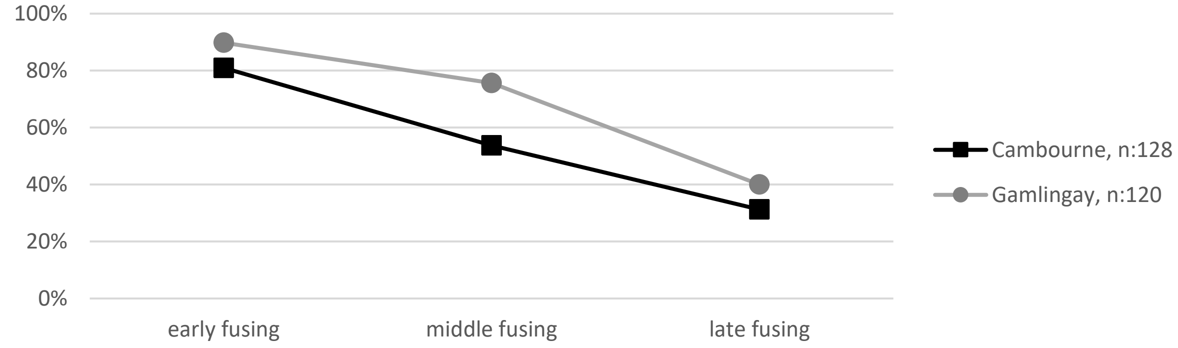


Fig. 6.2.12 Incidence of caprine fused elements in the three fusing stages proposed by Silver (1969) at Cambourne (n:128) and Gamlingay (n:120).

The culling strategies of suids could only be reconstructed for Early Anglo-Saxon Gamlingay (Figs. 6.2.13 and 6.2.14). There does not seem to have been a focus on a specific age range, pigs being slaughtered mainly as immature, subadult and adult individuals. Results from the analysis of long bone epiphyseal fusion broadly support those from dental ageing.

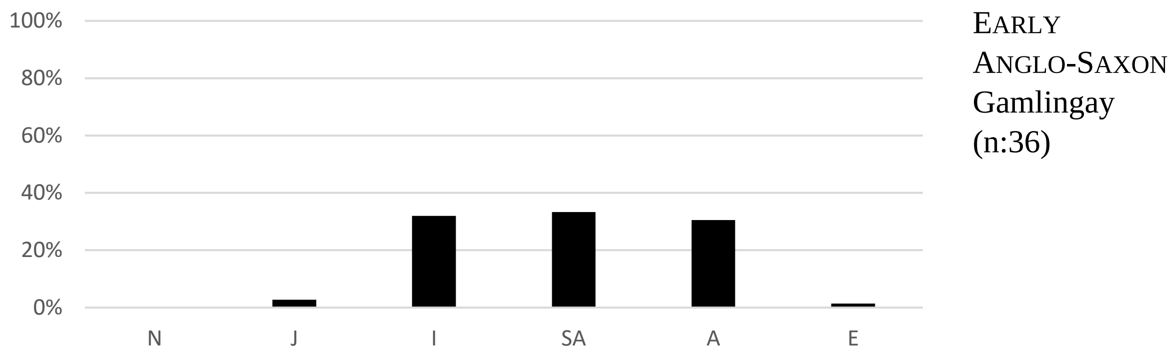


Fig. 6.2.13 Distribution of suid mandibular and maxillary wear stages in the age groups devised by O’Connor (1988) at Gamlingay (n:36). N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

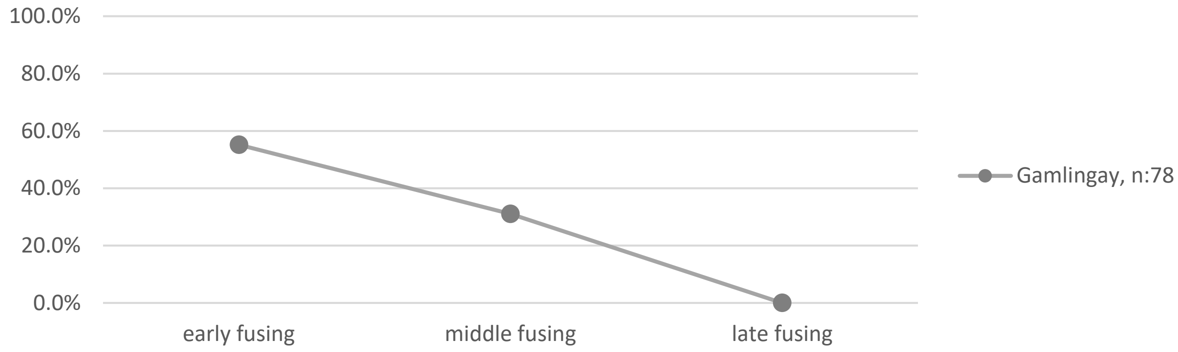
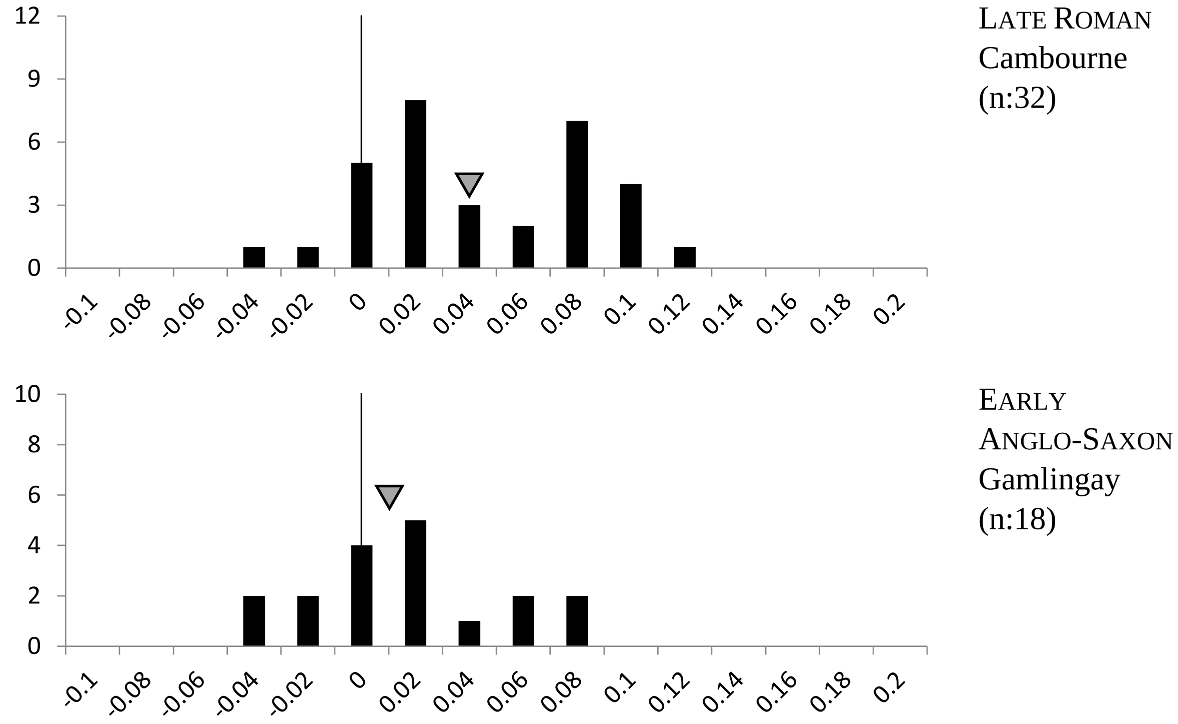


Fig. 6.2.14 Incidence of suid fused elements in the three fusing stages proposed by Silver (1969) at Gamlingay (n:78).

6.2.4 Sexing

Differences in the sex-ratio of domesticates from the Cambridgeshire sites could only be investigated for cattle, which provided enough measurements from highly sexually dimorphic bones (Fig. 6.2.15).

Both graphs, and especially the one for Late Roman Cambourne, display a bimodal distribution of values which reflects the presence of cows and oxen, as bulls would have been kept in low numbers for breeding purposes. Despite the small sample sizes, the higher incidence of lower values at Early Anglo-Saxon Gamlingay, reflecting the size range of Cambourne’s cows, might suggest a prevalence of females at the Anglo-Saxon site. The higher incidence of oxen at Late Roman Cambourne may mutually support the results from ageing analyses; dental ageing at this site indicated a higher frequency of adult and elderly individuals, which indeed might represent oxen spared for their traction force (§ 6.2.3). At the same time, the hypothesised higher incidence of females at Gamlingay must be taken into account in the interpretation of biometrical analyses (§ 6.2.7).


LATE ROMAN
Cambourne
(n:32)

EARLY
ANGLO-SAXON
Gamlingay
(n:18)

Fig. 6.2.15 Distribution of log ratio values of a selection of cattle bone widths (only the more sex-dependent measurements) from Cambourne and Gamlingay.

6.2.5 Distribution of anatomical elements

The distribution of cattle, caprine, and suid anatomical elements at Cambourne and Gamlingay is partly affected by taphonomic biases (Figs. 6.2.16-6.2.18). Those elements or parts of elements which fuse late, are less dense or have a thinner cortical bone (mainly proximal humeri, distal radius, femurs, proximal tibiae), are either absent or underrepresented in the two assemblages, as a result of preferential destruction in archaeological deposits; conversely, the more resistant bones are better represented, including mandibles which, in all cases, are the most abundant body part. Smaller elements, such as the 3rd carpal and phalanges, are also underrepresented due to recovery bias (§ 6.2.1). Although preservation and recovery biases apply to all the three main domesticates, the more fragile or smaller elements are more abundant for cattle.

In general, meat-bearing, lower limb, and cranial elements are well represented for the three taxa, suggesting the butchery and consumption on site of whole carcasses.

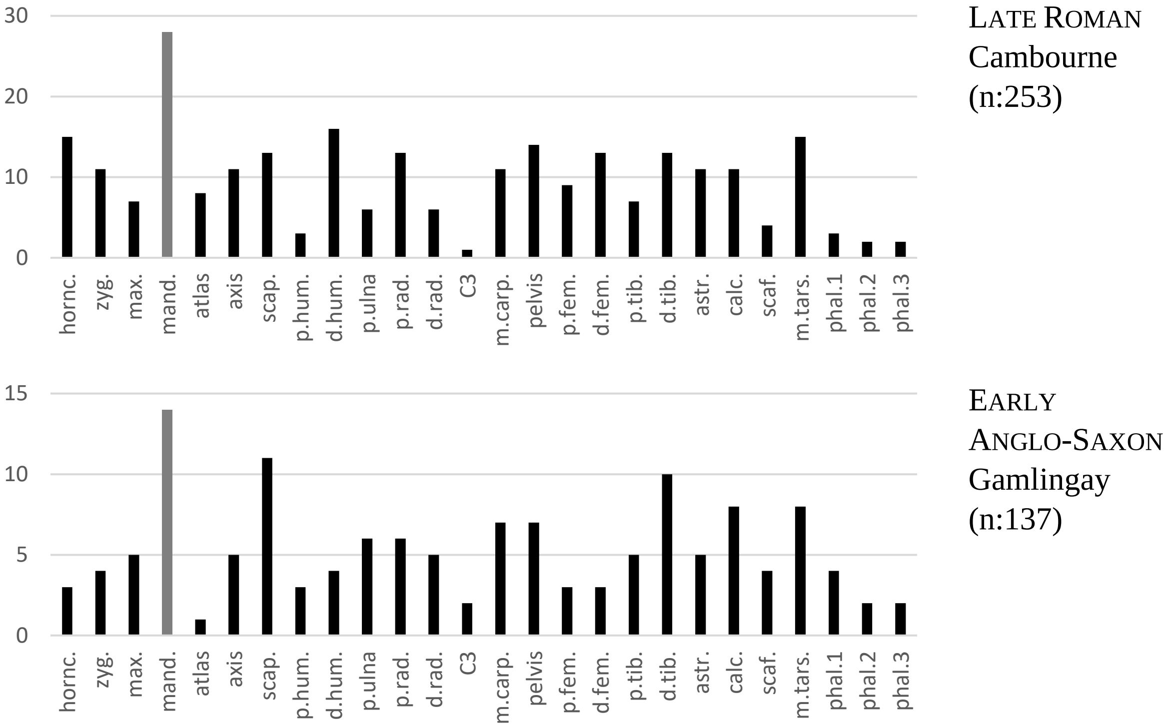


Fig. 6.2.16 Distribution of anatomical elements (MAU) for cattle at Cambourne (n:253) and Gamlingay (n:137).

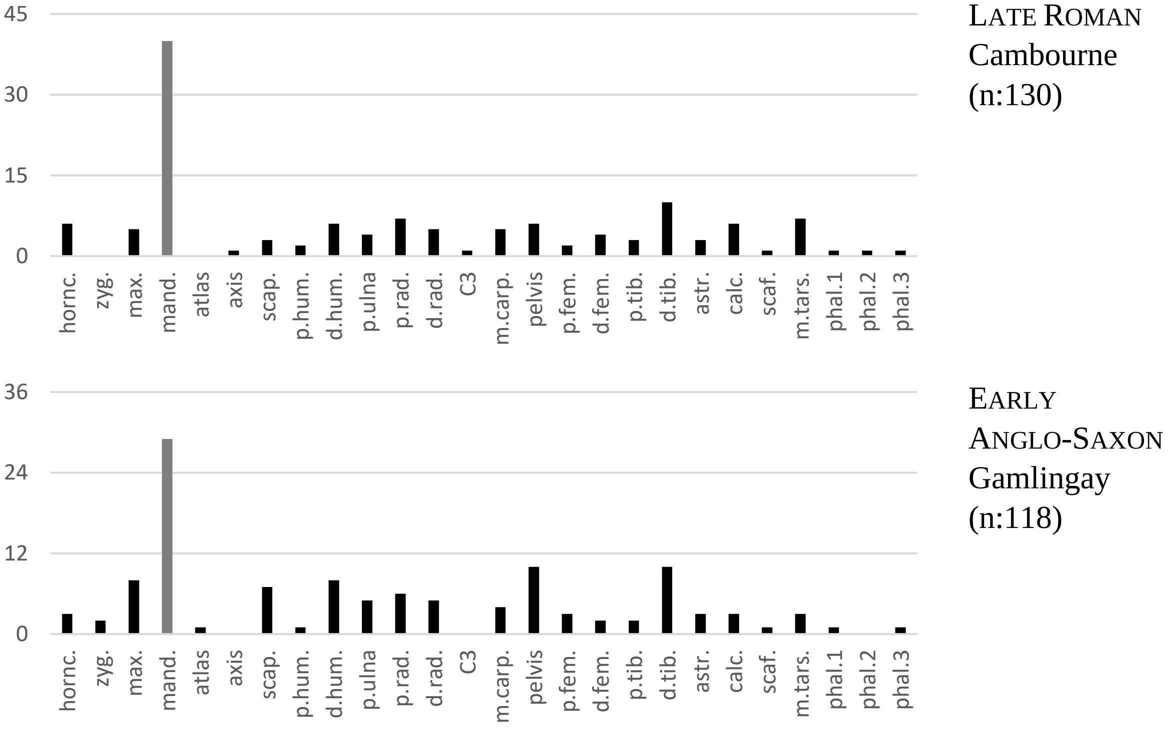


Fig. 6.2.17 Distribution of anatomical elements (MAU) for caprines at Cambourne (n:130) and Gamlingay (n:118).

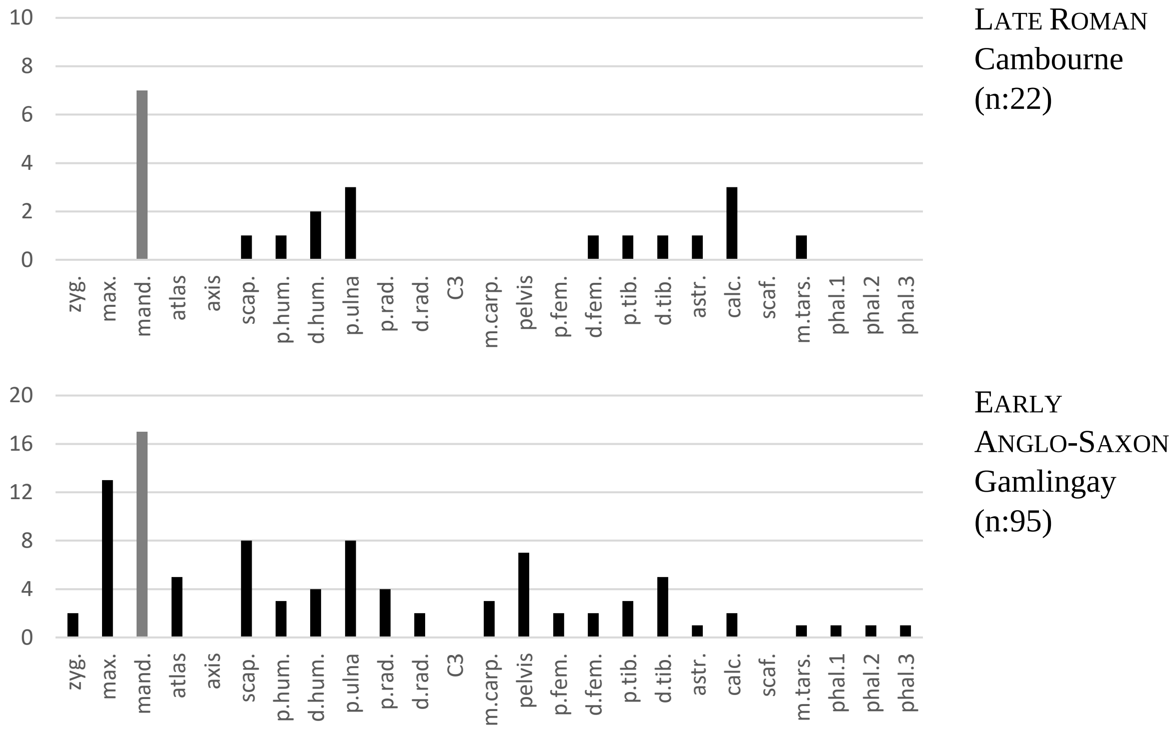


Fig. 6.2.18 Distribution of anatomical elements (MAU) for suids at Cambourne (n:22) and Gamlingay (n:95).

6.2.6 Butchery

The incidence of butchered countable elements of cattle, caprines, and suids do not show any clear trend or differences between Late Roman Cambourne and Early Anglo-Saxon Gamlingay (Fig. 6.2.19). Slightly more elements of cattle presented butchery marks; this is likely result of cattle carcasses being larger than those of caprines and suids, and therefore requiring more effort to be divided into sizeable portions. However, the overall incidence for the three main domesticates is low. Traits typical of Roman butchery practices are much rarer at Late Roman Cambourne than at the contemporary sites of Pakenham and Icklingham (Suffolk, § 6.1.6). At Cambourne, cut marks are more frequent than chop marks, which are instead more numerous at Early Anglo-Saxon Gamlingay; no changes could be detected for sheep (Fig. 6.2.20). The Late Roman assemblage did not present much evidence of intensive butchery, although some scapulae had been processed in a way that resembles the production of cured beef shoulders (§ 6.1.6; Schmid 1972; Lauwerier 1988).

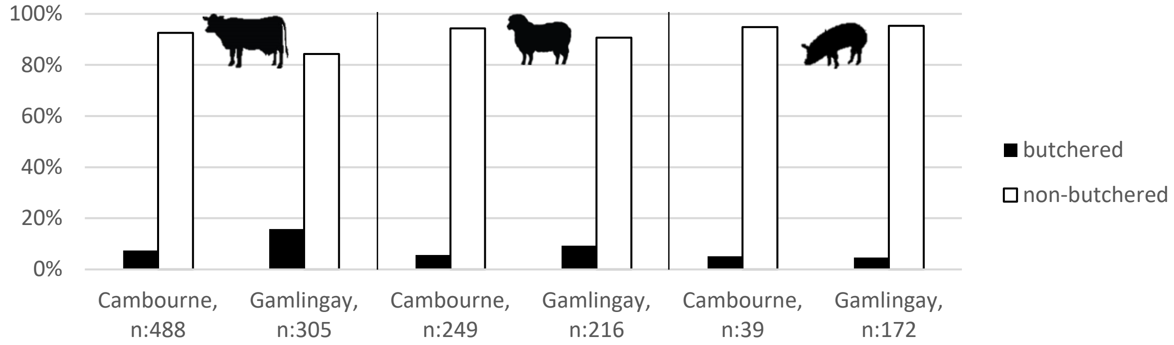


Fig. 6.2.19 Incidence of butchered countable elements for cattle, caprines, and suids at Cambourne and Gamlingay.

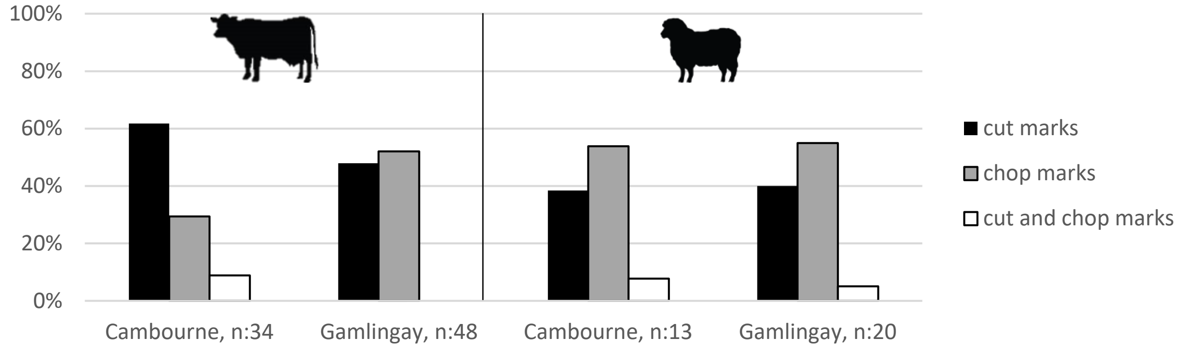


Fig. 6.2.20 Incidence of cut, chop, and cut and chop marks on cattle and caprine countable elements at Cambourne and Gamlingay.

6.2.7 Biometry

6.2.7.1 Cattle

In the scatter plots of cattle bone measurements, values from Late Roman Cambourne and Early Anglo-Saxon Gamlingay are not neatly separated, with small and large animals represented in both periods. However, Late Roman values seem skewed towards the top-right of the graphs, suggesting the presence of on-average larger cattle in this period. Early Anglo-Saxon values concentrate in the range of medium- and small-sized specimens, although some relatively large animals are present (Figs. 6.2.21 and 6.2.22).

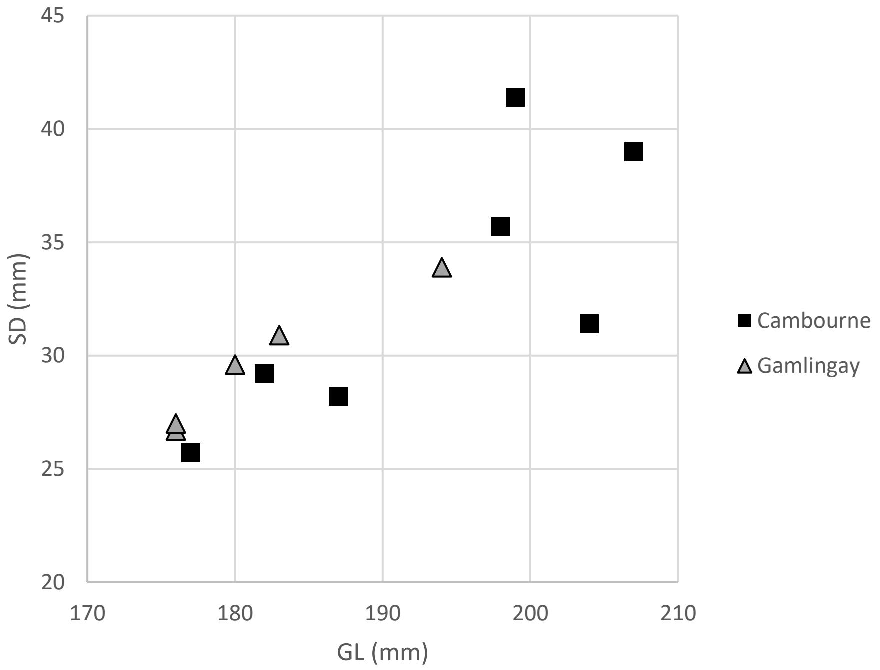


Fig. 6.2.21 Scatter plot of measurements from cattle metacarpals (GL *vs* SD) from Cambourne and Gamlingay.

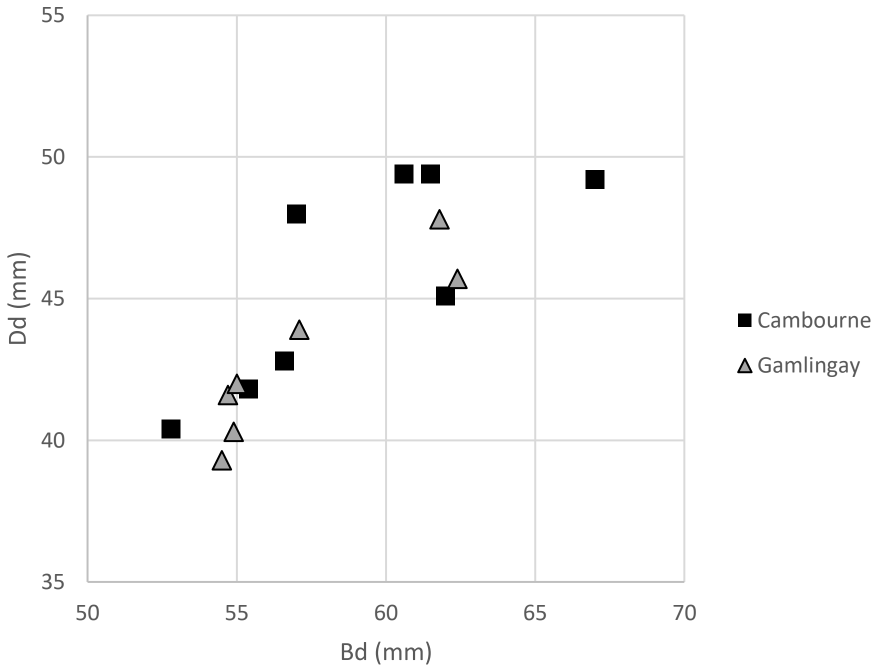


Fig. 6.2.22 Scatter plot of measurements from cattle tibiae (Bd *vs* Dd) from Cambourne and Gamlingay.

However, the sample sizes available for the scatterplots presented above are very small and, in order to further investigate potential differences in the size of cattle bones, sets of width, depth, and length measurements were merged into log ratio histograms. This produced larger samples and allowed to make observations on measurements lying on the three axes separately.

The analysis of bone widths confirms that cattle from Late Roman Cambourne were on average larger than those from Early Anglo-Saxon Gamlingay; the wider size range of values from Cambourne indicates the presence of animals of highly diverse sizes, although differences in the size ranges may also be the result of different sample sizes (Fig. 6.2.23). A selection of more sex-dependent width measurements had shown a potential higher incidence of females at Gamlingay, partly supported by ageing data (§ 6.2.3 and 6.2.4); females being smaller relative to males (castrates and bulls), the smaller average size of cattle from the Early Anglo-Saxon site might reflect differences in the sex ratio, rather than representing a genuine decrease in size in the post-Roman period. Similar differences in the distribution and average of depth values have been observed (Fig. 6.2.24); differences in length values, on the other hand, are clearer (Fig. 6.2.25). However, the sample sizes are smaller in this case, and do not allow drawing definite conclusions. The results of the Student's t-tests confirm that the differences described above are statistically significant, displaying very low *p* values (Tab. 6.2.1).

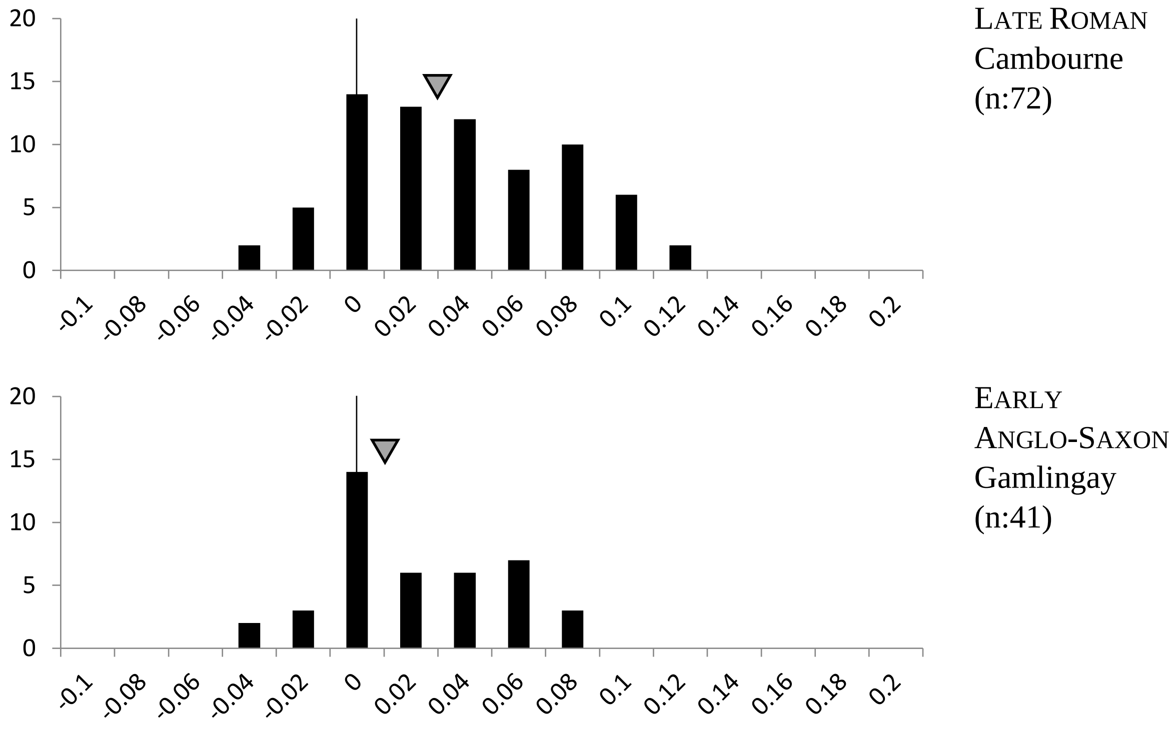


Fig. 6.2.23 Distribution of log ratio values of a selection of cattle bone widths from Cambourne and Gamlingay.

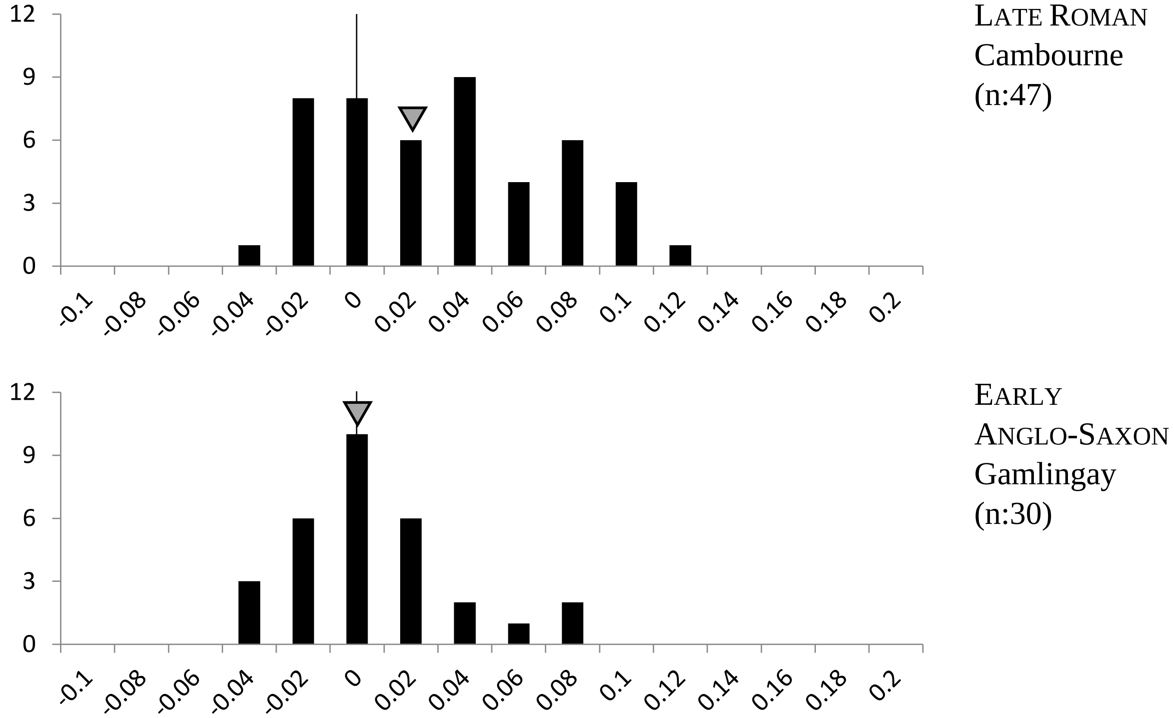


Fig. 6.2.24 Distribution of log ratio values of a selection of cattle bone depths from Cambourne and Gamlingay.

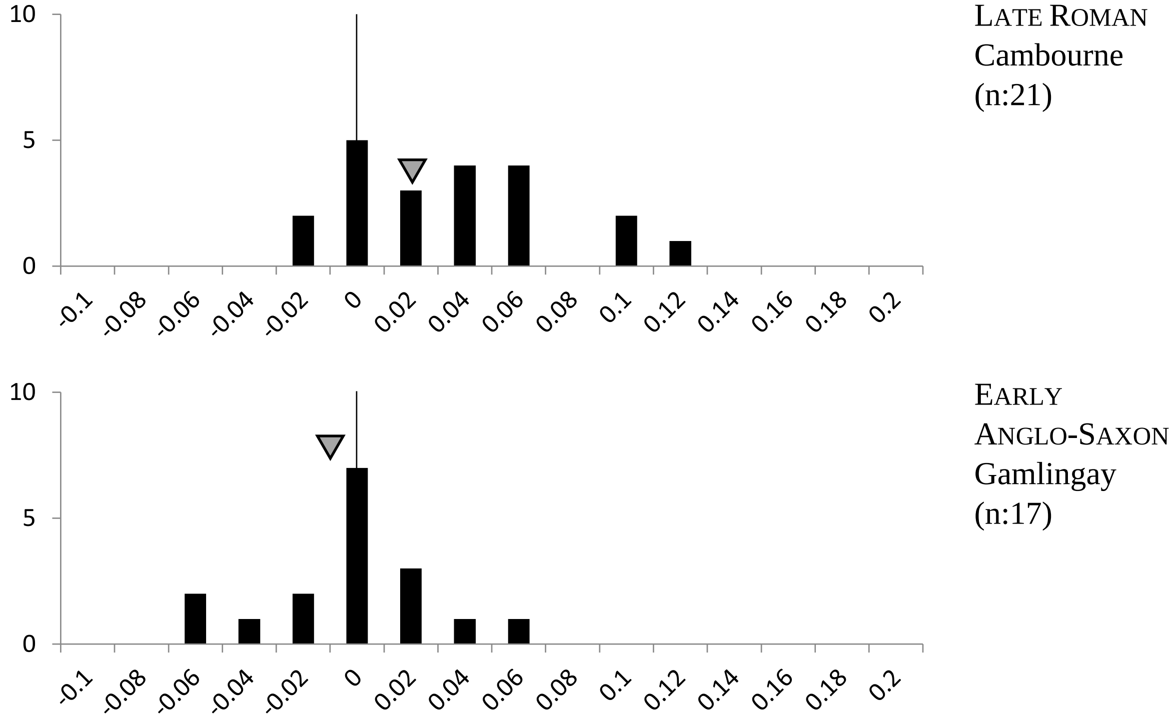


Fig. 6.2.25 Distribution of log ratio values of a selection of cattle bone lengths from Cambourne and Gamlingay.

The scatter plots of measurements from M_3s and M_2s seem to reflect the results from bone analyses: a wider range of values for Late Roman Cambourne and the near-lack of large values at Early Anglo-Saxon Gamlingay, both probably the results of differences in the sample size (Figs. 6.2.26 and 6.2.27). When all tooth widths are combined into log ratio histograms, no substantial differences in distribution and average size can be noticed (Fig. 6.2.28); visual results are supported by the statistical test, which shows no significant difference between the two groups of values (Tab. 6.2.1). As tooth size is less affected by sexual dimorphism, the higher incidence of females hypothesised above for Early Anglo-Saxon Gamlingay does not affect, or only affects minimally, the distribution of tooth values from this site; as a result, there seem to be no differences in the size of cattle teeth between the two assemblages.

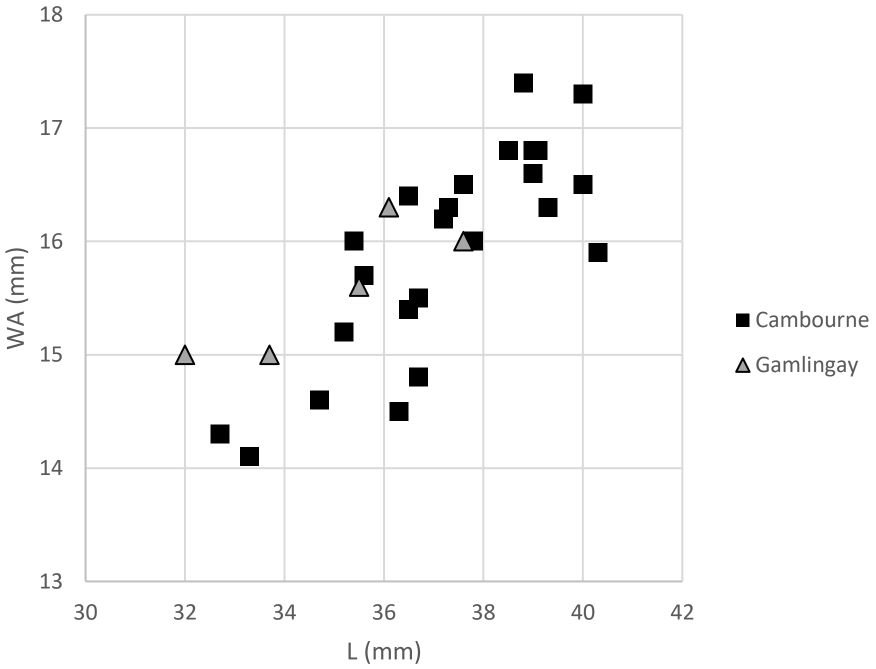


Fig. 6.2.26 Scatter plot of measurements from cattle M_3s (L *vs* WA) from Cambourne and Gamlingay.

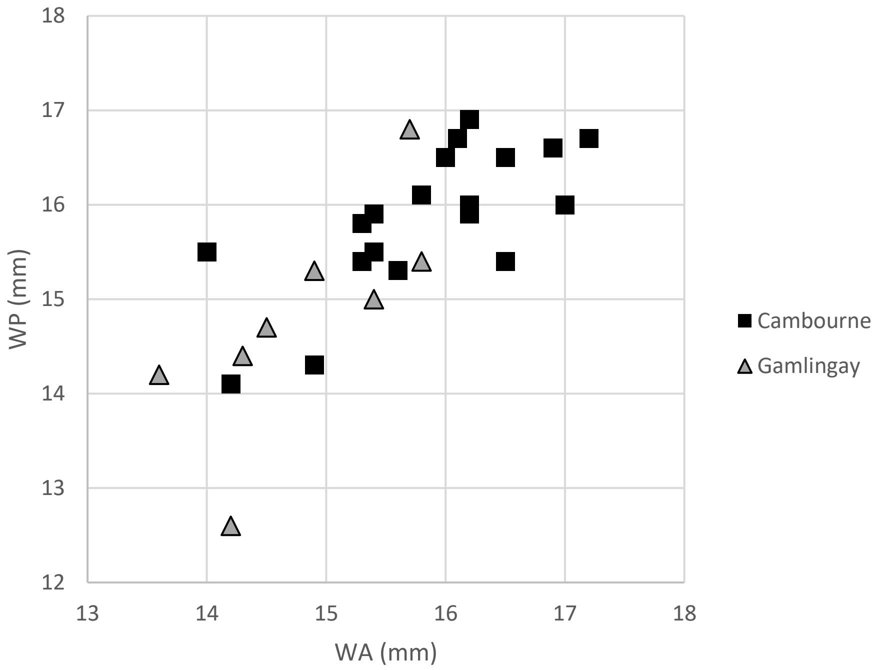


Fig. 6.2.27 Scatter plot of measurements from cattle M_2s (WA *vs* WP) from Cambourne and Gamlingay.

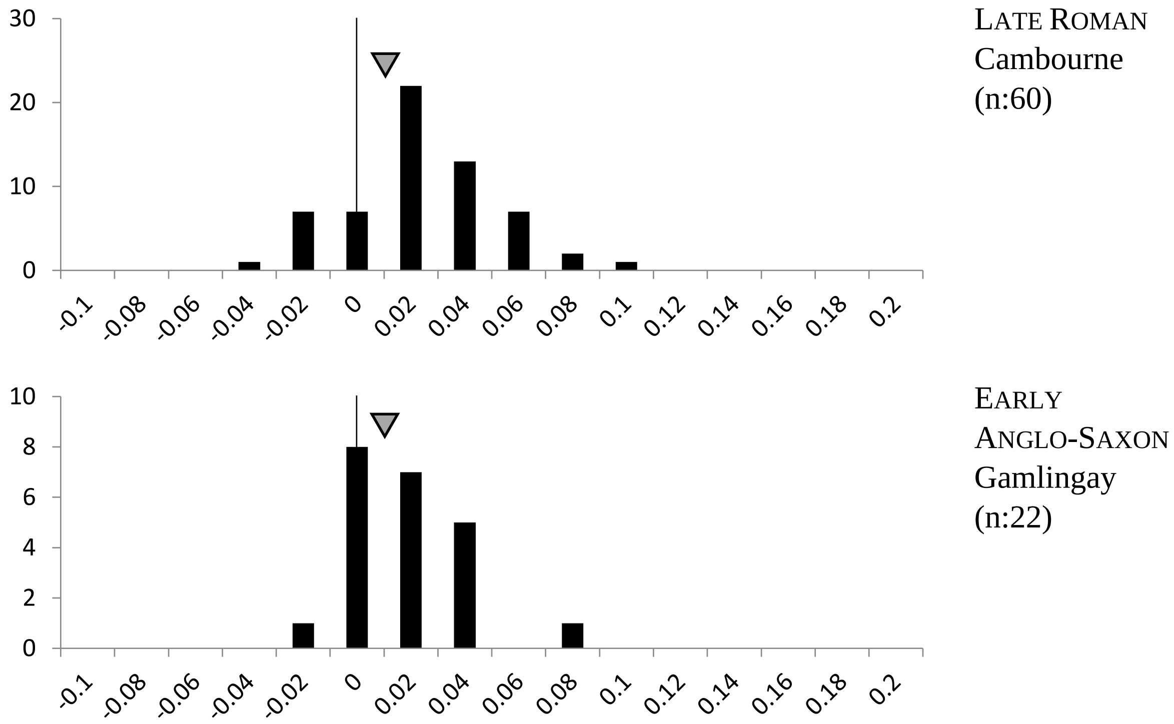


Fig. 6.2.28 Distribution of log ratio values of a selection of cattle tooth widths from Cambourne and Gamlingay.

6.2.7.2 Caprines

The scatter plot of measurements from the distal tibia seems to suggest no substantial differences in size between values from Late Roman Cambourne and Early Anglo-Saxon Gamlingay (Fig. 6.2.29). In order to increase the sample size, measurements from different elements were merged into log ratio histograms. Width and depth values confirm the lack of substantial differences on the average size of caprine bones (Figs. 6.2.30 and 6.2.31); however, in both cases the sample from Cambourne presents a much wider size range, possibly suggesting a higher degree of heterogeneity of the sheep population from the site. Length measurements, on the other hand, indicate that the Early Anglo-Saxon caprines from Gamlingay were on average shorter (Fig. 6.2.32). Although results from the analysis of length measurements rely on a small sample size, such inconsistency between measurements lying on different axes might suggest the presence of caprines characterised by different built, and possibly different types/breeds. At the same time, these results warn against the exclusive reliance on withers heights for the assessment of body size. Visual observations and the inconsistency between width and depth, and length measurements is supported by the results of a Student’s t-test, which produced a much lower *p* value for lengths (though still not statistically significant) (Tab. 6.2.1).

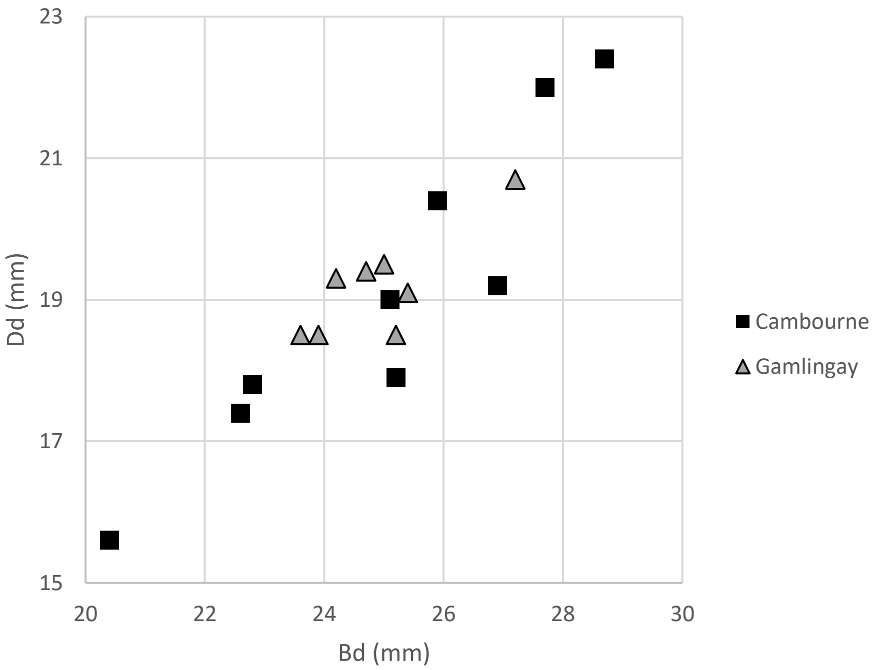


Fig. 6.2.29 Scatter plot of measurements from caprine tibiae (Bd *vs* Dd) from Cambourne and Gamlingay.

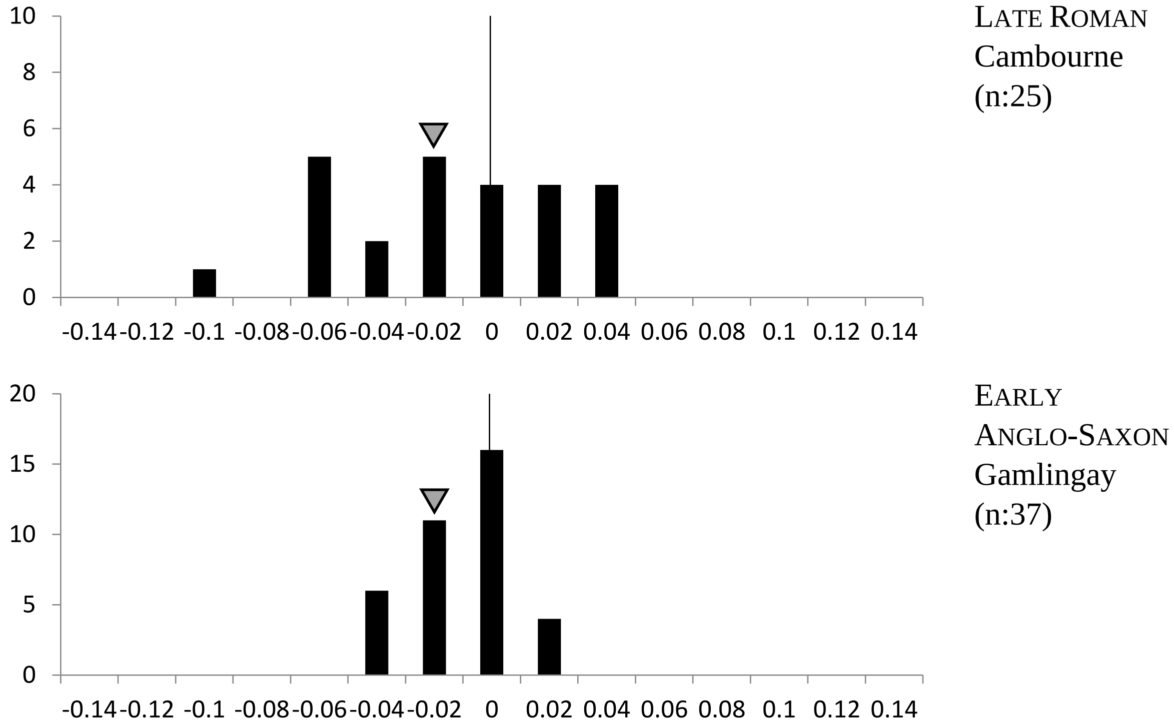


Fig. 6.2.30 Distribution of log ratio values of a selection of caprine bone widths from Cambourne and Gamlingay.

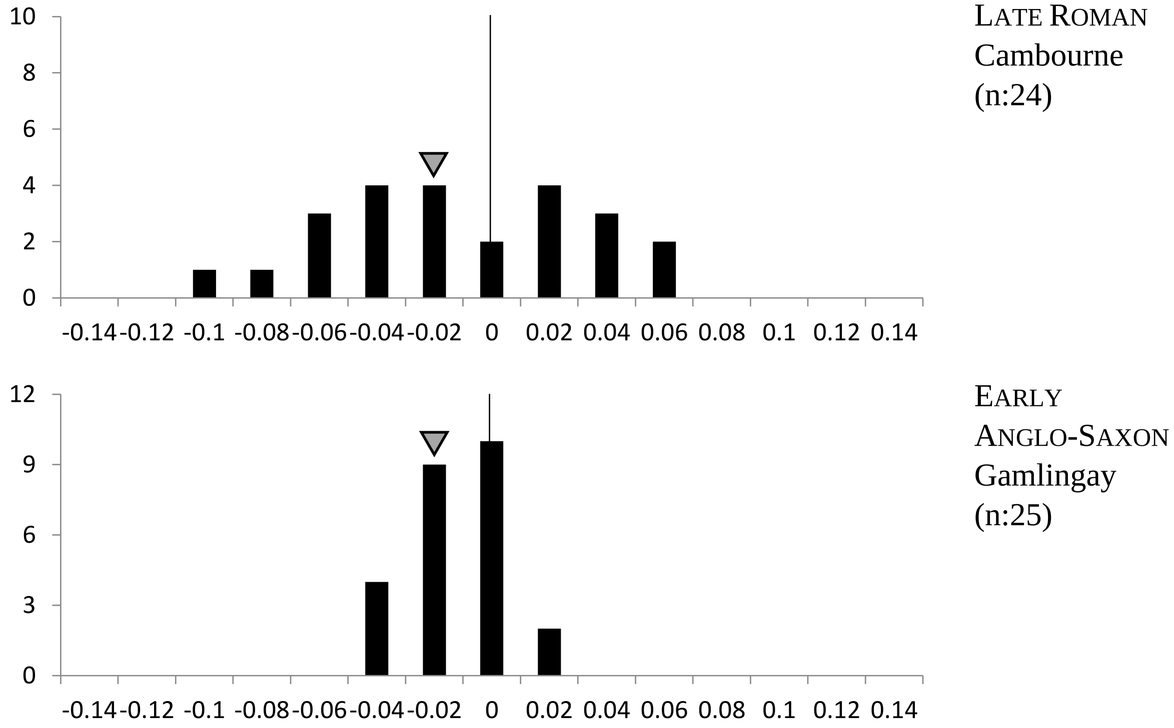


Fig. 6.2.31 Distribution of log ratio values of a selection of caprine bone depths from Cambourne and Gamlingay.

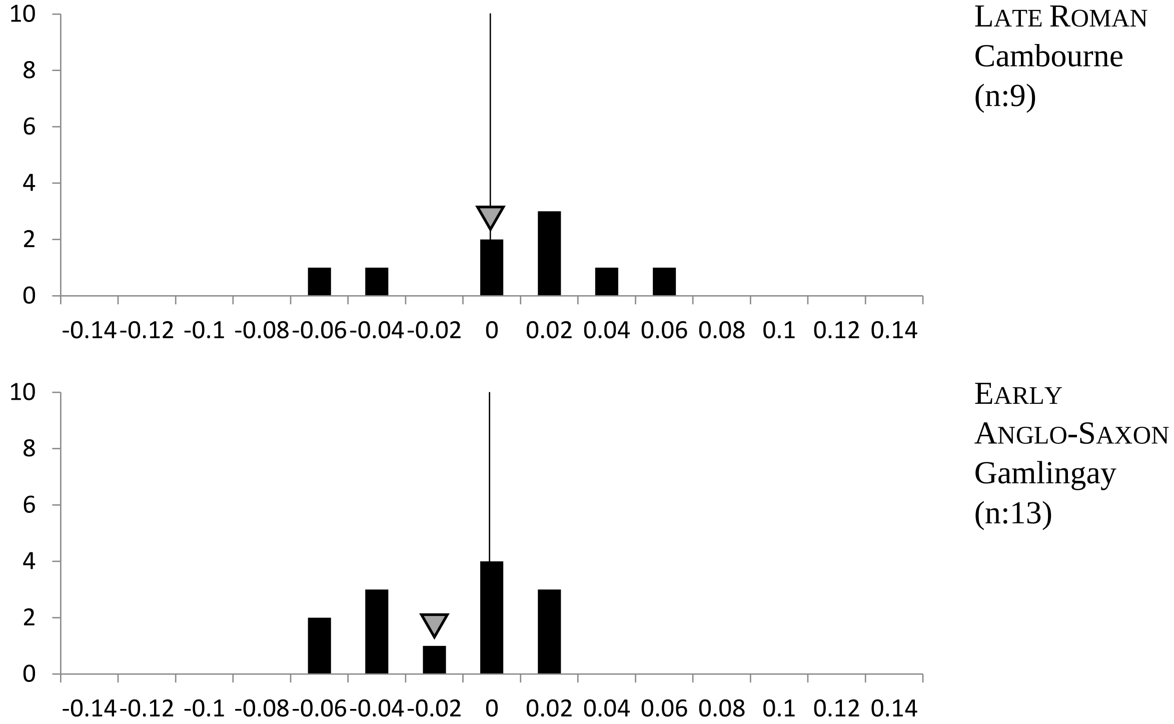


Fig. 6.2.32 Distribution of log ratio values of a selection of caprine bone lengths from Cambourne and Gamlingay.

The lack of substantial changes suggested by bone width and depth measurements is supported by the analyses of tooth measurements, which indicate no differences in the distribution and average size of teeth from Late Roman Cambourne and Early Anglo-Saxon Gamlingay (Figs. 6.2.33 and 6.2.34). These observations are supported by the result of a Student's t-test (Tab. 6.2.1).

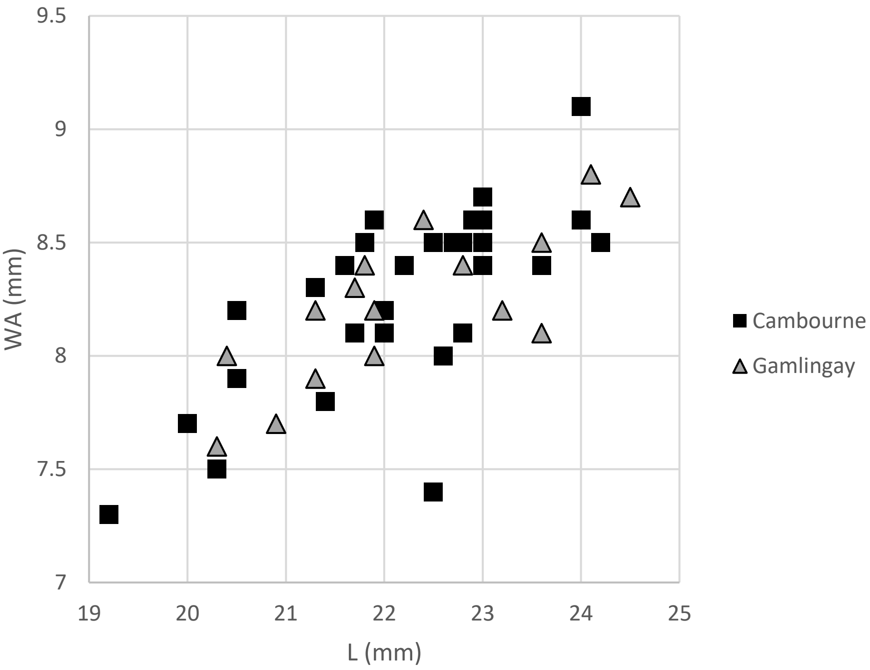


Fig. 6.2.33 Scatter plot of measurements from caprine M_3s (L *vs* WA) from Cambourne and Gamlingay.

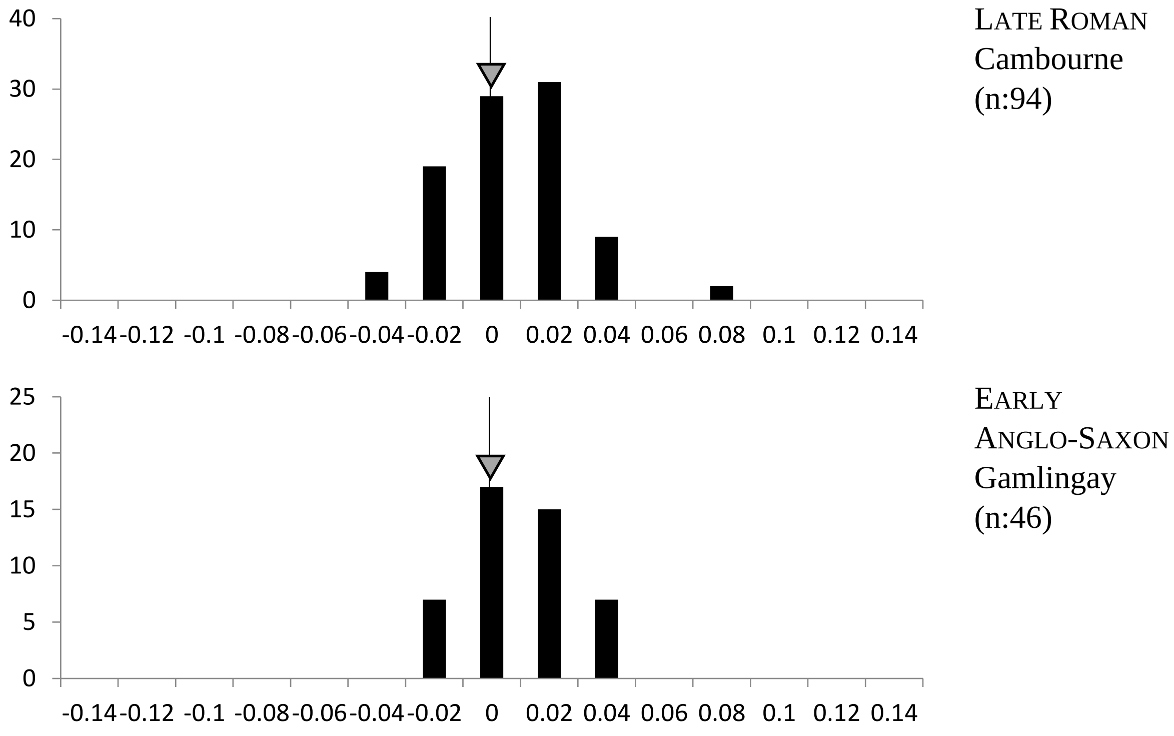


Fig. 6.2.34 Distribution of log ratio values of a selection of caprine tooth widths from Cambourne and Gamlingay.

6.2.7.3 Suids

The low frequency of suids in the assemblages here analysed does not allow a detailed investigation of bone and tooth size (§ 6.2.2); in addition, most pig bones are usually still immature when the animal reaches its optimum weight and is slaughtered, further reducing the amount of biometrical data available for analysis (§ 6.2.3).

Suid bone size could only be investigated for Early Anglo-Saxon Gamlingay (Fig. 6.2.35). Although the sample size does not allow drawing definite conclusions, pigs were particularly small, and smaller than those from Early Anglo-Saxon West Stow (§ 6.1.7.3). Tooth measurement analyses suggest pigs from Late Roman Cambourne could have been larger, though again the sample size from this site remains quite small (Figs. 6.2.36 and 6.2.37; Tab. 6.2.1). The results from suid bone and tooth analyses are contextualised and compared to those from other assemblages in § 6.5.

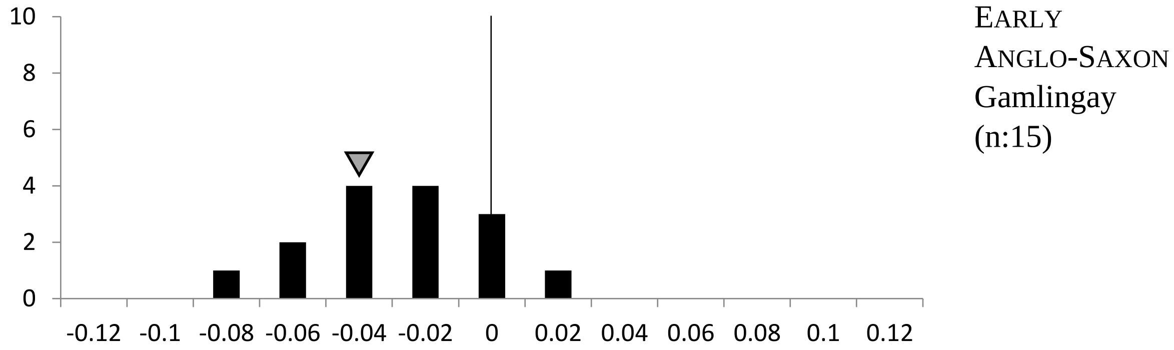


Fig. 6.2.35 Distribution of log ratio values of a selection of suid bone measurements from Gamlingay.

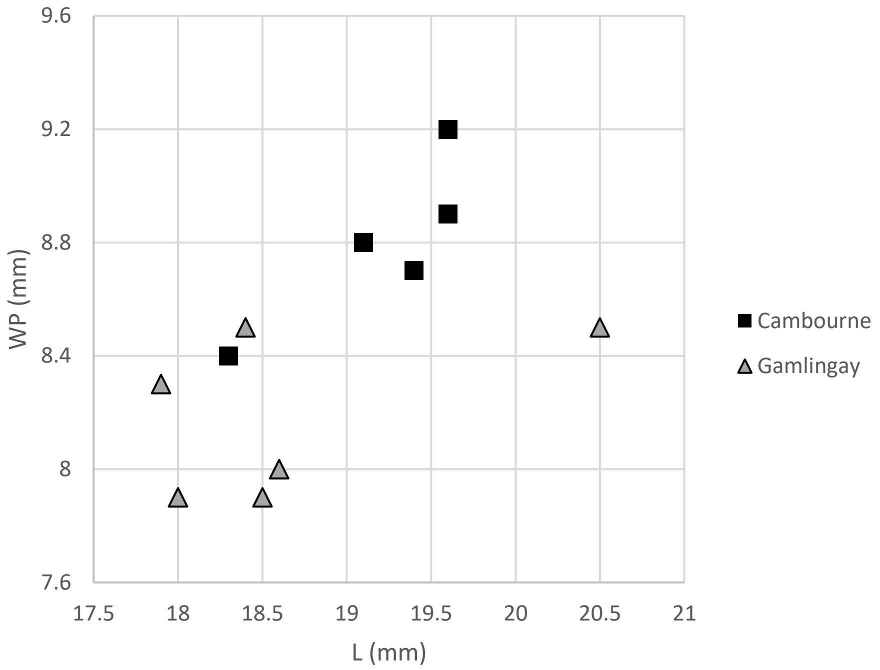


Fig. 6.2.36 Scatter plot of measurements from suid dP_4s (L *vs* WP) from Cambourne and Gamlingay.

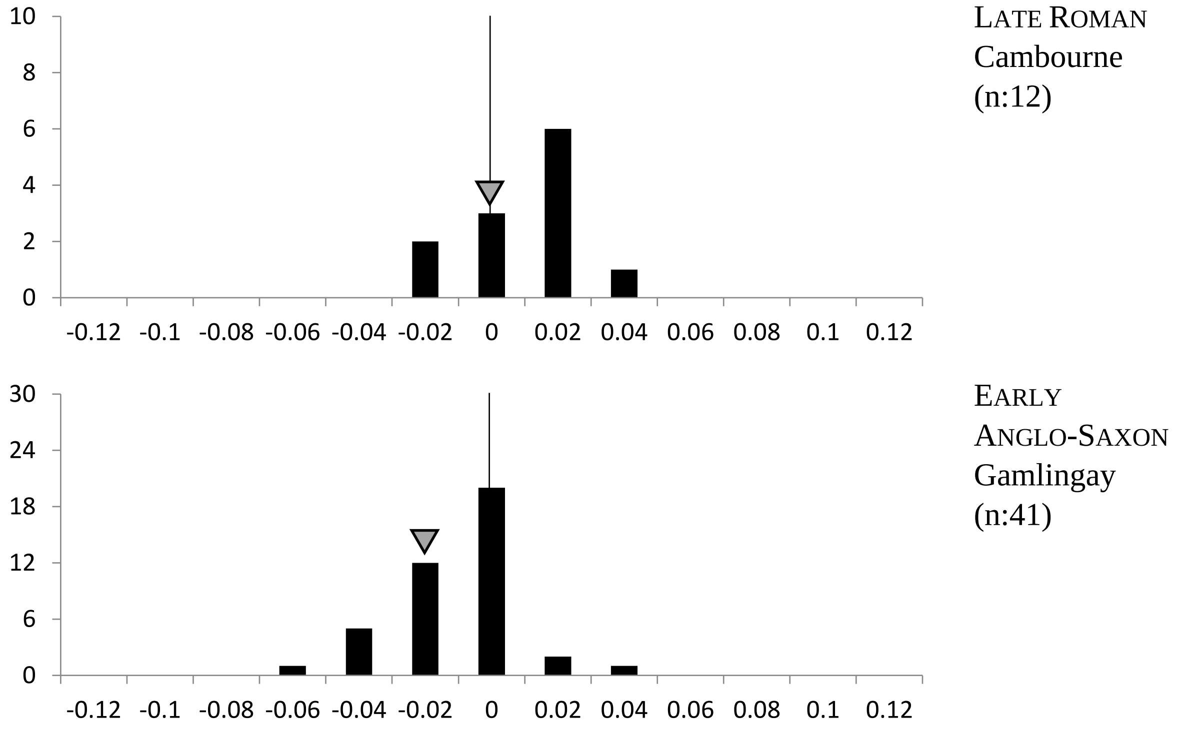


Fig. 6.2.37 Distribution of log ratio values of a selection of suid tooth widths from Cambourne and Gamlingay.

taxa	measurement types		*p* values
CATTLE	bone widths	Cambourne *vs* Gamlingay	0.02
	bone depths		< 0.01
	bone lengths		< 0.01
	tooth widths		0.36
CAPRINES	bone widths		0.54
	bone depths		0.83
	bone lengths		0.17
	tooth widths		0.57
SUIDS	tooth widths		< 0.01

Tab. 6.2.1 Results of the Student's t-tests for cattle, caprine, and suid bone and tooth measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance.

6.2.8 Pathology and non-metric traits

Pathological evidence was mainly detected on cattle lower limb bones, and is likely related to exploitation of this species for traction. At both Late Roman Cambourne and Early Anglo-Saxon Gamlingay, a number of phalanges (especially first phalanges) presented a deformed and asymmetric proximal end, often combined with extra-bone growth on and around the articulation. The only pathological upper limb bone was recorded for Gamlingay, where the head of a femur presented extensive exostosis and eburnation. The pathological conditions on proximal phalanges were not paralleled by the presence of splayed metapodials; only one severely splayed metapodial was recorded for Late Roman Cambourne (Tabs. 6.2.2 and 6.2.3). The biometrical analyses of distal metapodials do not display any visible outlier, confirming the lack of deformed specimens (Figs. 6.2.38 and 6.2.39).

Pathological conditions on caprines and suids are very rare. Some caprine mandibles and maxillae present evidence of overcrowding or malocclusion, while pitted and linear enamel hypoplasia was recorded on a number of suid mandibular and maxillary teeth from Gamlingay.

Non-metric traits only include dental anomalies, such as the absence of premolars on caprine and cattle mandibles, or the presence of an extra premolar on a suid mandible. Three cattle M$_3$s had their hypoconulid absent or reduced, accounting for about 7% of the total number of third lower molars.

	non-visibly splayed	splayed	total	**% splayed**
CAMBOURNE	21	0*	21	**0%**
GAMLINGAY	13	0	13	**0%**

Tab. 6.2.2 Presence and incidence of splayed metacarpals at Cambourne and Gamlingay. *One severely splayed metapodial has been recorded as a non-countable specimen, as most of the distal end had broken off and was not possible to identify it as a metacarpal or metatarsal.

	non-visibly splayed	splayed	total	**% splayed**
CAMBOURNE	30	0*	30	**0%**
GAMLINGAY	15	0	15	**0%**

Tab. 6.2.3 Presence and incidence of splayed metatarsals at Cambourne and Gamlingay. *One severely splayed metapodial has been recorded as a non-countable specimen, as most of the distal end had broken off and was not possible to identify it as a metacarpal or metatarsal.

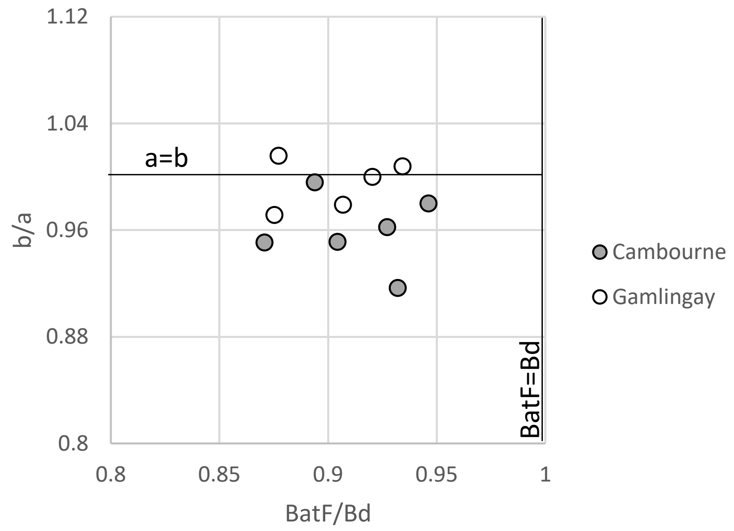


Fig. 6.2.38 Scatter plot of shape indices from cattle distal metacarpals at Cambourne and Gamlingay. The black lines represent the values at which BatF is the same as Bd, and perfect symmetry occurs between the widths of the two condyles (a=b).

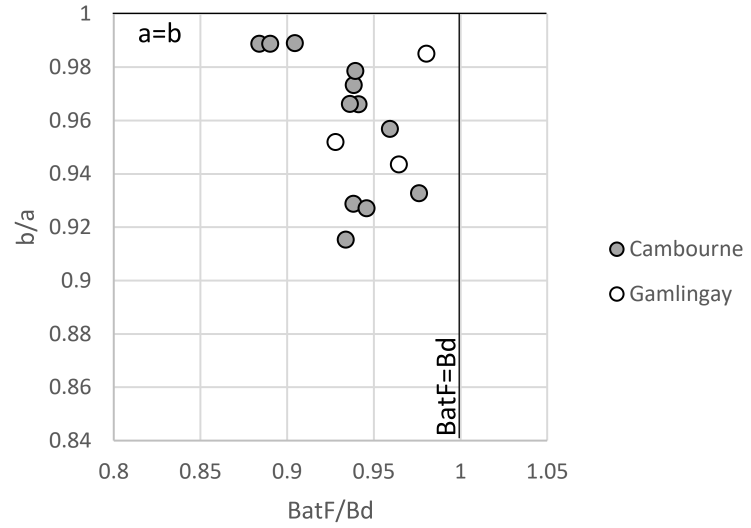


Fig. 6.2.39 Scatter plot of shape indices from cattle distal metatarsals at Cambourne and Gamlingay. The black lines represent the values at which BatF is the same as Bd, and perfect symmetry occurs between the widths of the two condyles (a=b).

6.2.9 Summary

Similarities and differences between the Late Roman and Early Anglo-Saxon assemblages from Cambridgeshire only partly reflect what has been seen at contemporary sites from Suffolk (§ 6.1).

The Late Roman assemblage from Cambourne is dominated by cattle; its exploitation was generalised, although there seems to have been a greater focus on traction in comparison to Early Anglo-Saxon Gamlingay. The three main domesticates are more equally represented at Gamlingay. Similarly to cattle, the exploitation of caprines was multi-purpose at both sites, possibly with a greater focus on meat production. Animals were butchered on-site and, differently from Suffolk, almost no differences in butchery practices have been noticed between the two site-periods.

Cattle bone biometrical analyses indicate that cattle were smaller at Early Anglo-Saxon Gamlingay; however, sexing biometrical analyses suggest that such difference may be the result of a higher incidence of cows at this latter site, rather than of a genuine decrease in size. The lack of changes in tooth size supports this hypothesis. Similarly to Suffolk, no changes in sheep bone and tooth size were detected, with the exception of lengths, which suggest the presence of shorter and more robust sheep at Gamlingay. The dearth of pig measurements does not allow drawing definite conclusions; however, there could have been a decrease in size from Late Roman times.

6.3 Oxfordshire

The assemblages analysed for Oxfordshire were collected from the sites of Asthall, Denchworth Road (Wantage), and Mill Street (Wantage) (Late Roman period), and Benson and Oxford Science Park (Early Anglo-Saxon period) (§ 4.4).

6.3.1 Preservation and recovery bias

The majority of the recorded material presented a good level of surface preservation; very few fragments were recorded with a medium or bad level of preservation. The assemblage from Late Roman Asthall represents an exception, with almost 20% of the material having been badly damaged by post-depositional taphonomic processes. Overall, however, most of the specimens could be properly identified anatomically and taxonomically; only at Asthall the bad surface preservation of some of the material partially hindered the identification of butchery marks or gnawing marks, or prevented taking measurements.

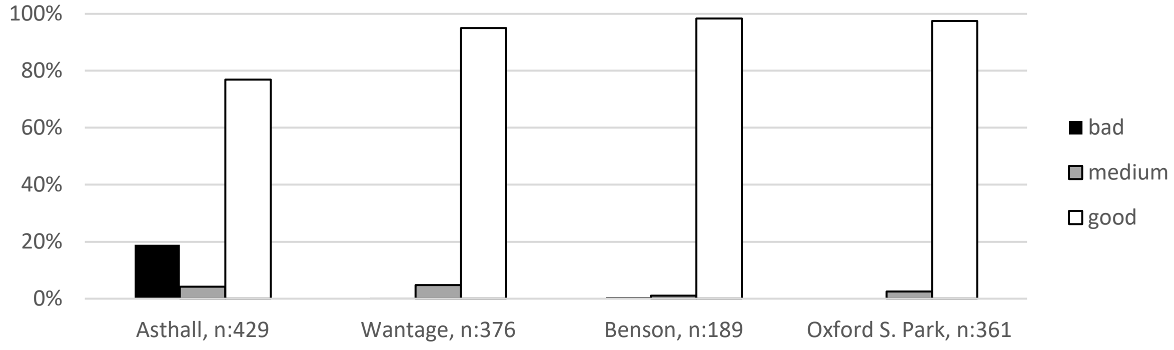


Fig. 6.3.1 Incidence of categories of surface preservation (§ *5.3.2*, Tab. 5.6) in the recorded material.

The impact of the recovery bias on quantification analyses was assessed by considering the proportions between distal metapodials and 1st phalanges in cattle and caprines (Fig. 6.3.2). All the assemblages had been hand-collected, and all are considerably affected by a recovery bias, whereby smaller elements and elements from smaller species are underrepresented. In addition to a higher incidence of badly preserved specimens, the assemblage from Asthall also seems to have been affected to a greater extent by a recovery bias. The different degrees of preservation and recovery biases will be taken into account in the quantification analyses below (§ 6.3.2).

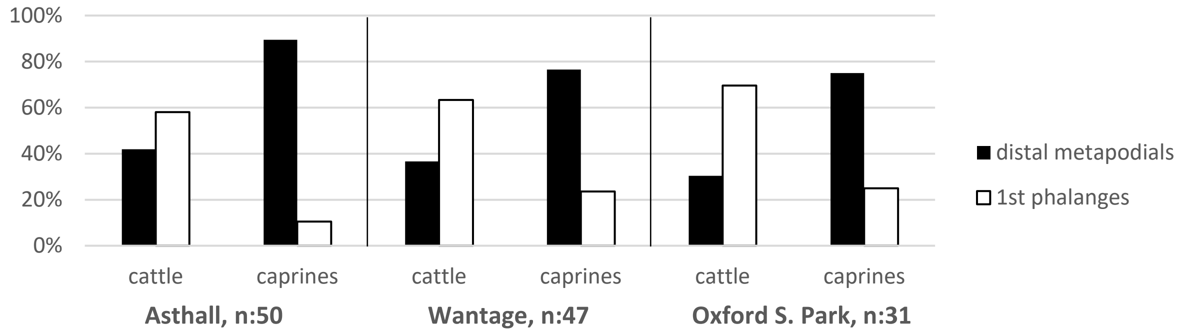


Fig. 6.3.2 Recovery bias analysis: proportions of distal metapodials *vs* 1st phalanges for cattle and caprines in the recorded assemblages (natural proportion: 1:2). The assemblage from Benson had to be excluded from this analysis due to the dearth of data from these elements.

6.3.2 Species frequency

NISP taxonomic frequencies do not highlight substantial differences between Late Roman and Early Anglo-Saxon assemblages (Fig. 6.3.3). Cattle prevail in all sites, its frequency ranging between 50 and 60%. The higher incidence of badly preserved specimens at Asthall and, especially, the slightly greater impact of a recovery bias on the assemblage from this site, could have over-emphasised the incidence of cattle in proportion to caprines and suids; cattle frequency at the site, however, is lower than that at contemporary Wantage, and similar to that from other Late Roman sites in central-southern Britain. Caprines are the second better represented taxon; morphological observations and biometrical analyses of caprine remains suggest most of them belonged to sheep (Figs. 6.3.4 and 6.3.5). The incidence of suids slightly increases to almost 20% in Early Anglo-Saxon Benson and Oxford Science Park; tooth and postcranial bone biometrical analyses suggest the majority of suids were domestic pigs (§ 6.3.7.3).

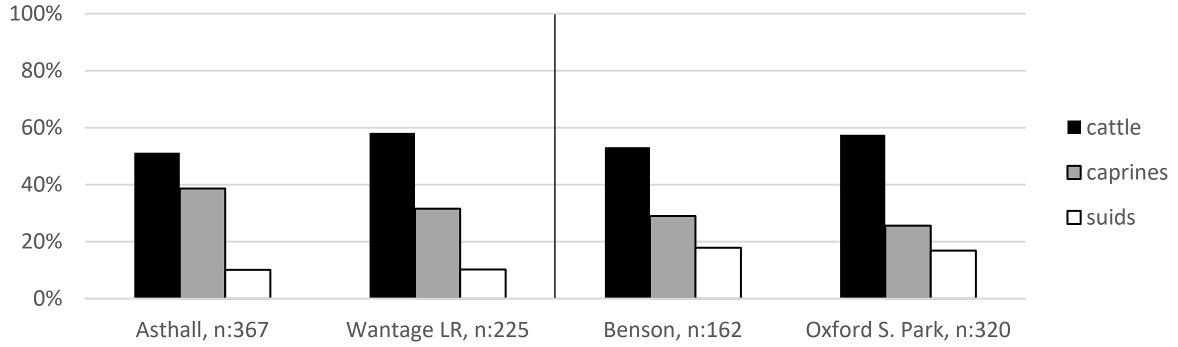


Fig. 6.3.3 NISP species frequencies for cattle, caprines, and suids. For Wantage, LR: Late Roman assemblage.

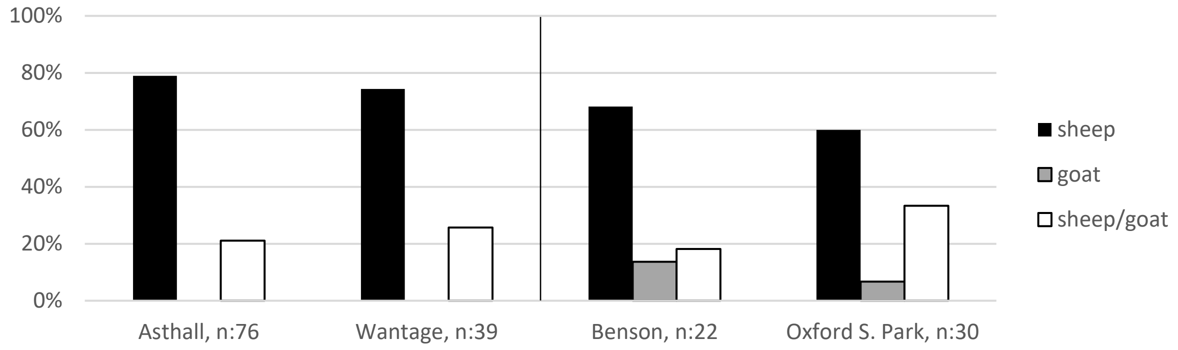


Fig. 6.3.4 Proportions of caprine remains recorded as sheep, goat, and sheep/goat, calculated using the set of selected elements on which the sheep-goat distinction is attempted.

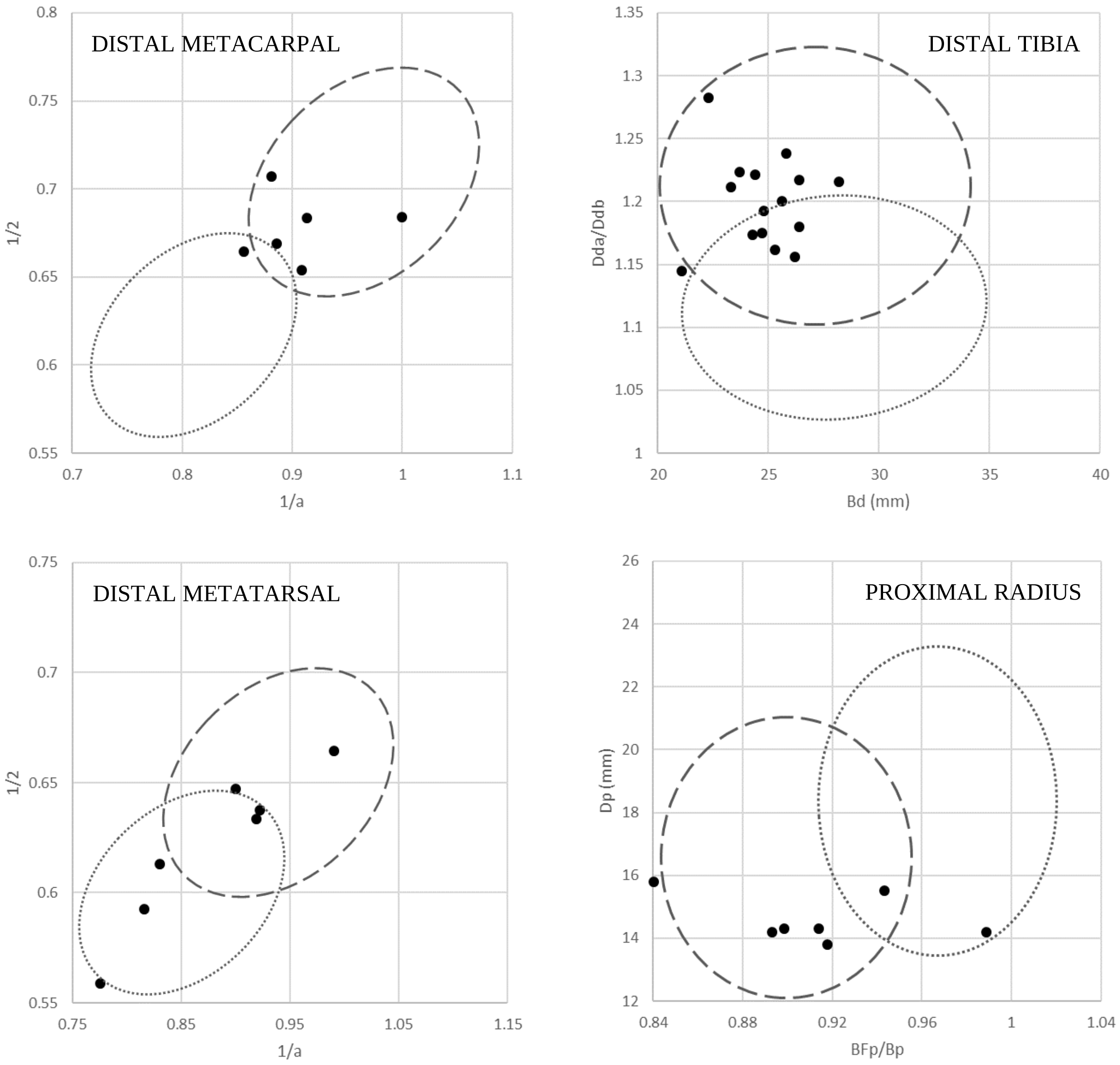


Fig. 6.3.5 Biometrical shape analyses of caprine bones against the approximate distributions of sheep (dashed line) and goat (dotted line) modern values from Salvagno and Albarella (2017). The scatter plots include values from Asthall, Wantage, Benson, and Oxford Science Park. All measurements from metacarpals and tibiae are compatible with sheep, while one radius and up to three metatarsals plot with the goat.

MNI frequencies are probably distorted by the disproportional high incidence of mandibles, especially caprines', which survive better than those of cattle (Fig. 6.3.6). The preferential survival of this element, which in most cases is the best represented bone (§ 6.3.4), coupled with the higher impact of taphonomic agents on postcranial bones, result in a much higher MNI frequency of caprines at Late Roman Asthall. In order to counteract this bias, new MNI estimations excluding mandibles and maxillae have been produced (Fig. 6.3.7). The new calculations remove the peak of caprines at Late Roman Asthall, confirming the unusual trend was solely the consequence of the high frequency of mandibles.

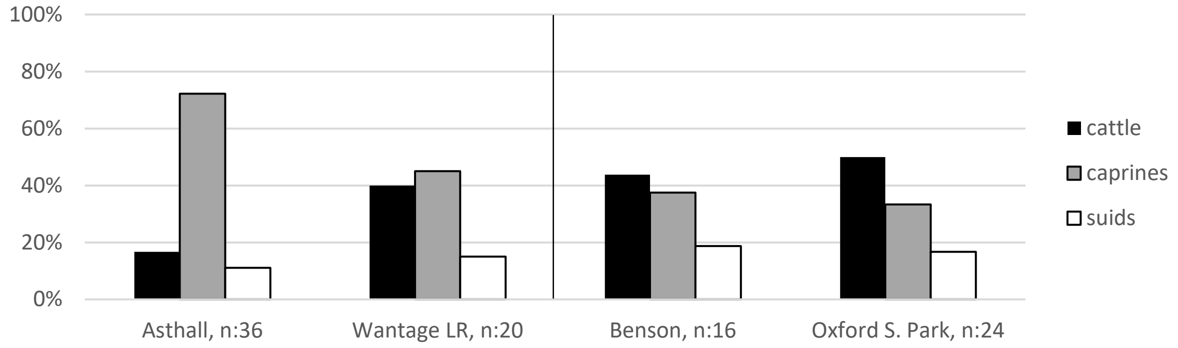


Fig. 6.3.6 MNI species frequencies for cattle, caprines, and suids. For Wantage, LR: Late Roman assemblage.

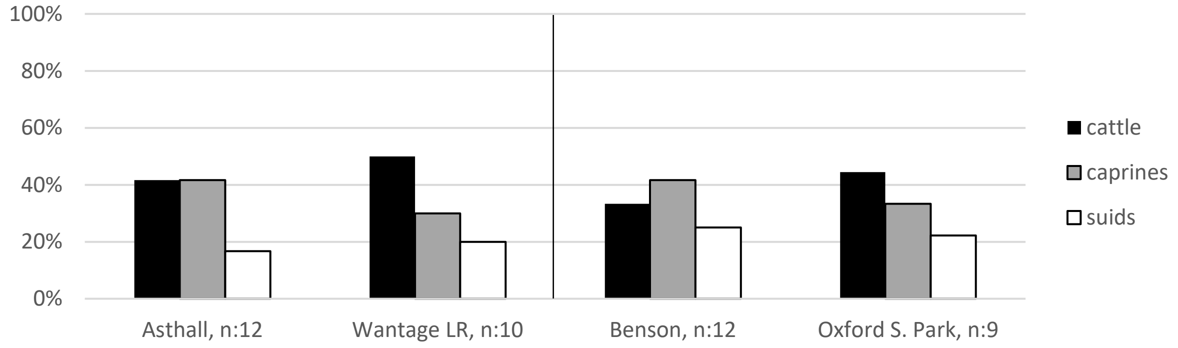
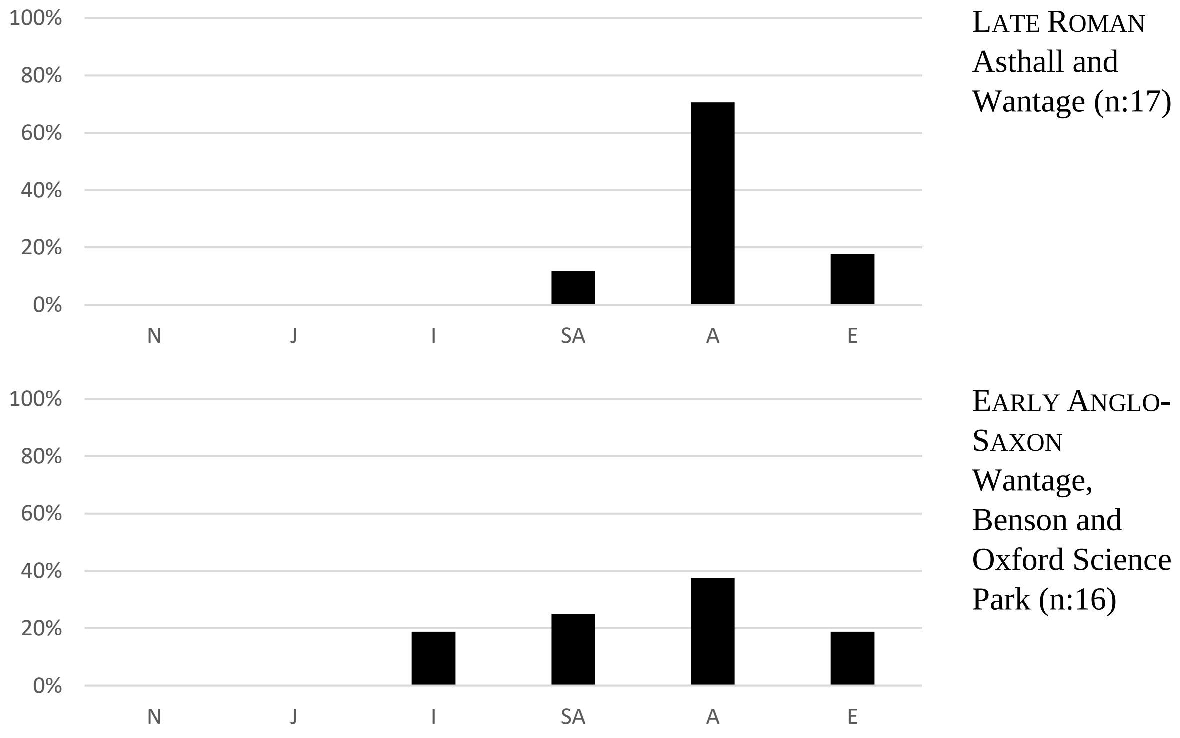


Fig. 6.3.7 MNI species frequencies for cattle, caprines, and suids without cattle, caprine, and suid mandibles and maxillae.

6.3.3 Ageing

The reconstruction of culling strategies for cattle and caprines relied on the analyses of mandibular wear stages and epiphyseal fusion stages of postcranial bones. Due to the dearth of mandibles, however, in most cases dental ageing data from contemporary sites had to be combined to provide large-enough datasets for reliable comparisons. Perinatal remains of caprines, cattle, and suids were recovered from Late Roman Asthall and Wantage, though in small quantities; only a perinatal suid bone was recovered from Early Anglo-Saxon Oxford Science Park, and none from Benson. These finds indicate that at least some of the main domesticates were bred on-site or close by; however, they have been excluded from the analyses of postcranial epiphyseal fusion presented below, as perinatal remains are more likely to represent natural losses rather than deliberate culling.

Cattle mandibular wear stages from Late Roman Asthall and Wantage had to be combined, and the same was done for the Early Anglo-Saxon assemblages (Fig. 6.3.8). Despite the small sample sizes, it seems that most cattle survived into adulthood in the Late Roman sites, where they were probably exploited for traction in the fields before being culled for meat; Early Anglo-Saxon mandibular wear stages, on the other hand, do not seem to focus on a specific age range, suggesting a more generalised exploitation of this animal. The results from epiphyseal fusion analyses broadly support this view, with many more animals culled by the middle fusing stage at the Early Anglo-Saxon sites; the reversed pattern observed for late fusing elements may simply be the result of the small sample size (Fig. 6.3.9).


LATE ROMAN Asthall and Wantage (n:17)

EARLY ANGLO-SAXON Wantage, Benson and Oxford Science Park (n:16)

Fig. 6.3.8 Distribution of cattle mandibular wear stages in the age groups devised by O’Connor (1988) at Late Roman Asthall and Wantage, and in the three Early Anglo-Saxon assemblages combined. N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

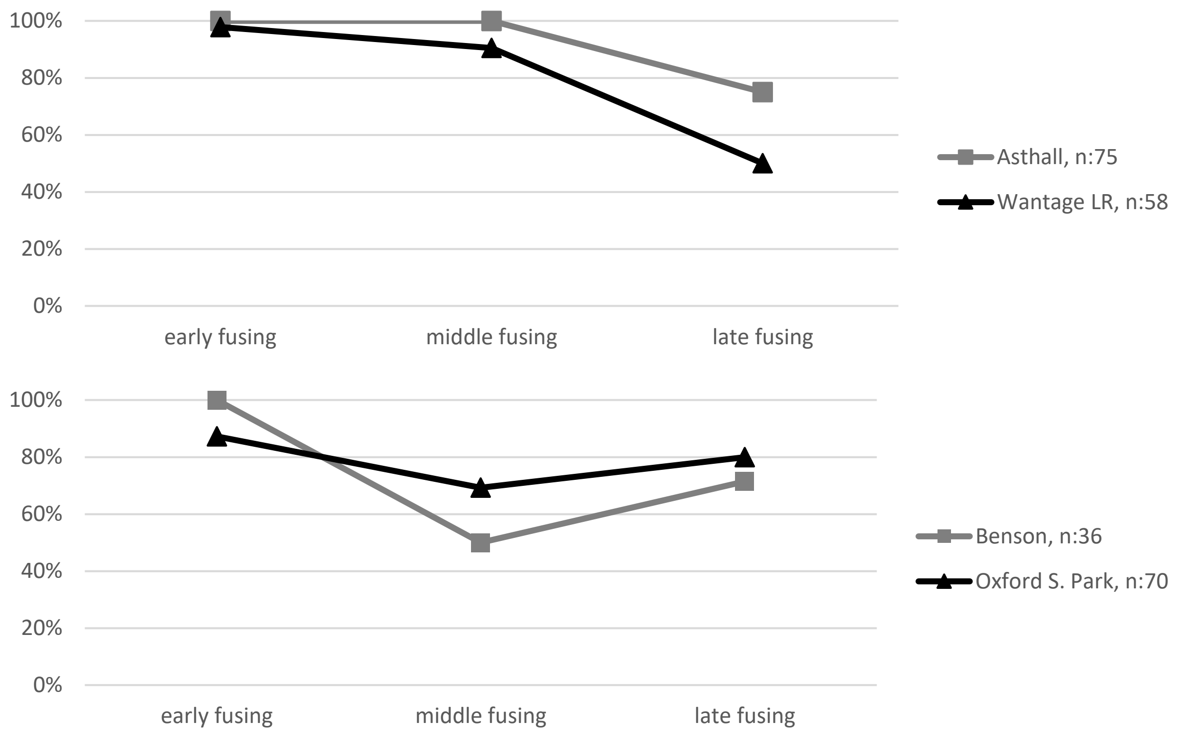
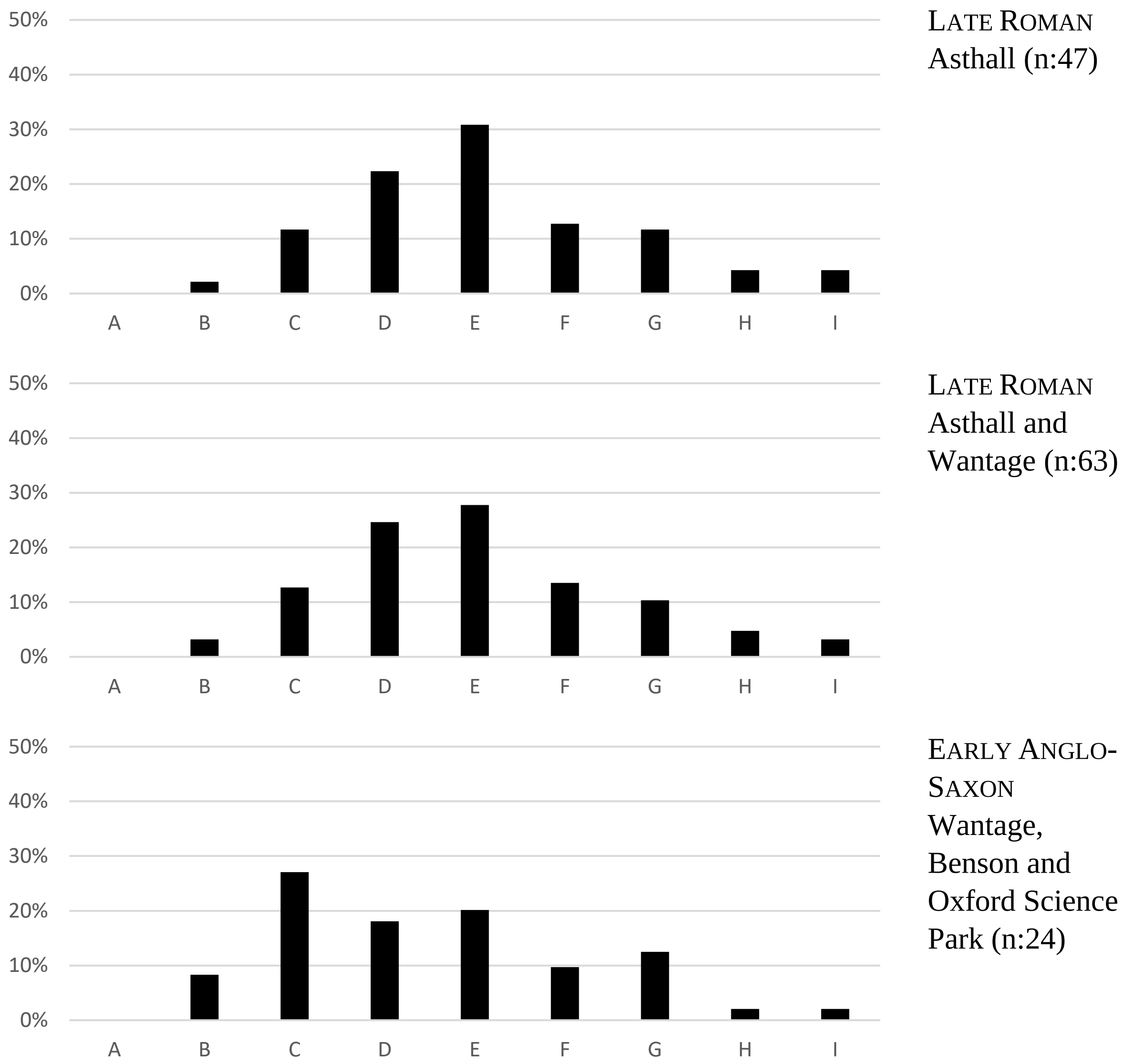


Fig. 6.3.9 Incidence of cattle fused elements in the three fusing stages proposed by Silver (1969) at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

Despite the larger amount of caprine mandibles, data from the Late Roman and Early Anglo-Saxon assemblages still had to be combined (Fig. 6.3.10). Similarly to what had been seen for the Suffolk and Cambridgeshire sites, in both periods sheep exploitation did not focus on specific outputs. However, there seems to be again a shift towards the culling of younger animals in Early Anglo-Saxon times, possibly suggesting a greater focus on meat production through the kill-off of excess lambs during autumn. The analysis of postcranial bone epiphyseal fusion can only in part support this hypothesis, with slightly more culling occurring by the end of the early fusing stage (age?) at the Early Anglo-Saxon sites, and no animals surviving into adulthood in the assemblage from Benson (Fig. 6.3.11).


LATE ROMAN Asthall (n:47)

LATE ROMAN Asthall and Wantage (n:63)

EARLY ANGLO-SAXON Wantage, Benson and Oxford Science Park (n:24)

Fig. 6.3.10 Distribution of caprine mandibular wear stages in the age groups devised by Payne (1973) at Late Roman Asthall and in the two Late Roman assemblages combined, and in the three Early Anglo-Saxon assemblages combined.

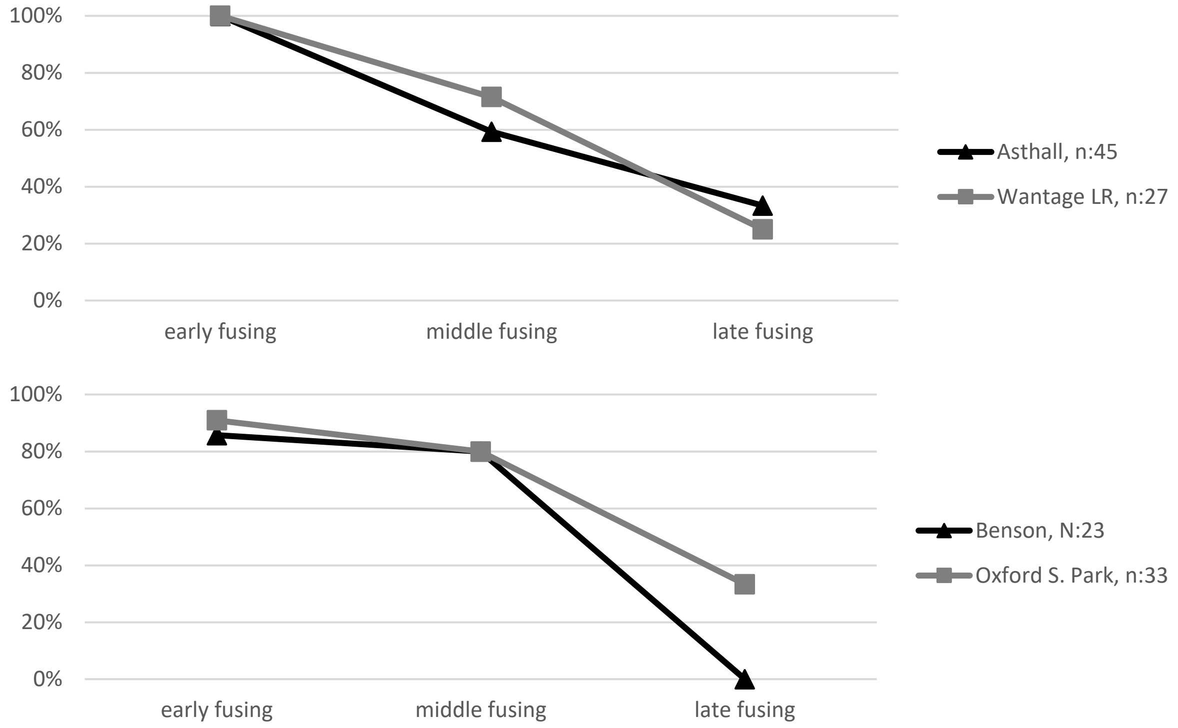


Fig. 6.3.11 Incidence of caprine fused elements in the three fusing stages proposed by Silver (1969) at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

Not enough data were available for an analysis of suid culling strategies. The few mandibles and maxillae from Asthall mainly belonged to subadult and adult individuals; however, the very small sample size does not allow drawing definite conclusions on pig management.

6.3.4 Distribution of anatomical elements

The distribution of cattle anatomical elements in all the assemblages here analysed is largely dictated by taphonomic biases (Fig. 6.3.12). Elements which fuse late and with a less dense and thinner cortical bone (mainly proximal humeri, distal radius, femurs, proximal tibiae) are absent or scarce, as a result of preferential destruction in archaeological deposits; similarly, smaller elements such as the 3rd carpal and phalanges are also underrepresented, as their presence is affected by a recovery bias (§ 6.3.1). Mandibles, which resist well to post-depositional taphonomic processes, are the most represented element in all assemblages. The ubiquitous presence of lower and upper limb bones and cranial elements suggests that both primary and secondary butchery would have occurred on site, where primary butchery waste cumulated along with waste from food consumption (i.e. meat-bearing elements).

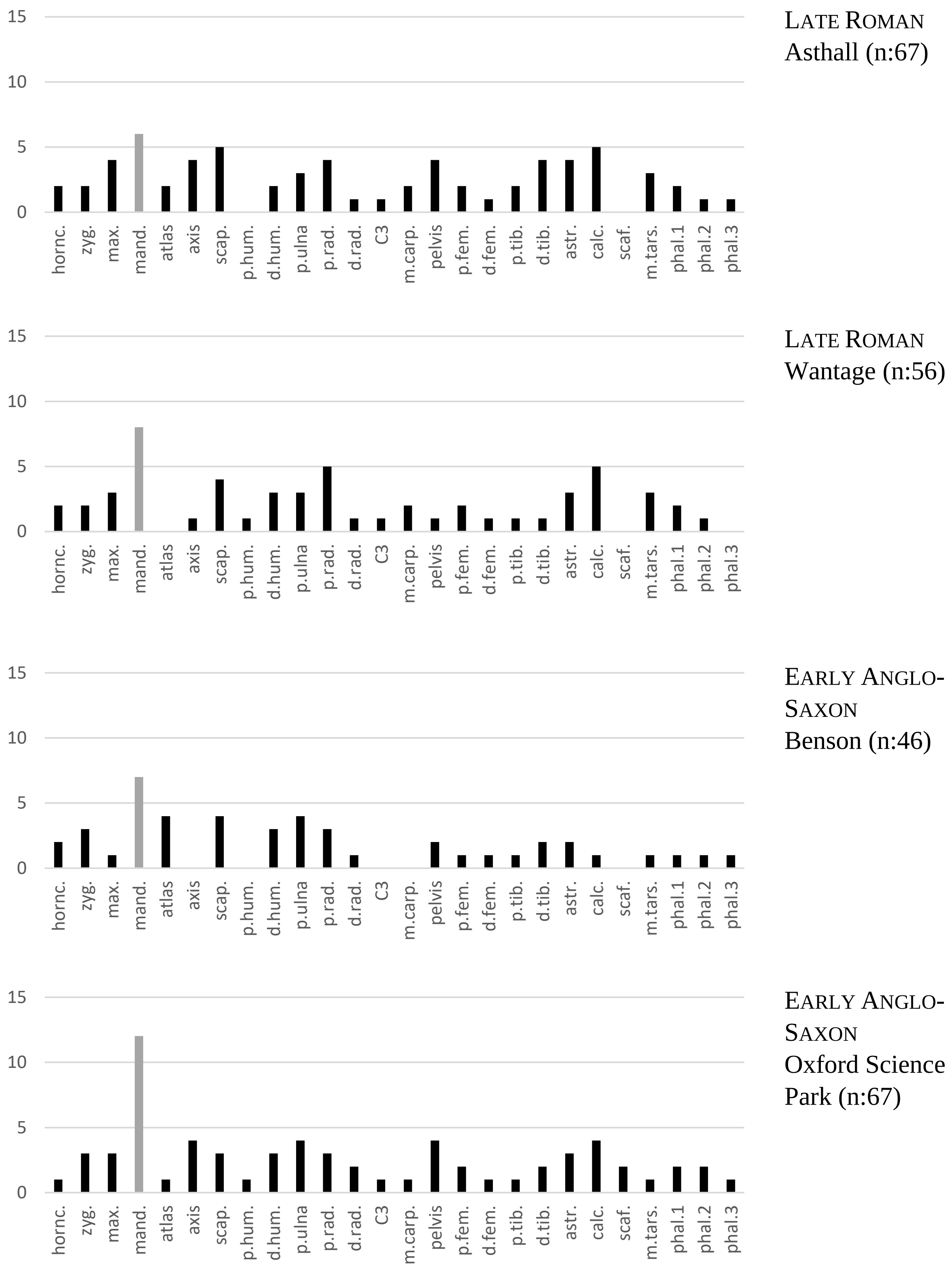
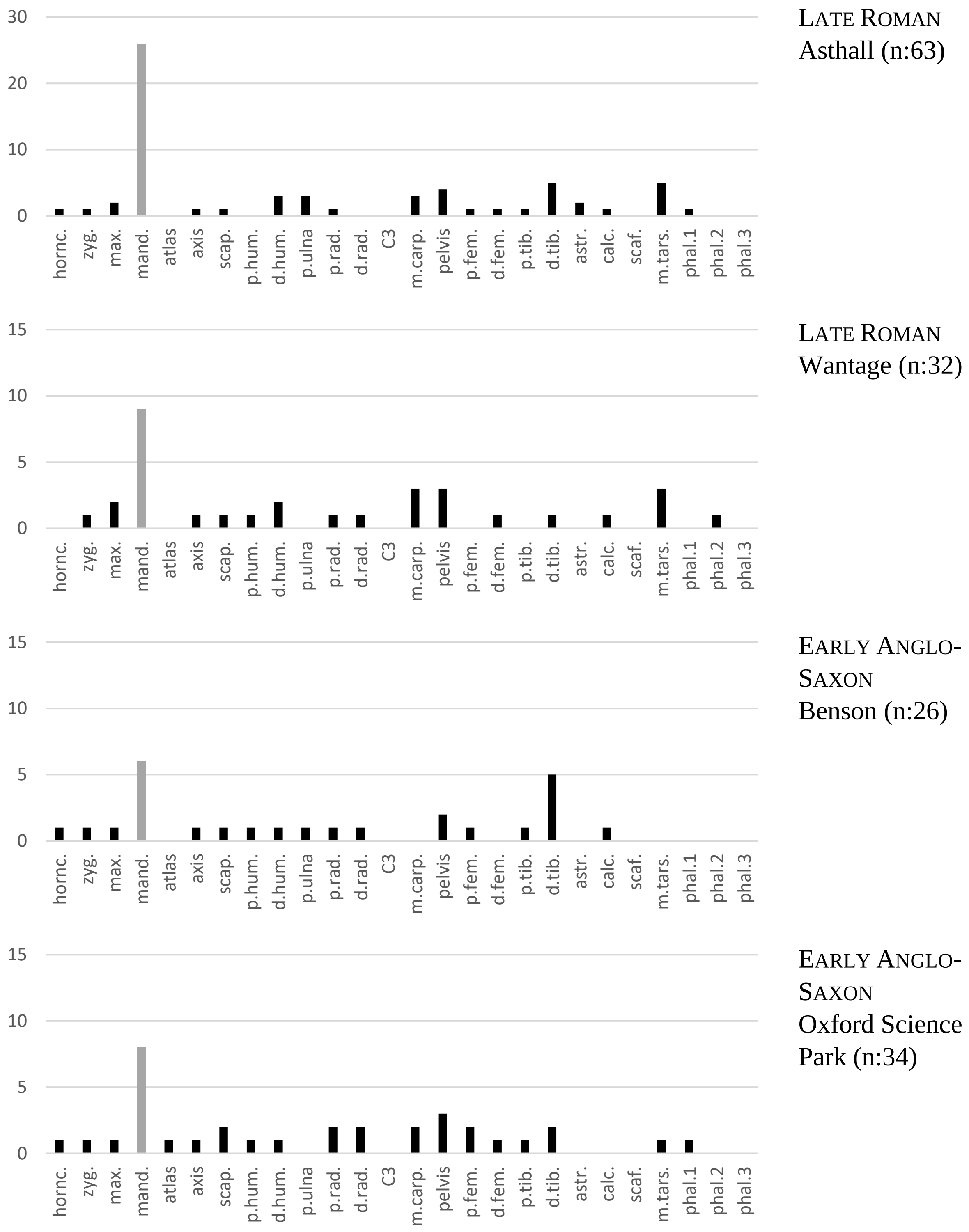


Fig. 6.3.12 Distribution of anatomical elements (MAU) for cattle at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

Caprine remains were similarly affected by differential preservation and recovery biases, with the less resistant body parts absent or scarce and the smaller elements (carpals/tarsals and phalanges) often missing (Fig. 6.3.13); the predominance of mandibles in all the assemblages reflects the high degree of bone density of this element (especially true for this taxon), hence its preferential survival in the archaeological record (Brain 1981). Overall, lower limb, cranial, and the more meat-bearing elements are present in all the assemblages, suggesting the butchery and consumption on site of whole caprine carcasses.

Due to the dearth of suid remains, the distribution of anatomical elements of pig could only be investigated for Early Anglo-Saxon Oxford Science Park (Fig. 6.3.14). Most of the diagnostic zones are represented, suggesting the on-site butchery and consumption of this animal. Also in this case, the prevalence of mandibles (and maxillae) is the result of their preferential survival in archaeological deposits.

In all the sites, vertebrae and ribs from large- and medium-sized mammals have been recorded, confirming the overall trends.



LATE ROMAN
Asthall (n:63)

LATE ROMAN
Wantage (n:32)

EARLY ANGLO-SAXON
Benson (n:26)

EARLY ANGLO-SAXON
Oxford Science Park (n:34)

Fig. 6.3.13 Distribution of anatomical elements (MAU) for caprines at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

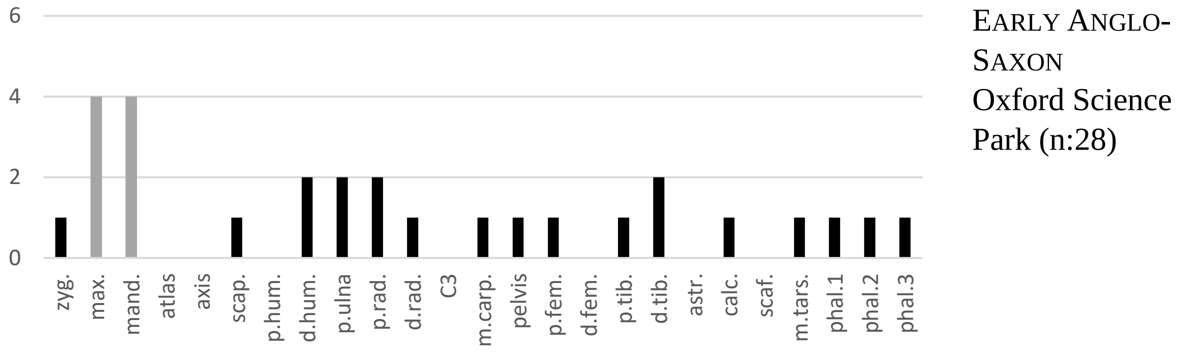


Fig. 6.3.14 Distribution of anatomical elements (MAU) for suids at Early Anglo-Saxon Oxford Science Park.

6.3.5 Butchery

Similarly to what has been seen for the assemblages from Suffolk, the incidence of butchered cattle elements is higher at the Late Roman sites (Asthall and Wantage) (Fig. 6.3.15). At the same time, the higher incidence of butchery marks on cattle remains relative to sheep is the result of the larger size of cattle carcasses, which therefore require more effort to be divided into sizeable portions. At the same time, such higher incidence of butchered cattle elements also reflects the standardised, large-scale butchery of cattle of Roman times, whereby multiple carcasses where consistently processed and portions redistributed. The clear prevalence of chop marks in the Late Roman assemblages supports this hypothesis, as carcasses would have been more quickly processed by chopping through the joints (Fig. 6.3.16). At the Early Anglo-Saxon sites of Benson and Oxford Science Park, the lower incidence of butchery marks on cattle remains may suggest a less standardised, *ad hoc* butchery of animals, which allowed more time to cut through tendons at the main joints and remove meat from the bone in a more careful way; unfortunately, not enough data were available to assess the incidence of different butchery marks.

The incidence of butchery marks on caprines does not reveal any clear trend (Fig. 6.3.15). While, on one hand, Roman large-scale meat production focused on cattle rather sheep, this result may simply reflect the fact that the smaller caprine carcasses require less processing before consumption.

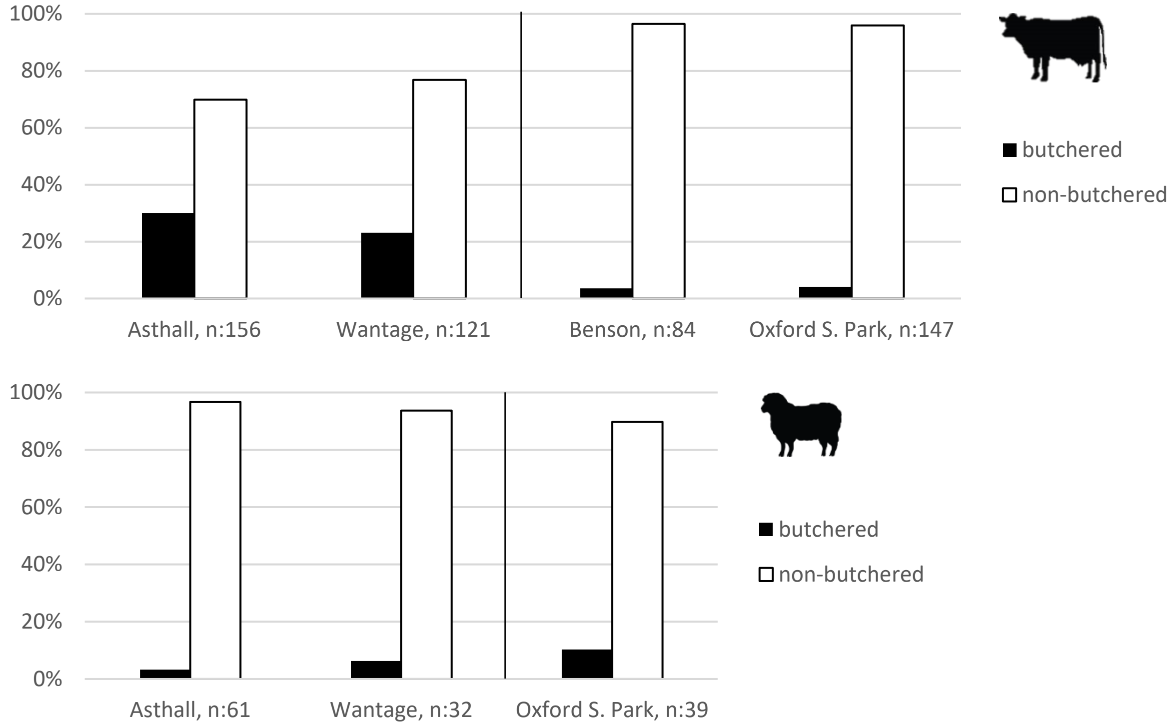


Fig. 6.3.15 Incidence of butchered elements for cattle and caprines at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

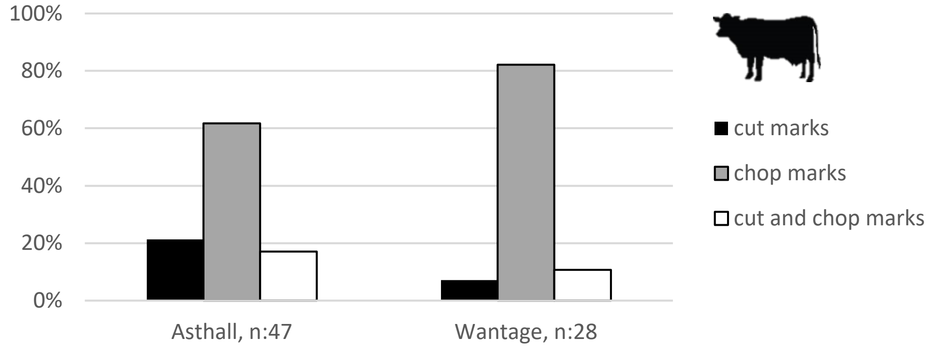


Fig. 6.3.16 Incidence of cut, chop, and cut and chop marks on cattle elements at Late Roman Asthall and Wantage.

Quantitative analyses of cattle butchery practices are further supported by the presence of specialised butchery products in the Late Roman assemblages, and by their scarcity or absence at Early Anglo-Saxon Benson and Oxford Science Park. Cattle scapulae with standardised, consistent butchery marks, thought to represent cured beef shoulders, have been found at both Asthall and Wantage; most of them present chop marks on the glenoid cavity and rim, scraping marks on the neck and borders, series of cut and scraping marks on the blade, and had the acromion chopped off. Such evidence, identified in other Late Roman assemblages from this study, is commonly found in the north-western provinces of the Roman Empire; the practice of curing beef shoulders probably originated from eastern Gaul and Germany. It was adopted as a way to supply the army with meat, and rapidly spread to civilian contexts (Schmid 1972; Lauwerier 1988; Dobney *et al*. 1996; Seetah 2006; Score *et al*. 2010; Johnstone and Albarella 2015). In addition to the evidence on scapulae, at the Late Roman sites some cattle long bones had been longitudinally split, or otherwise intensively chopped; these practices aimed at the extraction of marrow, a valuable and versatile product (Schmid 1972; van Mensch 1974; Maltby 2007; Johnstone and Albarella 2015). Similarly, some mandibles had been processed for removing the tongue, a practice which highlights once again the importance of full exploitation of cattle carcasses in Roman butchery in this part of the Empire.

6.3.6 Biometry

6.3.6.1 Cattle

Not enough data from individual skeletal elements were available to investigate changes in the size of cattle using absolute values. Biometrical analyses of postcranial bones had to rely on log ratio histograms, which allow plotting different measurements on the same scale and therefore increase the sample size (§ 5.6). Although it was not possible to assess differences in length measurements, width and depth, the data suggest cattle from the Early Anglo-Saxon assemblages were on average smaller, and about of the same size as those from contemporary West Stow and Gamlingay (Figs. 6.3.17 and 6.3.18). The distribution and mean of values from Late Roman Asthall recall those from other British Late Roman sites included in this study (§ 6.1.7.1 and 6.2.7.1). On the other hand, values from Late Roman Wantage are considerably higher; while such large animals are present in other contemporary assemblages, they usually represent the large end of value distributions. The almost exclusive presence of particularly large cattle is relatively rare in Roman Britain; it has been attested, for example, at the Late Roman farm at Great Holts Farm (Boreham, Essex), where large cattle are thought to have been imported from the Continent in order to improve the size of local populations (Albarella 1997). Statistical tests assessing the significance of differences between groups of width and depth values confirm the observations made above, including the difference between the Late Roman assemblages from Asthall and Wantage (Tab. 6.3.1).

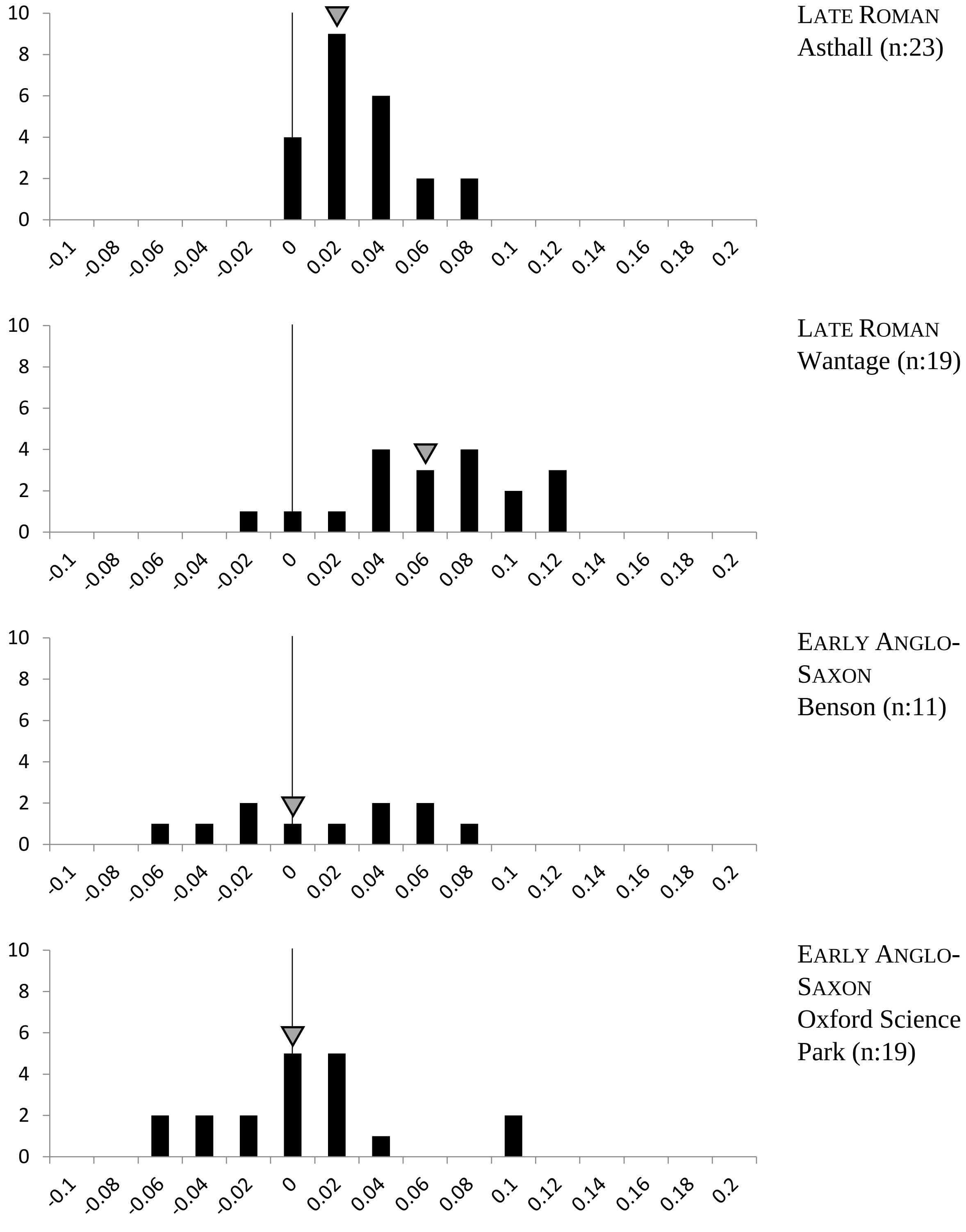


Fig. 6.3.17 Distribution of log ratio values of a selection of cattle bone widths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

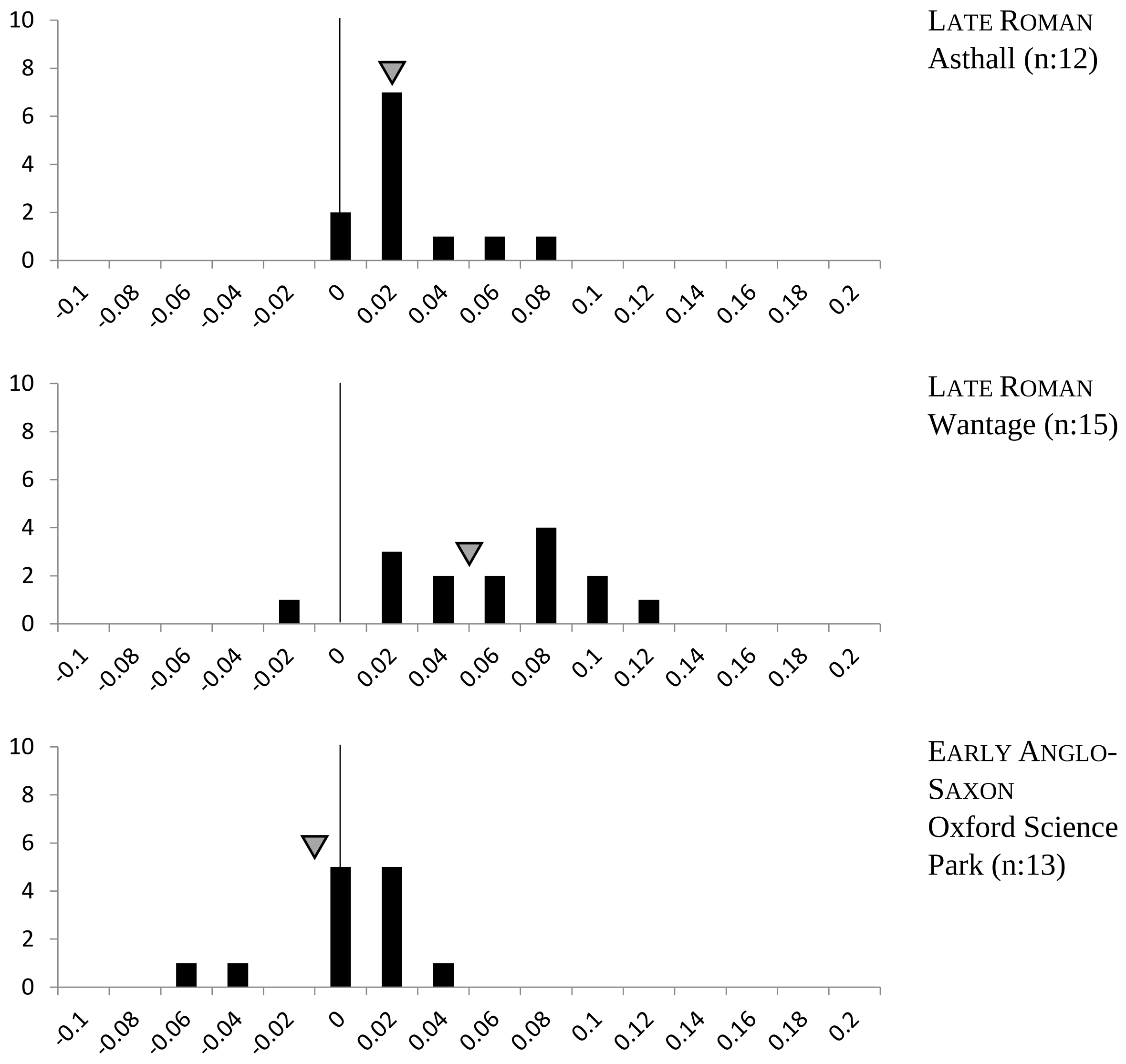


Fig. 6.3.18 Distribution of log ratio values of a selection of cattle bone depths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Oxford Science Park.

	A w	**W w**	**B w**	**OSP w**	**A d**	**W d**	**OSP d**
A w	-	< 0.01	0.17	0.02	-	-	-
W w	< 0.01	-	< 0.01	< 0.01	-	-	-
B w	0.17	< 0.01	-	0.60	-	-	-
OSP w	0.02	< 0.01	0.60	-	-	-	-
A d	-	-	-	-	-	0.02	0.02
W d	-	-	-	-	0.02	-	< 0.01
OSP d	-	-	-	-	0.02	< 0.01	-

Tab. 6.3.1 Results of the Student's t-tests for cattle bone measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. A: Asthall, W: Wantage, B: Benson, OSP: Oxford Science Park, w: widths, d: depths.

Differences seen in the distribution of values from postcranial bones can be observed, though in a less pronounced way, also in the analyses of tooth measurements (Figs. 6.3.19 and 6.3.20). While Late Roman values are on average larger, the distribution of measurements from Late Roman Asthall is similar to that from Early Anglo-Saxon Benson; at the same time, the gap in size between the two Late Roman sites is very much reduced, cattle teeth from Wantage being only slightly larger than those from Asthall. Such mitigation of differences in tooth analyses is likely to reflect the more conservative nature of tooth size, and does not invalidate observations made on the biometrical analyses of postcranial bones. Student's t-tests confirm these trends (Tab. 6.3.2).

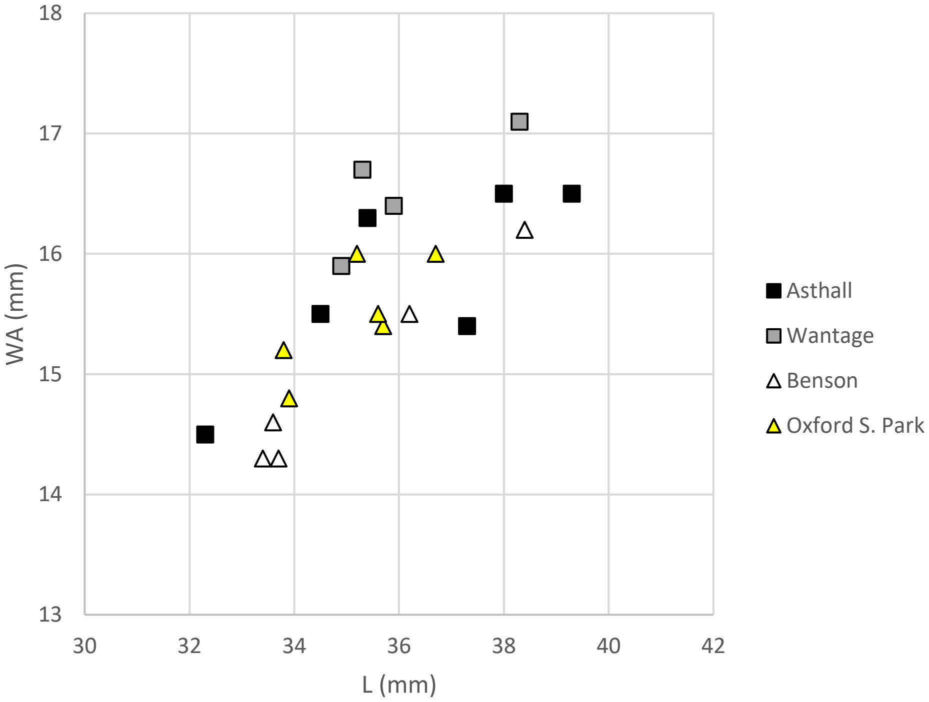


Fig. 6.3.19 Scatter plot of measurements from cattle M_3s (L *vs* WA) from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

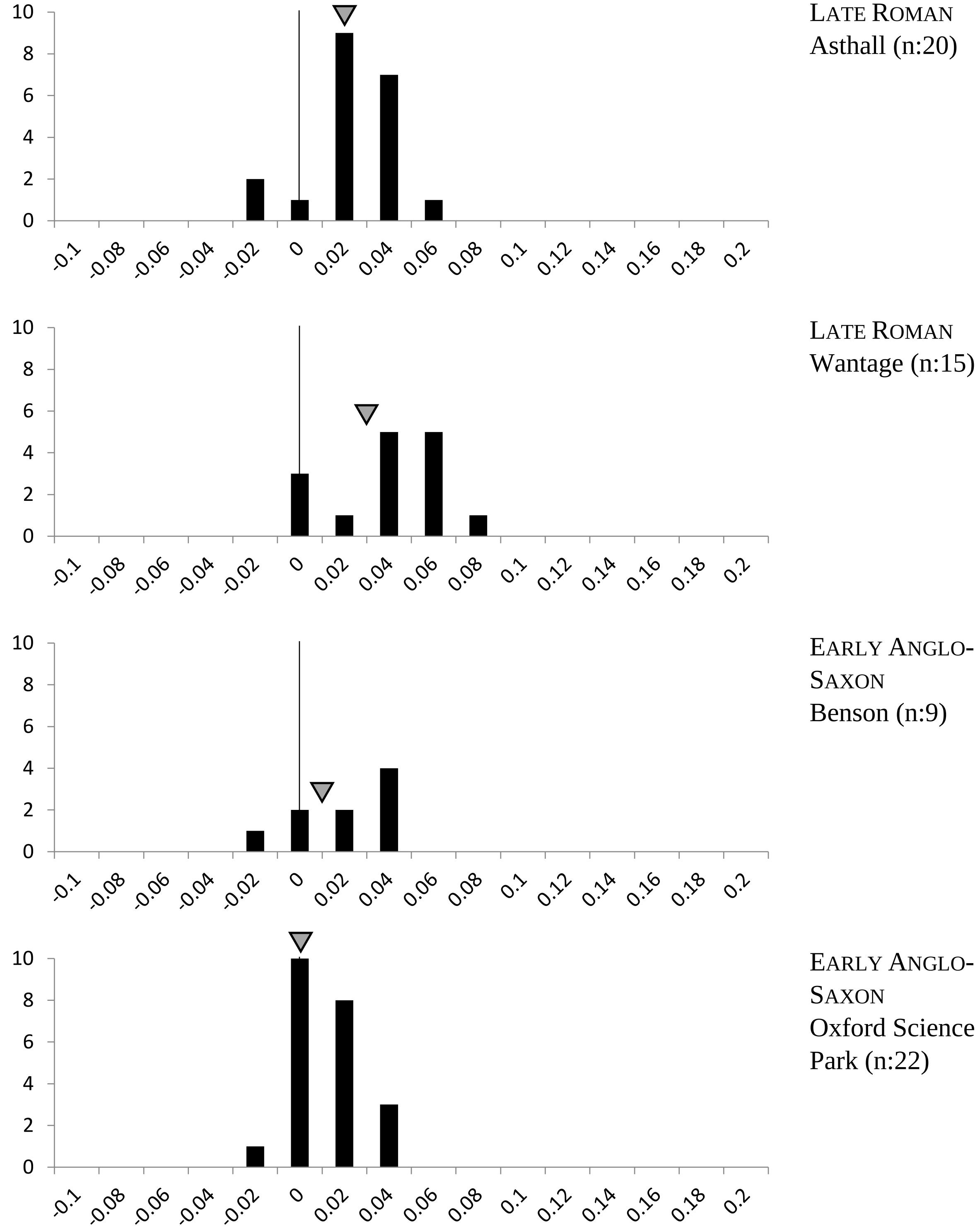


Fig. 6.3.20 Distribution of log ratio values of a selection of cattle tooth widths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

	A	W	B	OSP
A	-	0.05	0.50	0.03
W	0.05	-	0.04	< 0.01
B	0.50	0.04	-	0.32
OSP	0.03	< 0.01	0.32	-

Tab. 6.3.2 Results of the Student's t-tests for cattle tooth widths. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. A: Asthall, W: Wantage, B: Benson, OSP: Oxford Science Park.

6.3.6.2 Caprines

The biometrical analyses of caprine remains relied on log ratio histograms of bone and tooth measurements. In all the assemblages, caprines seem to have been smaller than those from the Late Roman and Early Anglo-Saxon sites from Suffolk (§ 6.1.7.2); on average, the size of postcranial bones parallels that of animals from Cambourne and Gamlingay (Cambridgeshire, § 6.2.7.2) (Figs. 6.3.21 and 6.3.22). Similarly to what has been seen for cattle, Wantage represents an exception; although most caprines from this site are small, the analysis of width measurements reveals the presence of a few large animals, which may represent rams or imported larger sheep. Although caprines from Early Anglo-Saxon Oxford Science Park are slightly smaller, the small size of samples and the variability of results do not allow arguing for a genuine decrease in the overall size of sheep. Results from Student's t-tests support the observations made above (Tab. 6.3.3).

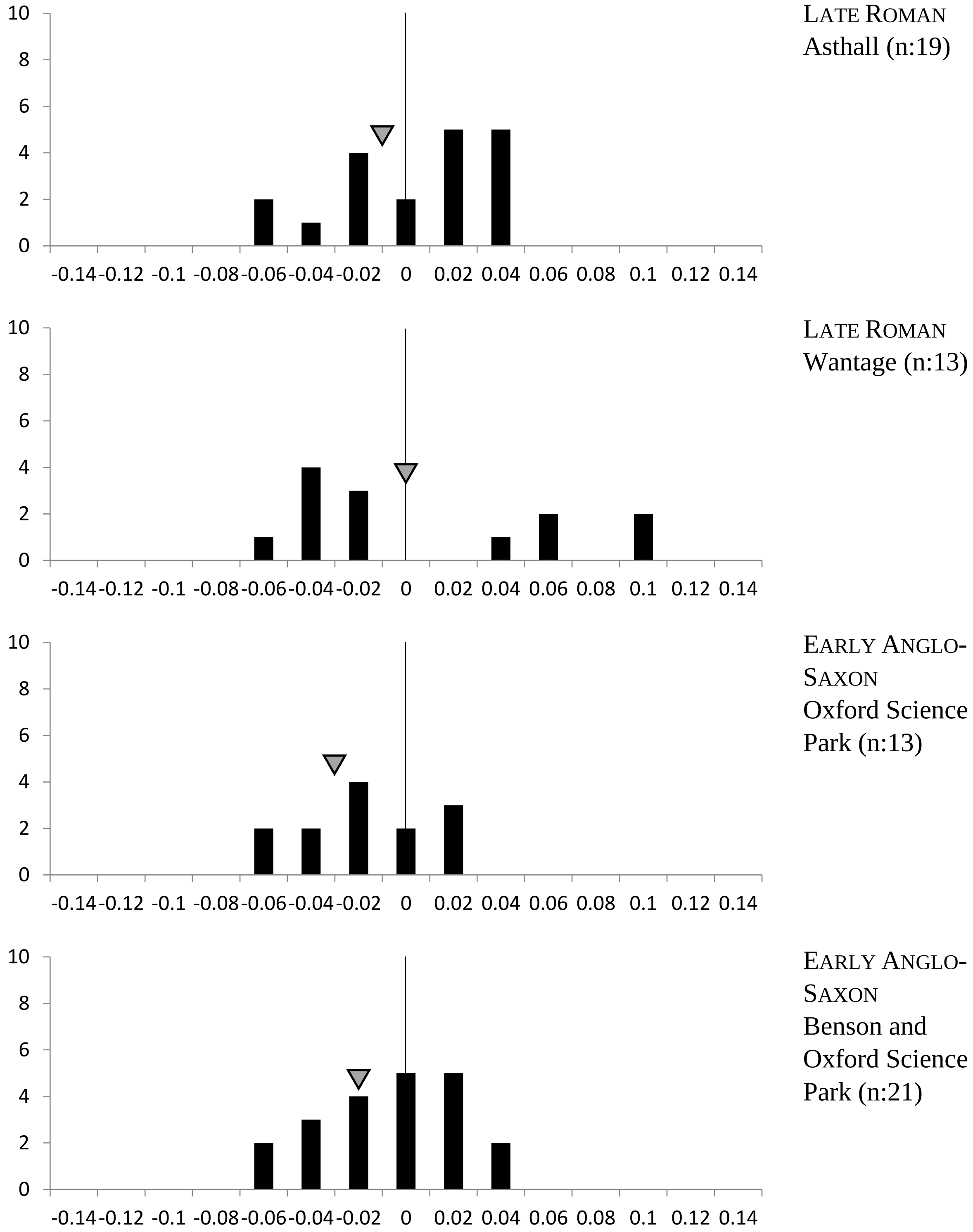
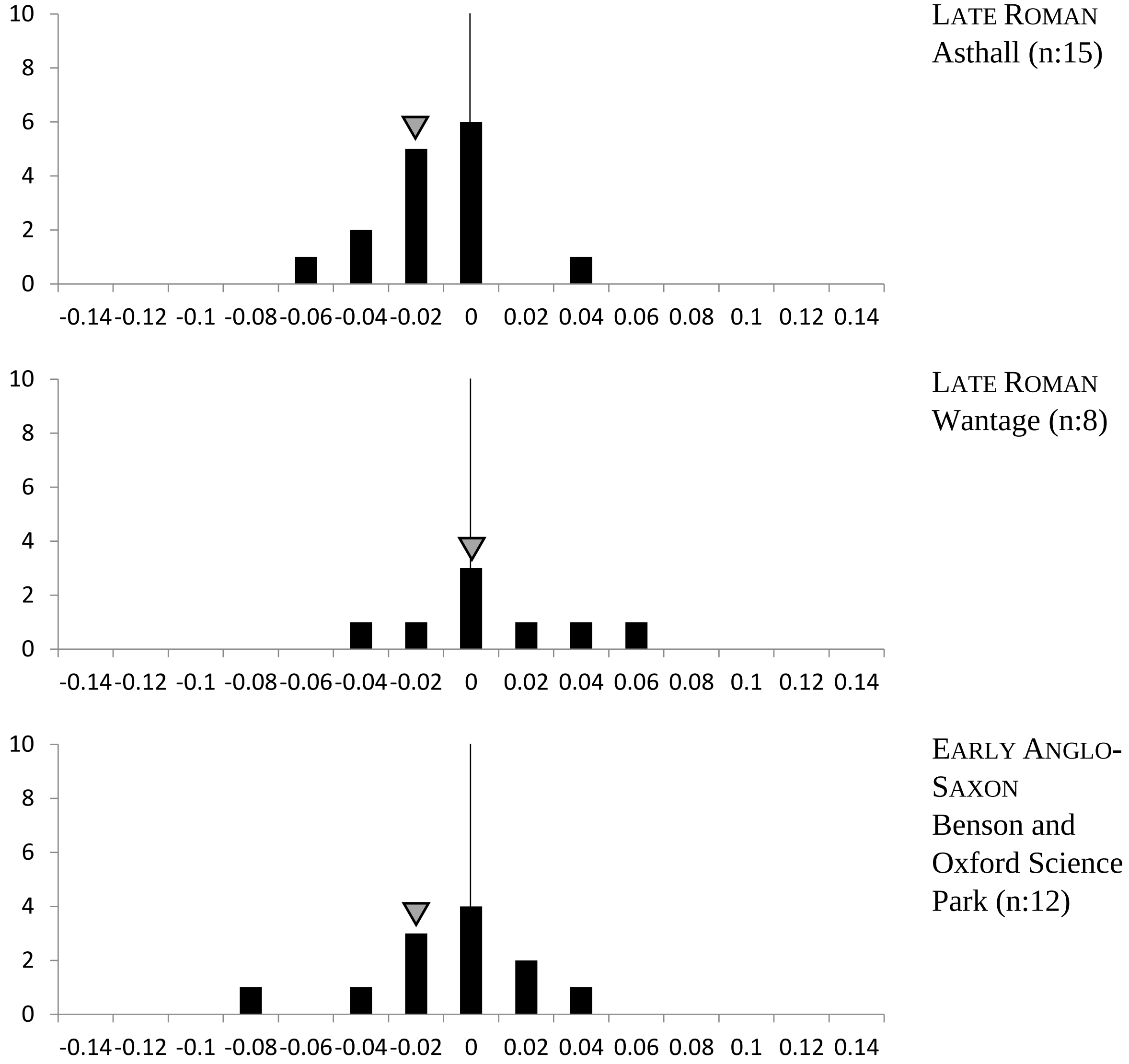


Fig. 6.3.21 Distribution of log ratio values of a selection of caprine bone widths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.



LATE ROMAN
Asthall (n:15)

LATE ROMAN
Wantage (n:8)

EARLY ANGLO-SAXON
Benson and Oxford Science Park (n:12)

Fig. 6.3.22 Distribution of log ratio values of a selection of caprine bone depths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

	A w	**W w**	**OSP w**	**B+O w**	**A d**	**W d**	**B+O d**
A w	-	0.85	0.08	0.30	-	-	-
W w	0.85	-	0.20	0.38	-	-	-
OSP w	0.08	0.20	-	-	-	-	-
B+O w	0.30	0.38	-	-	-	-	-
A d	-	-	-	-	-	0.10	0.78
W d	-	-	-	-	0.10	-	0.23
B+O d	-	-	-	-	0.78	0.23	-

Tab. 6.3.3 Results of the Student's t-tests for caprine bone measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. A: Asthall, W: Wantage, OSP: Oxford Science Park, B+O: Benson and Oxford Science Park, w: widths, d: depths.

Tooth measurements do not offer a clearer view on changes in caprine size from Late Roman to Early Anglo-Saxon times (Figs. 6.3.23 and 6.3.24). While both scatter plot and histograms indicate the absence of large values at the Early Anglo-Saxon sites, the average size and distributions are similar in all assemblages, suggesting no or insignificant differences between the groups of values. The results of Student’s t-tests broadly support this view (Tab. 6.3.4).

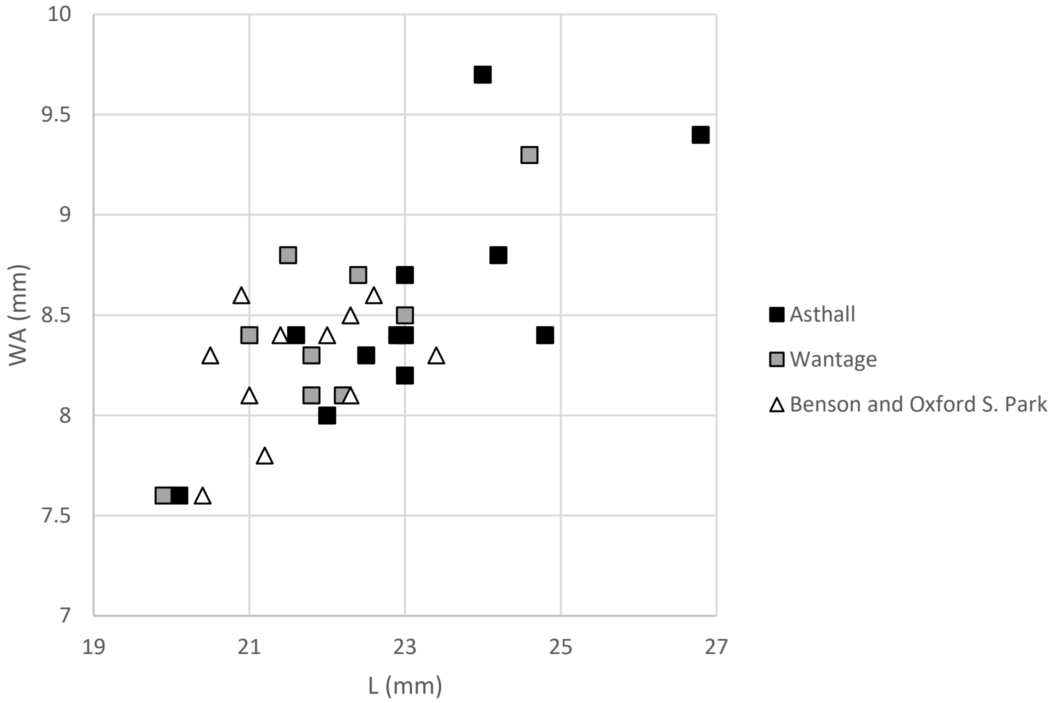
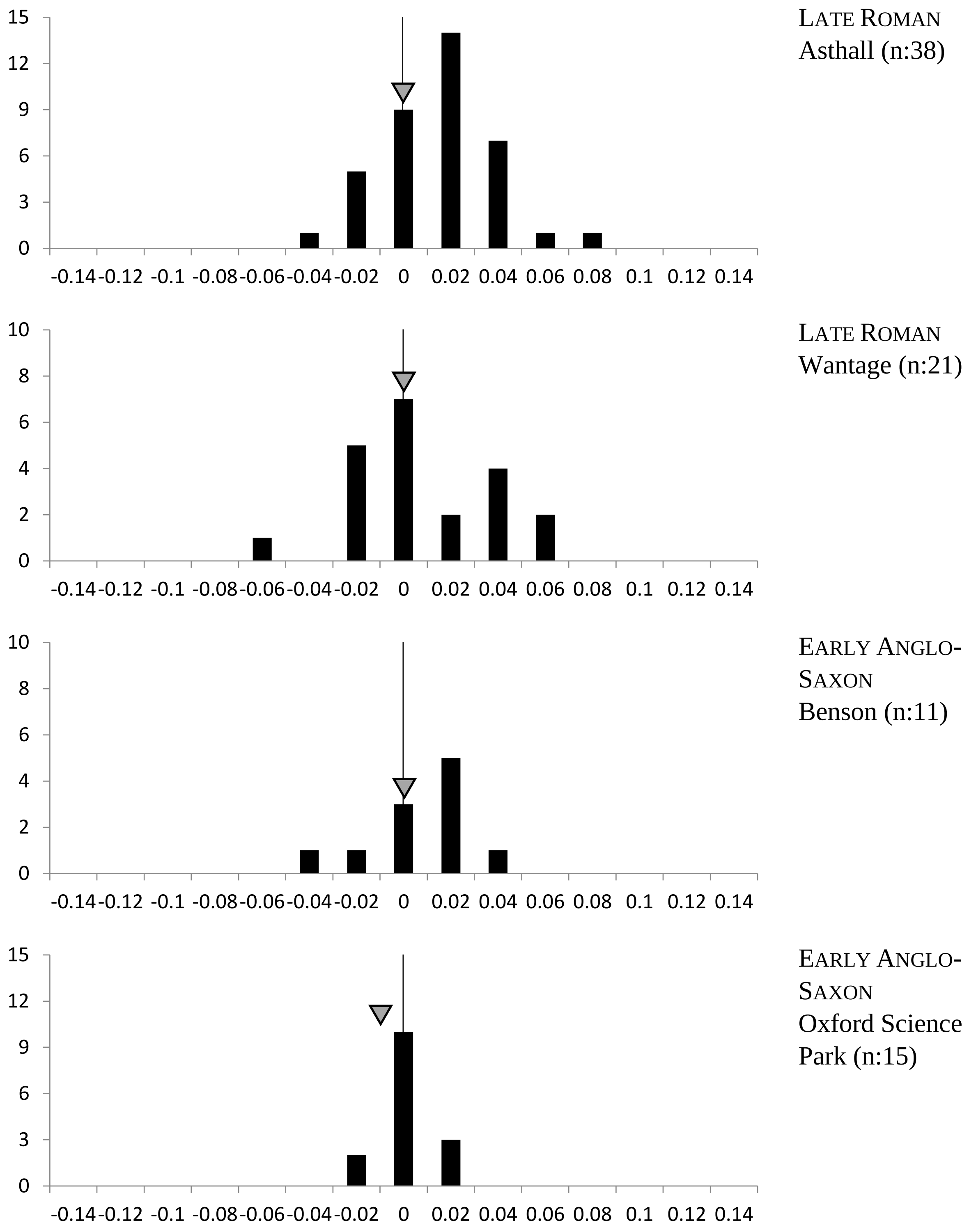


Fig. 6.3.23 Scatter plot of measurements from caprine M_3s (L *vs* WA) from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.



LATE ROMAN
Asthall (n:38)

LATE ROMAN
Wantage (n:21)

EARLY ANGLO-SAXON
Benson (n:11)

EARLY ANGLO-SAXON
Oxford Science Park (n:15)

Fig. 6.3.24 Distribution of log ratio values of a selection of caprine tooth widths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

	A	**W**	**B**	**OSP**
A	-	0.50	0.62	0.07
W	0.50	-	0.95	0.35
B	0.62	0.95	-	0.26
OSP	0.07	0.35	0.26	-

Tab. 6.3.4 Results of the Student's t-tests for caprine tooth widths. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. A: Asthall, W: Wantage, B: Benson, OSP: Oxford Science Park.

6.3.6.3 Suids

The biometrical analysis of suid remains was limited to teeth, due to the dearth of fused postcranial bones. Pigs from Early Anglo-Saxon Benson and Oxford Science Park seem to have been slightly smaller than those from the Late Roman assemblages; two large outliers, one from Wantage and another from Oxford Science Park, could belong to wild boar (Fig. 6.3.25). The Student's t-tests indicate no statistically significant differences between the groups of Late Roman and Early Anglo-Saxon values (Tab. 6.3.5). However, the small size of the samples invites caution in the interpretation of results, which will be reviewed alongside those from other assemblages in § 6.5.

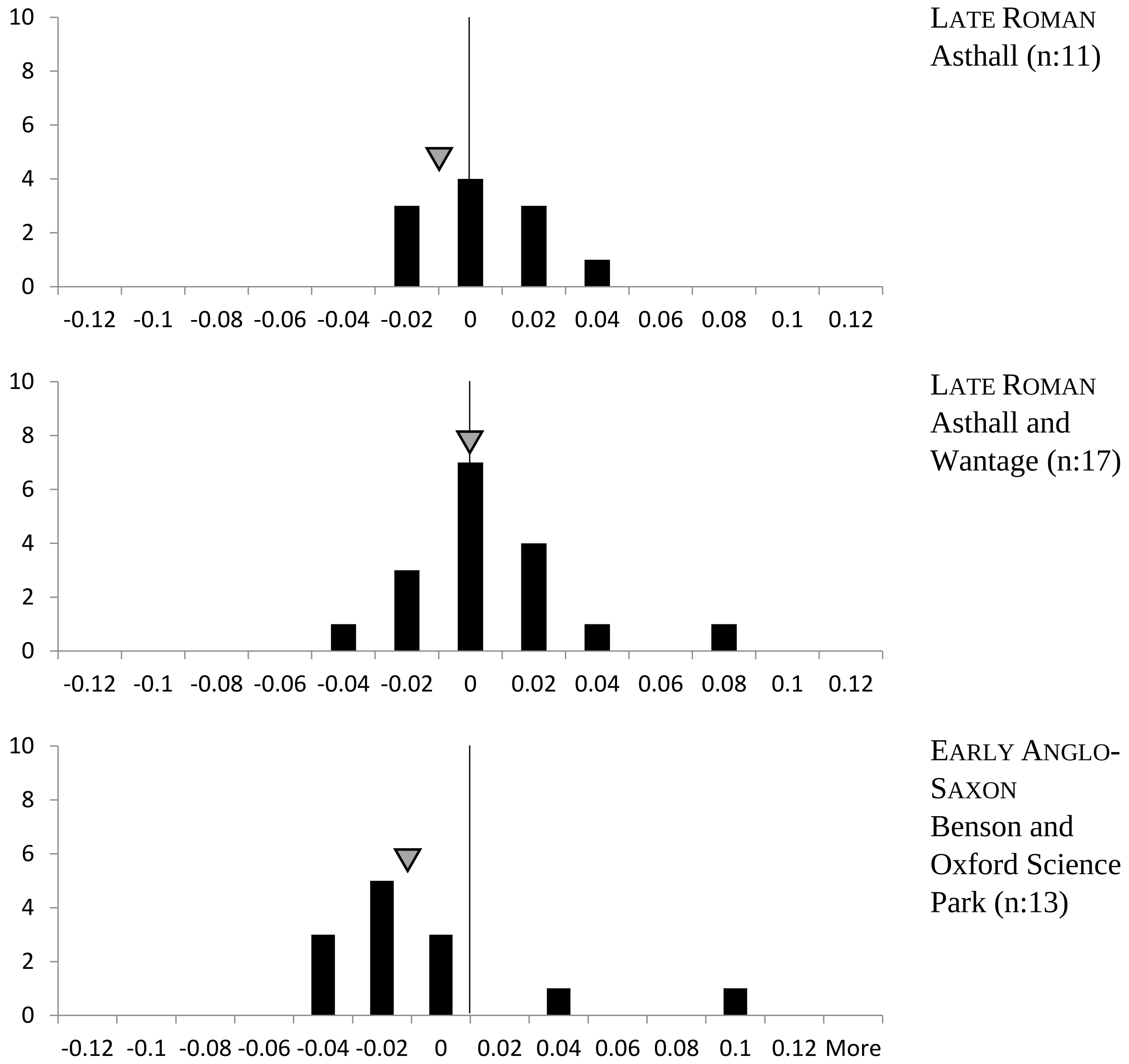


Fig. 6.3.25 Distribution of log ratio values of a selection of suid tooth widths from Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

	A	A+W	B+O
A	-	-	0.47
A+W	-	-	0.30
B+O	0.47	0.30	-

Tab. 6.3.5 Results of the Student's t-tests for suid tooth widths. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. A: Asthall, A+W: Asthall and Wantage, B+O: Benson and Oxford Science Park.

6.3.7 Pathology and non-metric traits

Similarly to the assemblages from Suffolk and Cambridgeshire, most of the pathological evidence on cattle bone remains is represented by conditions on lower limb elements; these are probably related to the exploitation of this animal for traction. In Late Roman Wantage and Early Anglo-Saxon Oxford Science Park, the proximal articulation of first phalanges was often affected by exostosis to various degrees; similar conditions were also recorded on other articulations, such as on and around glenoid cavities, at Wantage and Benson, while at the latter site a cattle astragalus was probably affected by osteochondrosis dissecans. Only two distal metapodials from Wantage were visibly splayed; however, the overall small number of metapodials does not allow a reliable estimation of the proportion of animals affected by such conditions (Tabs. 6.3.6 and 6.3.7). The biometrical analyses of distal metapodials also point to a low incidence of splayed specimens; the only addition may be a Late Roman metatarsal plotting in between the visually splayed specimen and the group of 'healthy' bones (Figs. 6.3.26 and 6.3.27).

	non-visibly splayed	splayed	total
LATE ROMAN	6	1	7
EARLY ANGLO-SAXON	4	0	4

Tab. 6.3.6 Presence and incidence of splayed metacarpals at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

	non-visibly splayed	splayed	total
LATE ROMAN	10	1	11
EARLY ANGLO-SAXON	6	0	6

Tab. 6.3.7 Presence and incidence of splayed metatarsals at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park.

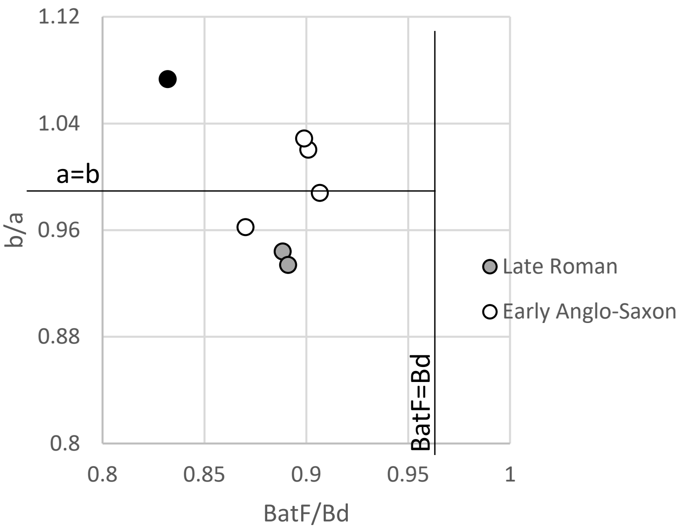


Fig. 6.3.26 Scatter plot of shape indices from cattle distal metacarpals at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park. Full black circle: morphologically identified as splayed (Late Roman specimen). The black lines represent the values at which BatF is the same as Bd, and perfect symmetry occurs between the widths of the two condyles (a=b).

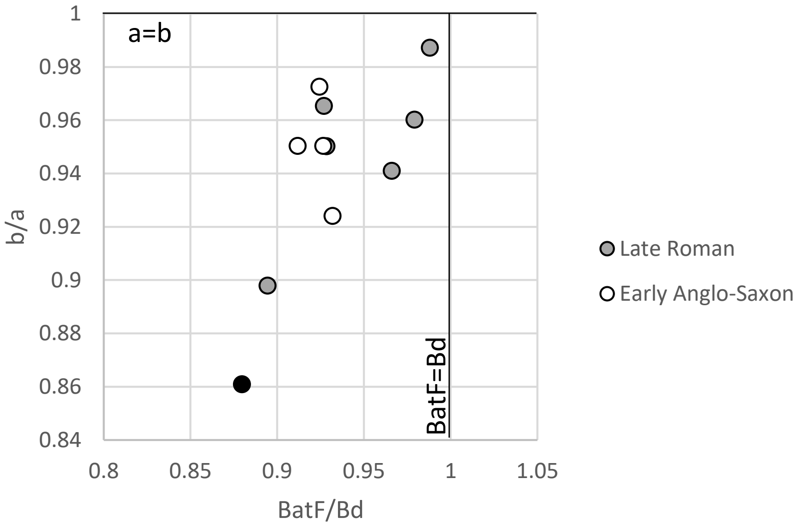


Fig. 6.3.27 Scatter plot of shape indices from cattle distal metatarsals at Late Roman Asthall and Wantage, and Early Anglo-Saxon Benson and Oxford Science Park. Full black circle: morphologically identified as splayed (Late Roman specimen). The black lines represent the values at which BatF is the same as Bd, and perfect symmetry occurs between the widths of the two condyles (a=b).

Pathological conditions were very rare on caprine and suid remains. Some sheep and pig mandibles from Asthall and Benson presented evidence of overcrowding and/or malocclusion; hypoplasia on suid teeth was only recorded on a few mandibles from Benson.

Unlike other assemblages included in this study, no cattle lower third molars had their third hypoconulid absent or reduced. This may be the result of the small size of M_3 samples from each site, coupled with the usual low incidence of this non-metric trait, or of a genuine absence of this genetic trait.

6.3.8 Summary

Animal husbandry practices at the Late Roman and Early Anglo-Saxon sites analysed for the Oxfordshire region present several similarities with contemporary case-studies from Suffolk and Cambridgeshire, as well as some differences.

The usual prevalence of cattle at the Late Roman sites is maintained in the Early Anglo-Saxon assemblages, possibly underlining the higher degree of inter-site variability in the importance of the three main domestic taxa in the post-Roman period. Despite this apparent continuity, the use and role of cattle probably changed in Early Anglo-Saxon times: like in other study-regions, most animals survived into adulthood at the Late Roman sites, being exploited in the fields for years before being culled for their meat. The kill-off patterns for Benson and Oxford Science Park, on the other hand, suggest a more generalised exploitation of cattle. Cattle butchery practices at the Late Roman sites recall those from several other contemporary sites, with a higher incidence of butchered elements, a preference for chop marks, and the presence of specialised beef products, all suggesting the standardised, large-scale butchery and redistribution of cattle carcasses. Caprines (mainly sheep) were kept for a variety of purposes in both periods; also in this case, however, there seems to have been a slight shift towards a preference for mutton production in Early Anglo-Saxon times.

Similarly to the other study-regions, cattle was smaller in the post-Roman assemblages, suggesting a decrease in the average size of this animal. At Late Roman Wantage, cattle was particularly large, possibly indicating the presence of imported stock used for the improvement of local animals. Variability and smaller sample sizes prevent a proper interpretation of biometrical analyses for suids; in the case of caprines, however, there seems to have been no or little decrease in average size.

6.4 Lower Rhineland

The assemblages analysed for the Lower Rhineland were collected from the sites of De Geer, Oegstgeest, and Valkenburg, located on the 'western' part of the region (formerly part of the Roman Empire), and Heeten and Wijnaldum, located on the 'eastern' part of the region (outside the Roman Empire). The assemblages from De Geer and Heeten are dated to the Late Roman period, and those from Oegstgeest and Valkenburg to the Merovingian period, while Wijnaldum is a multi-period site (§ 4.5). The analyses of material from the Lower Rhineland are limited to the reconstructions of species frequencies (NISP), kill-off patterns, butchery practices, and biometry, and aim to provide comparative evidence for the contextualisation and interpretation of the results obtained from British sites.

6.4.1 Species frequency

Cattle is the most represented species in all 'western' assemblages, regardless of their chronology; cattle dominate the assemblage from Heeten as well, while caprines prevail in all phases at the Frisian site of Wijnaldum (Fig. 6.4.1). The prevalence of cattle at Late Roman De Geer and Merovingian Oegstgeest and Valkenburg reflects a long tradition of cattle rearing in the area. The high incidence of pig also reflects a long-standing cultural preference for this animal in this part of north-western Europe; the preference of pig over caprines, which are poorly represented at these sites, responds as well to the practicalities of environmental conditions (§ 3.2). The similar frequency of species reconstructed for 3rd-4th century Heeten ('eastern' region) is probably the result of the site's proximity to the area of the (former) *limes*; local husbandry traditions may have been more similar to those from the western Lower Rhineland, and may have been influenced by Roman traditions. The abundance of caprines at Wijnaldum reflects a local preference for this animal relative to pig, which distinguishes Frisia from the western region (§ 3.2). Morphological observations and biometrical analyses of caprine remains suggest that most of them, if not all, belonged to sheep (Figs. 6.3.2 and 6.3.3). Similarly, tooth and postcranial bone biometrical analyses suggest that most bovine and suid remains represent domestic cattle and pigs respectively (§ 6.4.4.1 and 6.4.4.2).

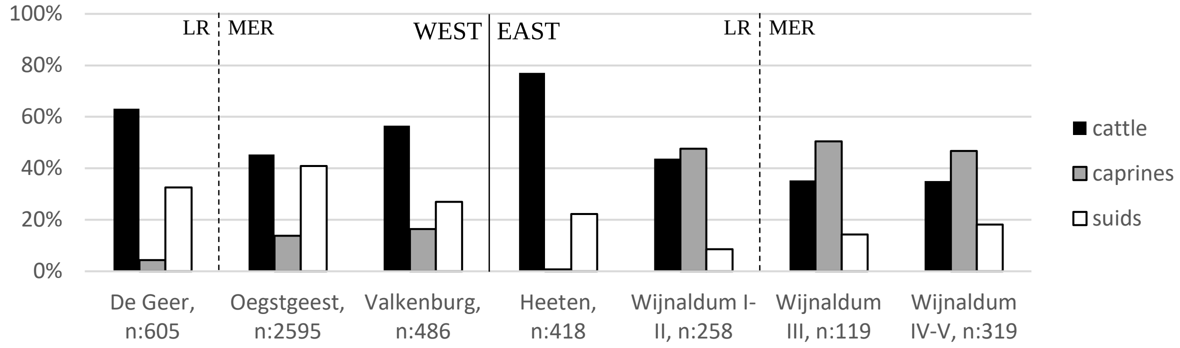


Fig. 6.4.1 NISP species frequencies for cattle, caprines, and suids at Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, 3rd-4th c. Heeten, and Wijnaldum (I-II: late 2nd-mid-4th c., III: early 5th-mid-6th c., IV-V: mid-6th-mid-8th c.). LR: Late Roman, MER: Merovingian.

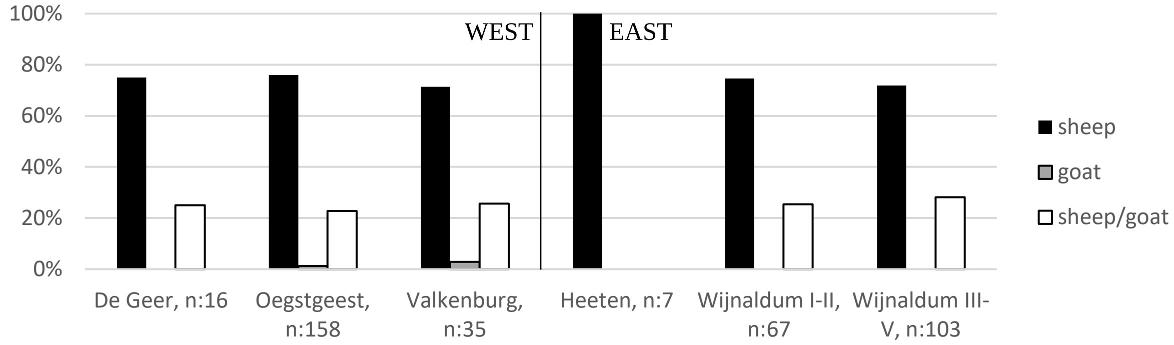


Fig. 6.4.2 Proportions of caprine remains recorded as sheep, goat, and sheep/goat, calculated using the set of selected elements on which the sheep-goat distinction is attempted.

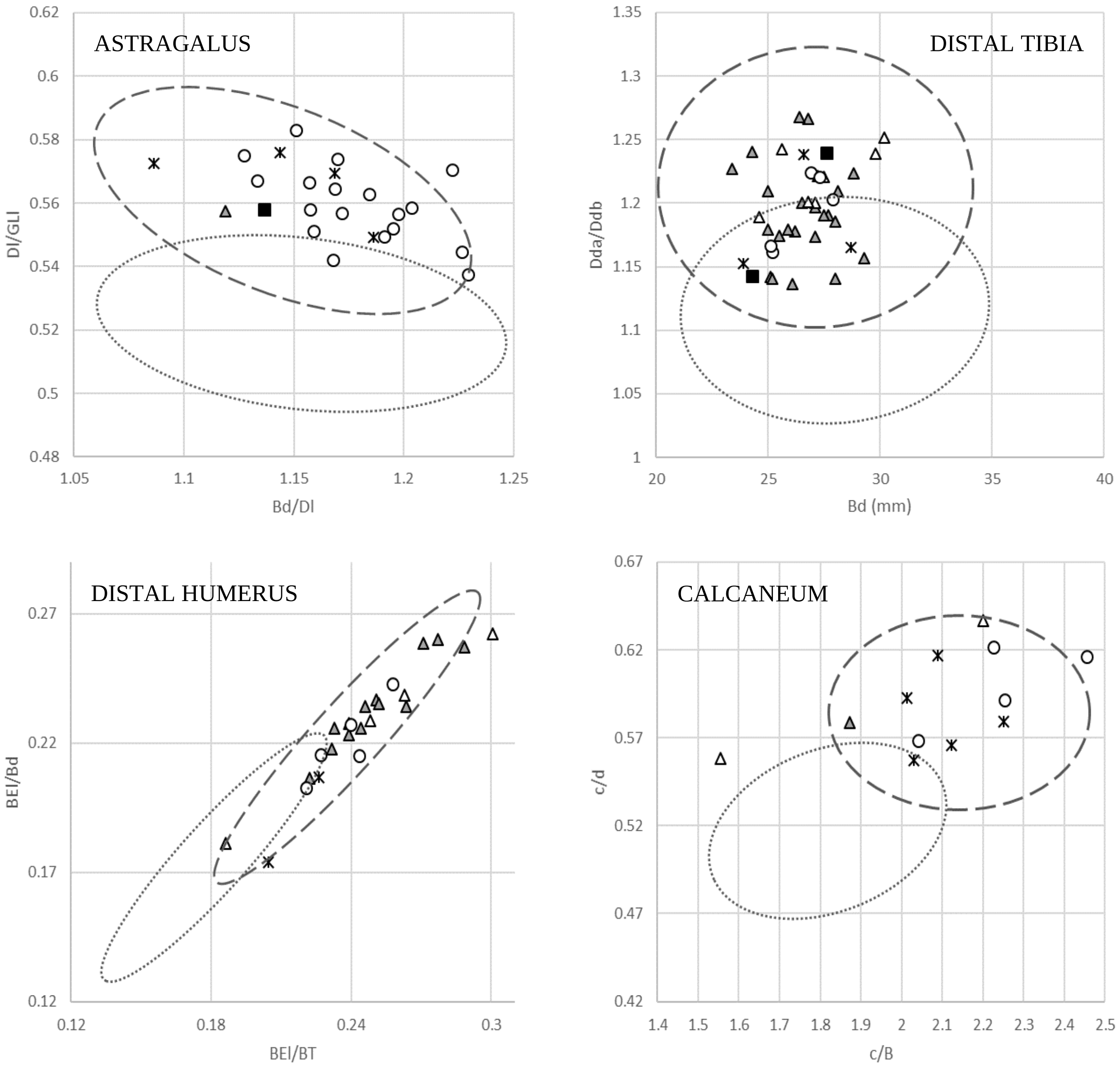
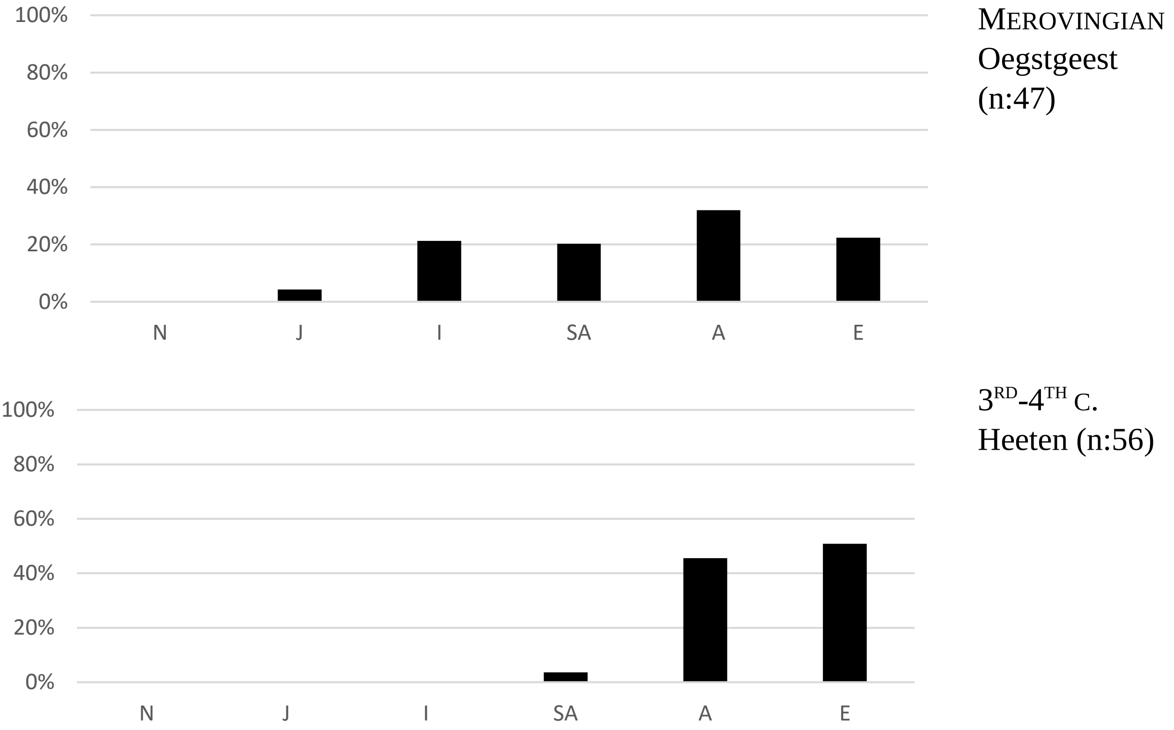


Fig. 6.4.3 Biometrical shape analyses of caprine bones against the approximate distributions of sheep (dashed line) and goat (dotted line) modern values from Salvagno and Albarella (2017). Black squares: Late Roman De Geer; grey triangles: Merovingian Oegstgeest; white triangles: Merovingian Valkenburg; black asterisks: late 2nd-mid-4th c. Wijnaldum; white circles: early 5th-mid-8th c. Wijnaldum. All scatter plots show a compact cluster of values, probably belonging to sheep; two humeri and one calcaneum plot separately from the main groups and are more likely to derive from goats.

6.4.2 Ageing

Merovingian Oegstgeest and 3rd-4th century Heeten provided enough cattle mandibular wear stages to allow the reconstruction of possible kill-off patterns (Fig. 6.4.4). Cattle exploitation does not seem to have focused on specific products at Oegstgeest: over 40% of the animals were culled for meat as immature and subadult individuals, while the rest survived into adulthood and elderly ages, probably being employed in agricultural works. The difference with Heeten is clear: here, almost all animals survived into adulthood, and over half of them were culled or died as elderly individuals. It is reasonable to assume that cattle was intensively exploited as traction force in the surrounding countryside, and then brought to the settlement for butchery at the end of their life. The reconstruction and comparison of cattle culling profiles from these and other sites, however, had to largely rely on the analyses of long bone epiphyseal fusion, due to the small size of samples from the other sites (Fig 6.4.5). The predominance of adult and elderly cattle at Heeten is confirmed: over 80% of the animals survived into adulthood. Similarly, at Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg, over 60% of the animals survived into adulthood, suggesting a major focus on the exploitation of cattle in agricultural works. The inconsistency between dental and postcranial bone ageing analyses at Oegstgeest might be a result of differential preservation, whereby the more fragile bones of immature individuals survived in smaller numbers. The ‘Late Roman’ and Merovingian phases at the Frisian site of Wijnaldum show a different pattern, with more animals culled as immature and subadult individuals, suggesting a more generalised use of cattle.


MEROVINGIAN Oegstgeest (n:47)

3RD-4TH C. Heeten (n:56)

Fig. 6.4.4 Distribution of cattle mandibular wear stages in the age groups devised by O’Connor (1988) at Merovingian Oegstgeest, and 3rd-4th c. Heeten. N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

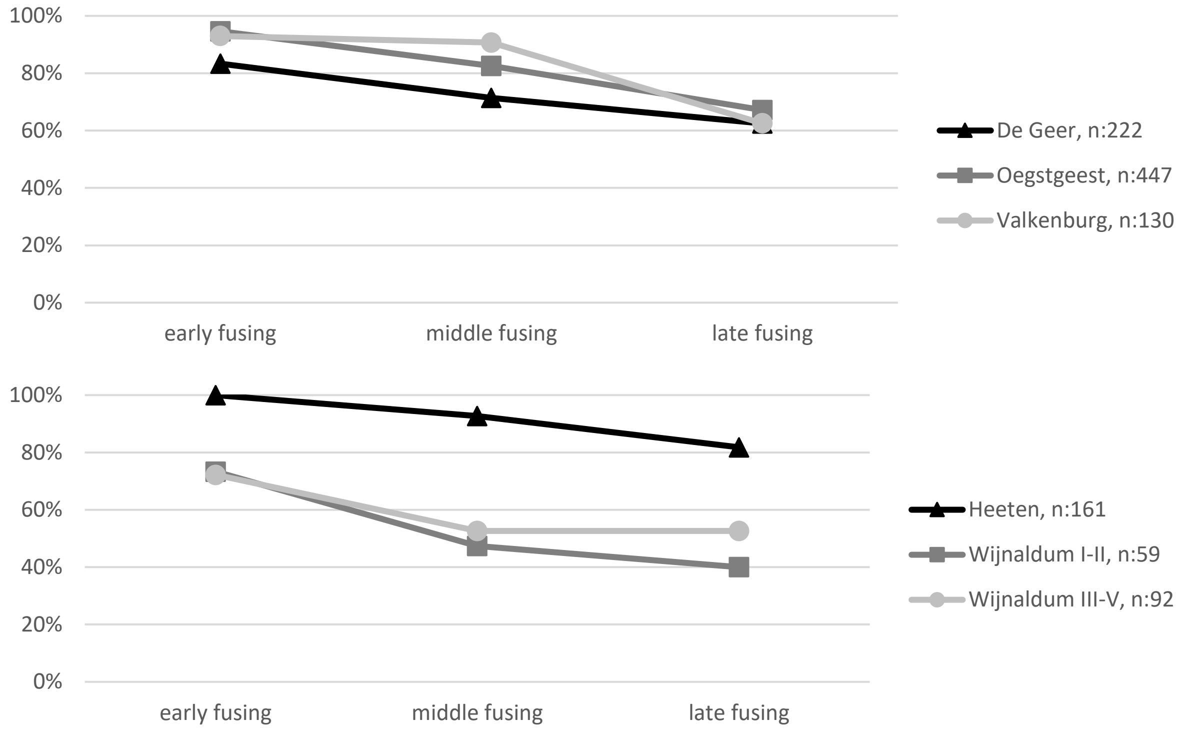


Fig. 6.4.5 Incidence of cattle fused elements in the three fusing stages proposed by Silver (1969) at Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, 3rd-4th c. Heeten, and Wijnaldum (I-II: late 2nd-mid-4th c., III-V: early 5th-mid-8th c.).

Ageing data for caprines were very limited, due to the dearth of this taxon in most sites. Mandibular wear stages at Merovingian Oegstgeest (western region) indicate a diversified exploitation of sheep products (mutton, wool, and possibly milk) (Fig. 6.4.6). Postcranial bone epiphyseal fusion analyses support this view, possibly with an underrepresentation of immature animals due to the preferential destruction of their more fragile bones in the archaeological record; similarly to cattle, both phases from Frisian Wijnaldum show again a much higher culling of juvenile and subadult individuals (only 20-30% of caprines survive into adulthood), indicating a stronger focus on meat production (Fig. 6.4.7).

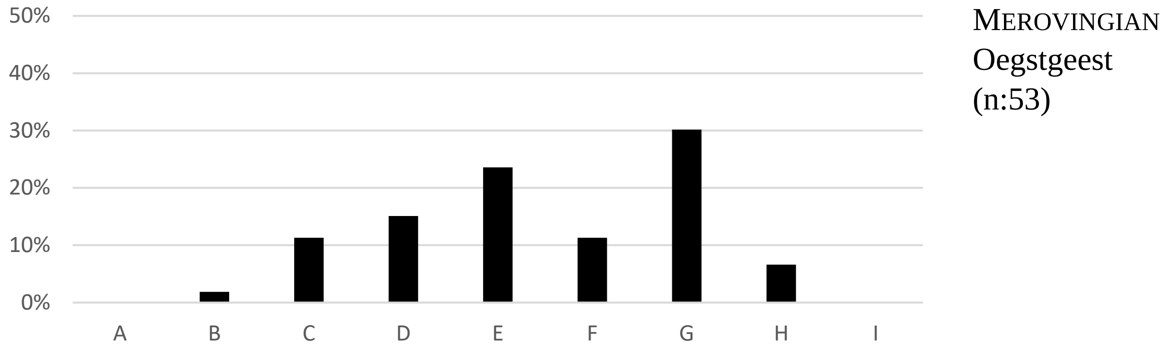


Fig. 6.4.6 Distribution of caprine mandibular wear stages in the age groups devised by Payne (1973) at Merovingian Oegstgeest.

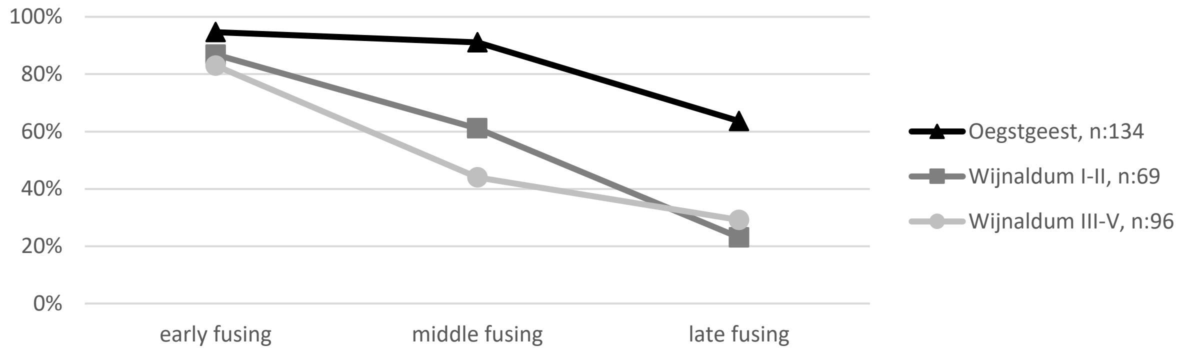


Fig. 6.4.7 Incidence of caprine fused elements in the three fusing stages proposed by Silver (1969) at Merovingian Oegstgeest, and Wijnaldum (I-II: late 2nd-mid-4th c., III-V: early 5th-mid-8th c.).

Suid mandibular wear stages from the western sites consistently indicate that pigs were mainly slaughtered as adult individuals (Fig. 6.4.8). Epiphyseal fusion analyses, however, suggest that only 20-30% of the animals survived beyond the late fusing stage (36-48 months) (Fig. 6.4.9); as this age broadly corresponds to the ‘Adult’ stage in the O’Connor (1988) system, the results from the two ageing methods would only be compatible if most adult pigs were slaughtered at the beginning of the late fusing stage, when late fusing elements would have still been unfused or fusing. As pigs are usually slaughtered as soon as they reach their optimum weight, the prevalence of adults rather than subadult individuals indicates the presence of unimproved pig populations, where pigs required more time to complete their growth. Long bone ageing data from Heeten and Merovingian Wijnaldum provide similar results, perhaps with a greater preference for juvenile pigs at the former site (Fig. 6.4.9). The small size of some of the samples analysed, however, invites caution in the interpretation of results.

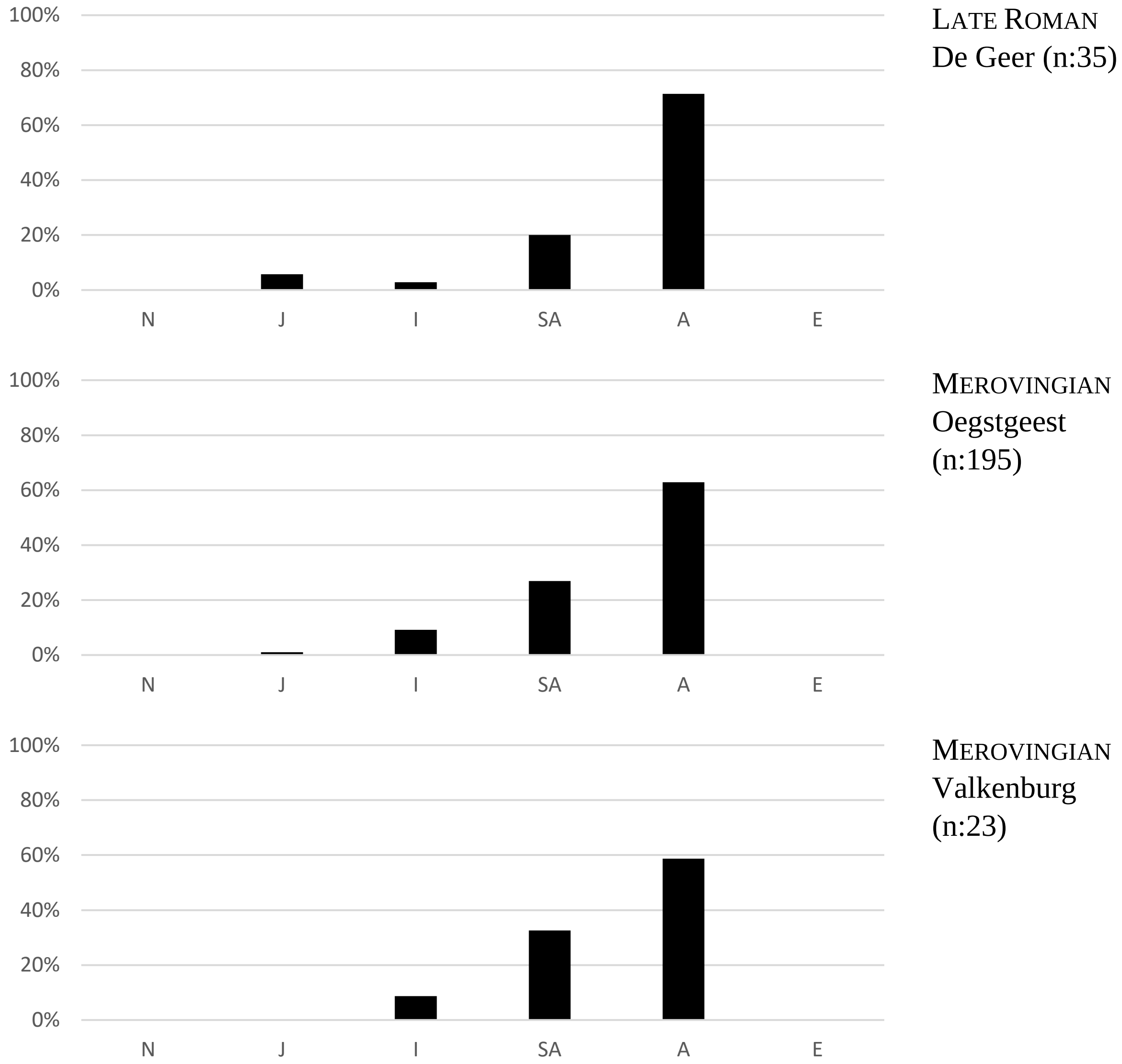


Fig. 6.4.8 Distribution of suid mandibular and maxillary wear stages in the age groups devised by O'Connor (1988) at Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg. N: neonatal, J: juvenile, I: immature, SA: subadult, A: adult, E: elderly.

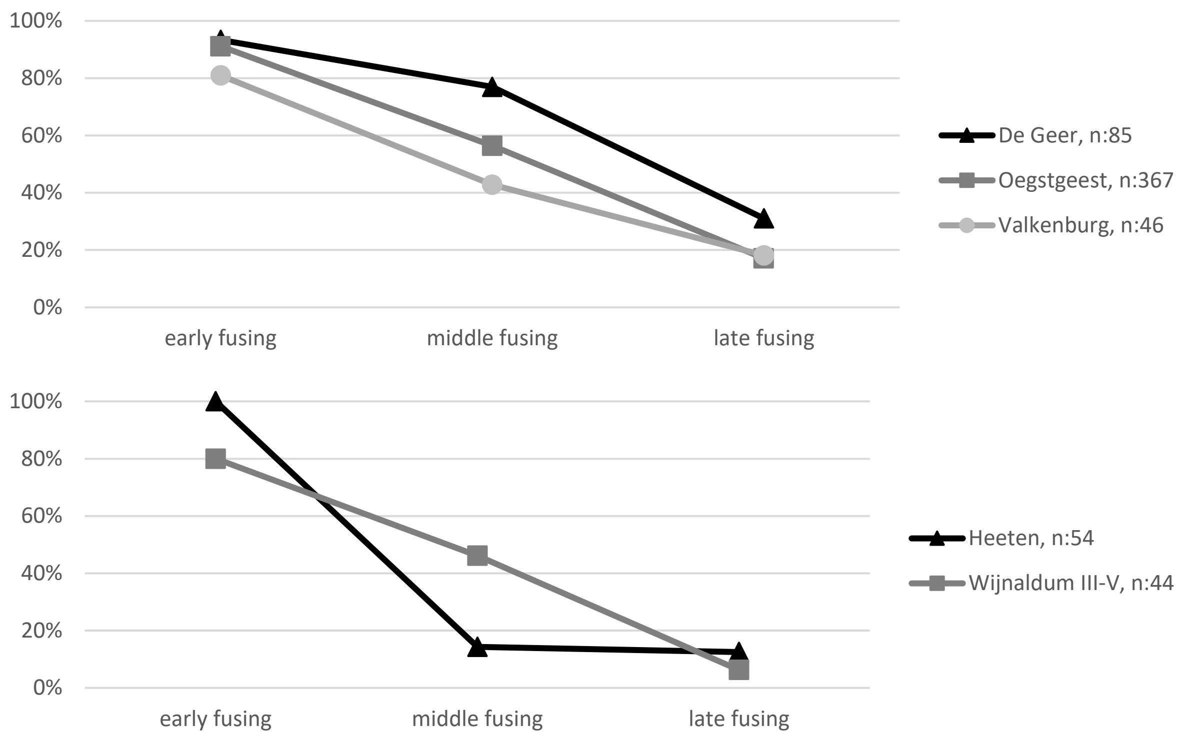


Fig. 6.4.9 Incidence of suid fused elements in the three fusing stages proposed by Silver (1969) at Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, 3rd-4th c. Heeten, and Wijnaldum (III-V: early 5th-mid-8th c.).

6.4.3 Butchery

The frequencies of cattle, caprine, and suid butchered elements in all the assemblages here considered are generally low, and do not highlight any discernible trends (Fig. 6.4.10). The incidence of butchered cattle elements is higher at 'Late Roman' Wijnaldum (eastern region), and slightly higher at Merovingian Oegstgeest (western region). The large sample size of this latter assemblage allowed investigating the distribution of cut and chop marks for the three main domesticates (Fig. 6.4.11): chop marks prevail clearly, possibly as a result of the need to quickly process large amounts of meat in this large rural settlement, or more simply as a reflection of local butchery traditions and technology.

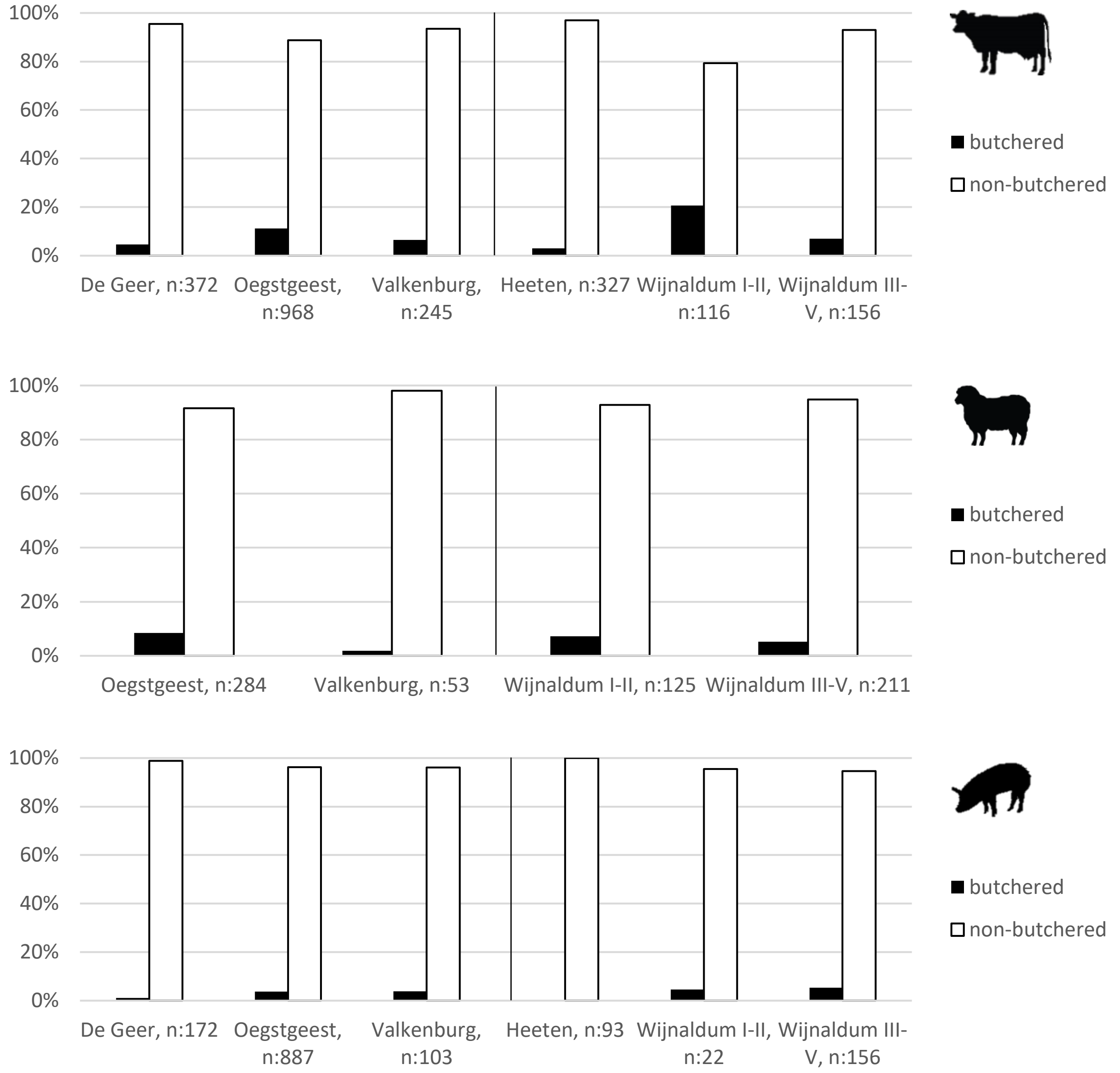


Fig. 6.4.10 Incidence of butchered elements for cattle, caprines, and suids at Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, 3rd-4th c. Heeten, and Wijnaldum (I-II: late 2nd-mid-4th c., III: early 5th-mid-6th c., IV-V: mid-6th-mid-8th c.).

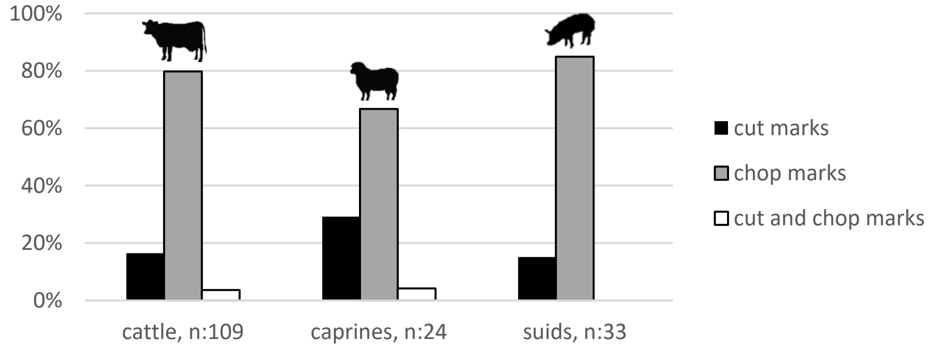


Fig. 6.4.11 Incidence of cut, chop, and cut and chop marks on cattle, caprine, and suid elements at Merovingian Oegstgeest.

Evidence for specialised butchery practices is almost absent at Late Roman De Geer, with only one cattle scapula presenting longitudinal scraping marks on the ventral side of the blade. Intensively butchered specimens and remains of specific products are instead very abundant in the western Merovingian assemblages from Oegstgeest and Valkenburg. Cattle scapulae from the former site often had their coracoid process chopped off, the glenoid itself intensively chopped, scraping marks along the borders and chop marks on the blade below the neck; metapodials and other long bones from both Oegstgeest and Valkenburg had been longitudinally split or otherwise intensively chopped. All these features are very often recorded on material from Roman British sites (§ 3.1, e.g. § *6.1.6* and *6.3.5*), as well as in other Roman assemblages from the north-western provinces of the Empire, and are thought to represent the remains of cured beef shoulders and the by-products of marrow extraction respectively (Schmid 1972; van Mensch 1974; Lauwerier 1988; Dobney *et al*. 1996; Seetah 2006; Maltby 2007; Score *et al*. 2010; Johnstone and Albarella 2015). Interestingly, similar butchery evidence has been detected on suid and caprine remains from Merovingian Oegstgeest: here, a number of pig scapulae had their coracoid chopped off, the glenoid rim trimmed, and presented chop marks on the neck, along the borders, and on the ventral blade; some caprine scapulae and metapodials had been butchered in a similar way. Specialised butchery activities are much rarer in the assemblages from the eastern part of the study-area; at Heeten, one cattle scapula presented butchery marks similar to those described above, and a few other caprine and suid specimens had been intensively butchered.

The dearth of evidence for specialised butchery practices in the Late Roman period assemblages here considered (De Geer and Heeten) is intriguing, but more likely to represent an exception to the rule: intensively butchered (especially cattle) bones have been recorded in large quantities in other Late Roman sites from the Lower Rhineland (Lauwerier 1988; Groot 2016).

6.4.4 Biometry

6.4.4.1 Cattle

The scatter plots of cattle bone measurements from the western sites of De Geer (Late Roman), Oegstgeest and Valkenburg (Merovingian) suggest animals from the former site were on average larger (Figs. 6.4.12 and 6.4.13). Th ranges of values from astragali are similar for the three sites, but a large part of measurements from the Merovingian assemblages plot on the bottom-left part of the graph, while no such small values are present at Late Roman De Geer; the very large outliers may possibly represent aurochsen, suggesting the majority of bovine measurements were taken from domestic cattle remains (Fig. 6.4.12). Measurements from distal tibiae broadly confirm this pattern. The smaller groups of larger values present in all assemblages may represent males (oxen and/or bulls), though part of them could belong to aurochsen; if they do represent domestic cattle, the groups of females and males from Late Roman De Geer appear skewed towards the top-right, confirming the larger size of animals from this site (Fig. 6.4.13).

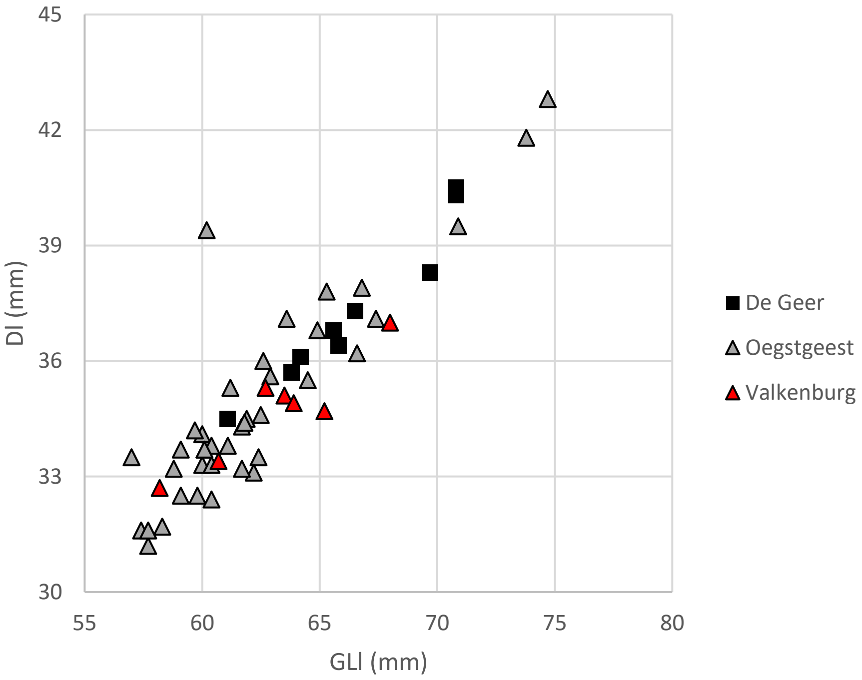


Fig. 6.4.12 Scatter plot of measurements from cattle astragali (GLl *vs* Dl) from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

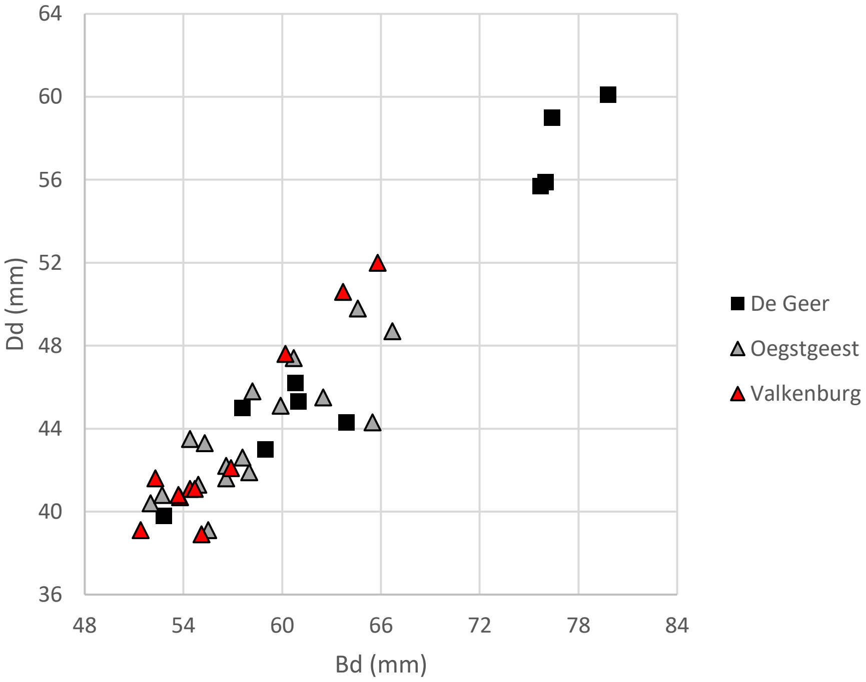


Fig. 6.4.13 Scatter plot of measurements from cattle tibiae (Bd *vs* Dd) from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

Values from Late Roman De Geer are compared to those from contemporary Heeten and Wijnaldum (I-II: late 2nd-mid-4th c.) (eastern part of the region) in Figs. 6.4.14 and 6.4.15 respectively. Measurements from Heeten overlap very well with those from De Geer, suggesting cattle from this ‘eastern’ site were as large as those in the Roman assemblage (Fig. 6.4.14). On the contrary, animals from Wijnaldum (I-II) were clearly smaller than those from De Geer and Heeten (Fig. 6.4.15).

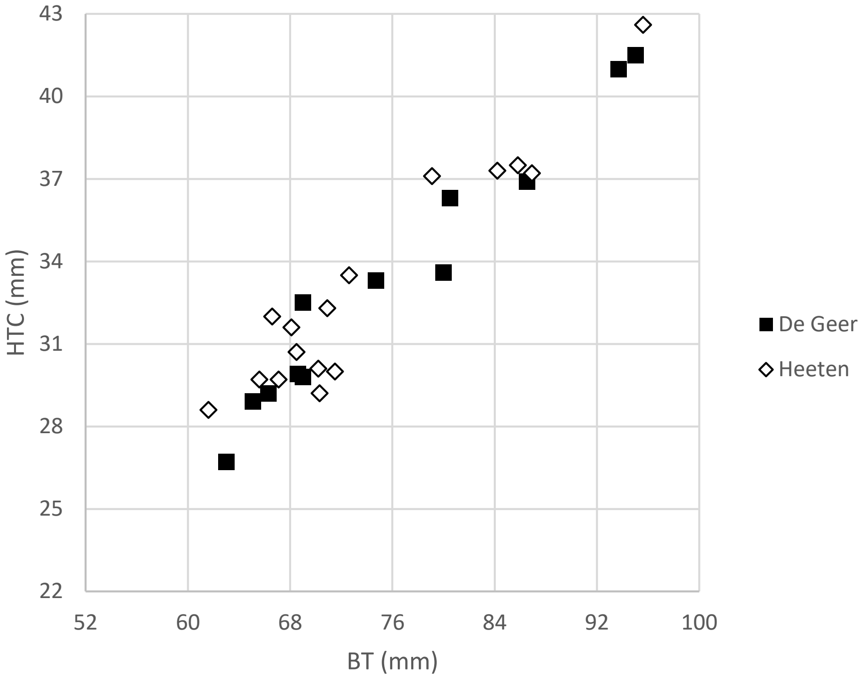


Fig. 6.4.14 Scatter plot of measurements from cattle humeri (BT *vs* HTC) from Late Roman De Geer, and 3rd-4th c. Heeten.

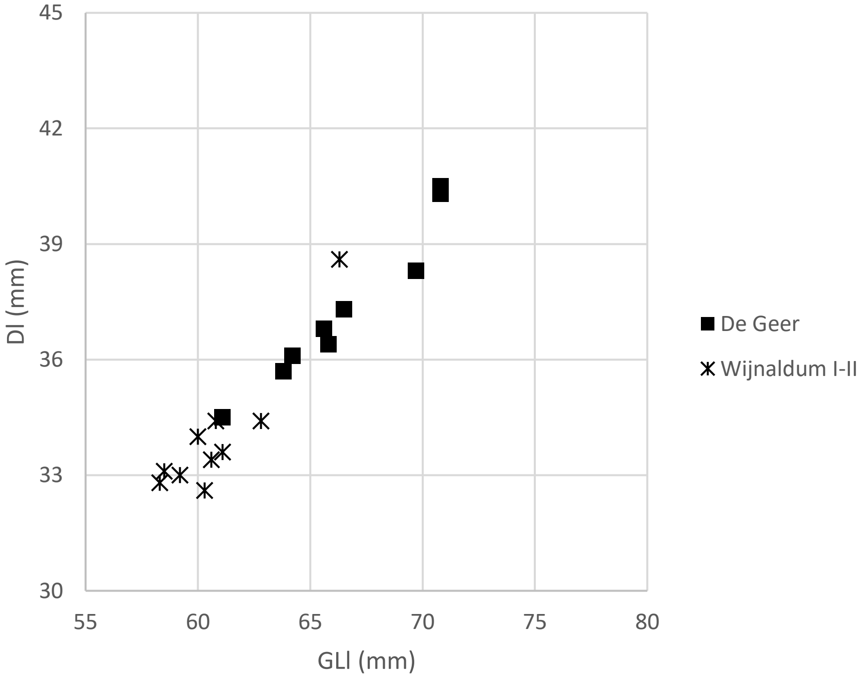


Fig. 6.4.15 Scatter plot of measurements from cattle astragali (GLl *vs* Dl) from Late Roman De Geer, and late 2nd-mid-4th c. Wijnaldum (I-II).

In order to increase the sample size and to allow further comparisons between site-periods, selections of width, depth, and length measurements were merged into log ratio histograms.

Width and depth measurements broadly confirm the observations made above (Figs. 6.4.16-6.4.19). The average of values from Late Roman De Geer is higher than those from Merovingian Oegstgeest and Valkenburg (western sites). In addition, despite the sample sizes from De Geer are half those from Oegstgeest and only slightly larger than those from Valkenburg, the distribution of both width and depth values is wider at the Late Roman site (Figs. 6.4.16 and 6.4.18). The average and distribution of values at 3rd-4th century Heeten are similar to those of Late Roman De Geer, the animals being visibly larger than those from the 2nd-4th and 6th-8th century phases from Wijnaldum (eastern sites) (Figs. 6.4.17 and 6.4.19). Cattle from De Geer and Heeten are larger than those from most of the Late Roman British sites considered in this study, but are similar in size to those from Wantage (Oxfordshire) and Great Holts Farm (Essex) (§ 6.3.6.1 and 6.5.1.2). The results of Student's t-tests confirm the observations made above (Tabs. 6.4.1 and 6.4.2).

Length measurements support the results from width and depth measurements analyses, though the differences in size between Late Roman De Geer and Heeten, and Merovingian Oegstgeest and Valkenburg and the two phases from Wijanldum are smaller (Figs. 6.4.20 and 6.4.21). The smaller average values of length measurements in comparison to widths and depths at De Geer and Heeten might suggest that cattle from these two sites were not just larger, but also more robust; these features would fit very well with the exploitation of cattle as traction force in agricultural works, as suggested by ageing analyses for 3rd-4th century Heeten (§ 6.4.2). Student's t-tests produced significant differences between the groups of values from De Geer and Heeten, and those from the other assemblages (Tab. 6.4.3). The dearth of large outliers, only detected for depth and length measurements at Late Roman De Geer, confirm that the vast majority of values belong to domestic cattle.

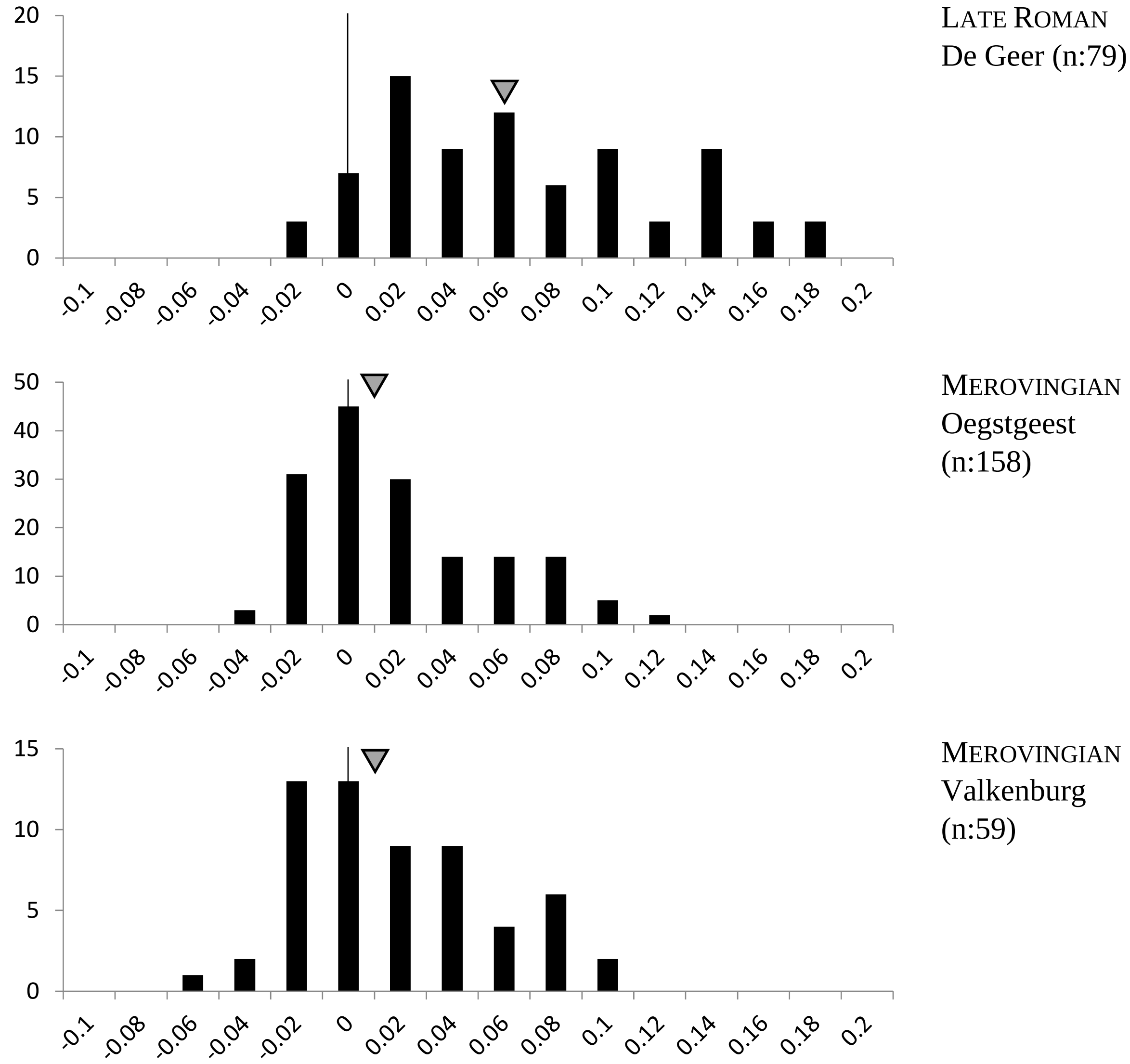


Fig. 6.4.16 Distribution of log ratio values of a selection of cattle bone widths from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

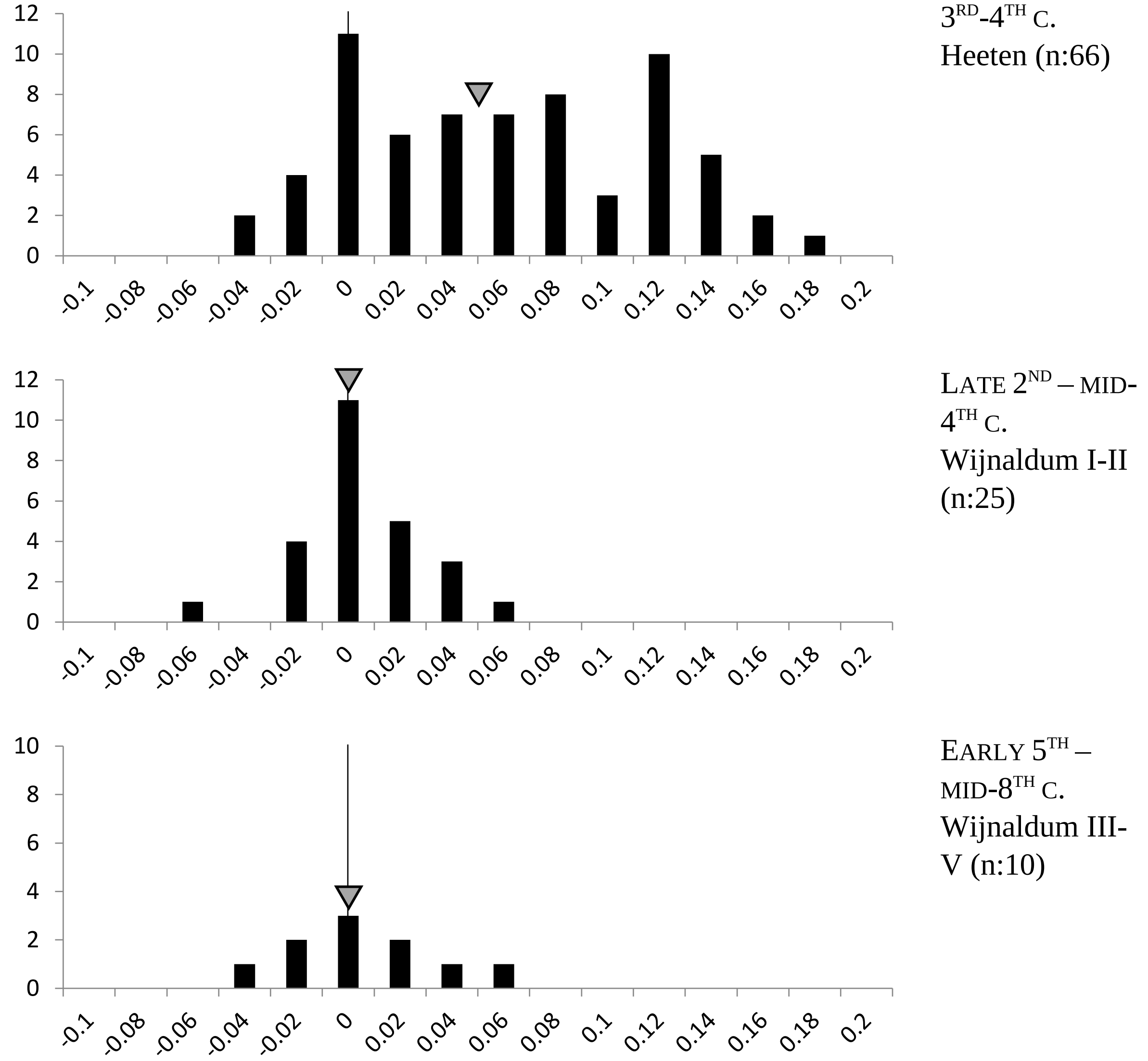


Fig. 6.4.17 Distribution of log ratio values of a selection of cattle bone widths from 3rd-4th c. Heeten, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

	DG	O	V	H	W1	W2
DG	-	< 0.01	< 0.01	0.49	< 0.01	< 0.01
O	< 0.01	-	0.67	< 0.01	0.10	0.27
V	< 0.01	0.67	-	< 0.01	0.20	0.38
H	0.49	< 0.01	< 0.01	-	< 0.01	< 0.01
W1	< 0.01	0.10	0.20	< 0.01	-	0.97
W2	< 0.01	0.27	0.38	< 0.01	0.97	-

Tab. 6.4.1 Results of the Student's t-tests for cattle bone widths. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. DG: De Geer, O: Oegstgeest, V: Valkenburg, H: Heeten, W1: Wijnaldum I-II (late 2nd-mid-4th c.), W2: Wijnaldum III-V (early 5th-mid-8th c.).

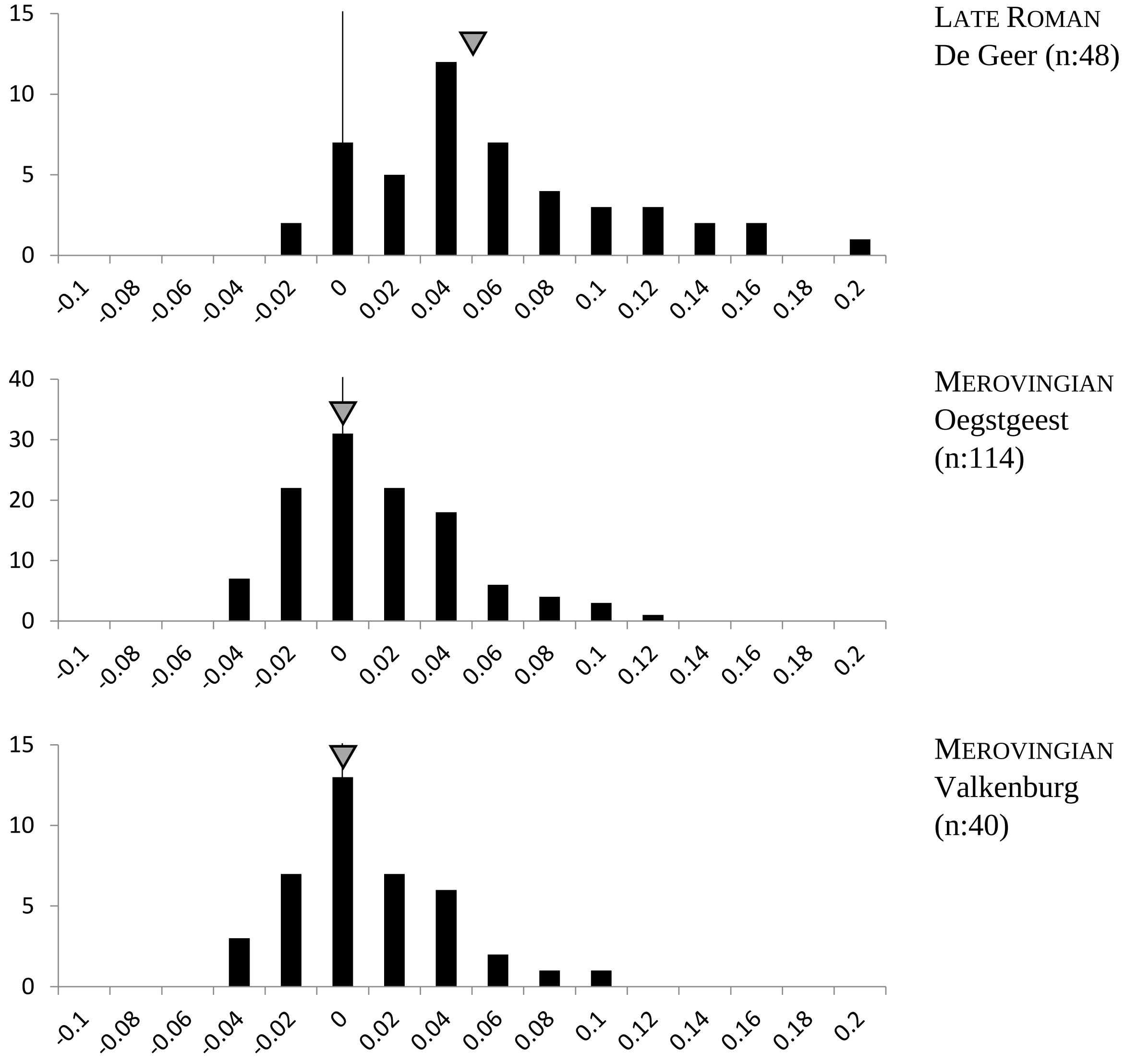


Fig. 6.4.18 Distribution of log ratio values of a selection of cattle bone depths from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

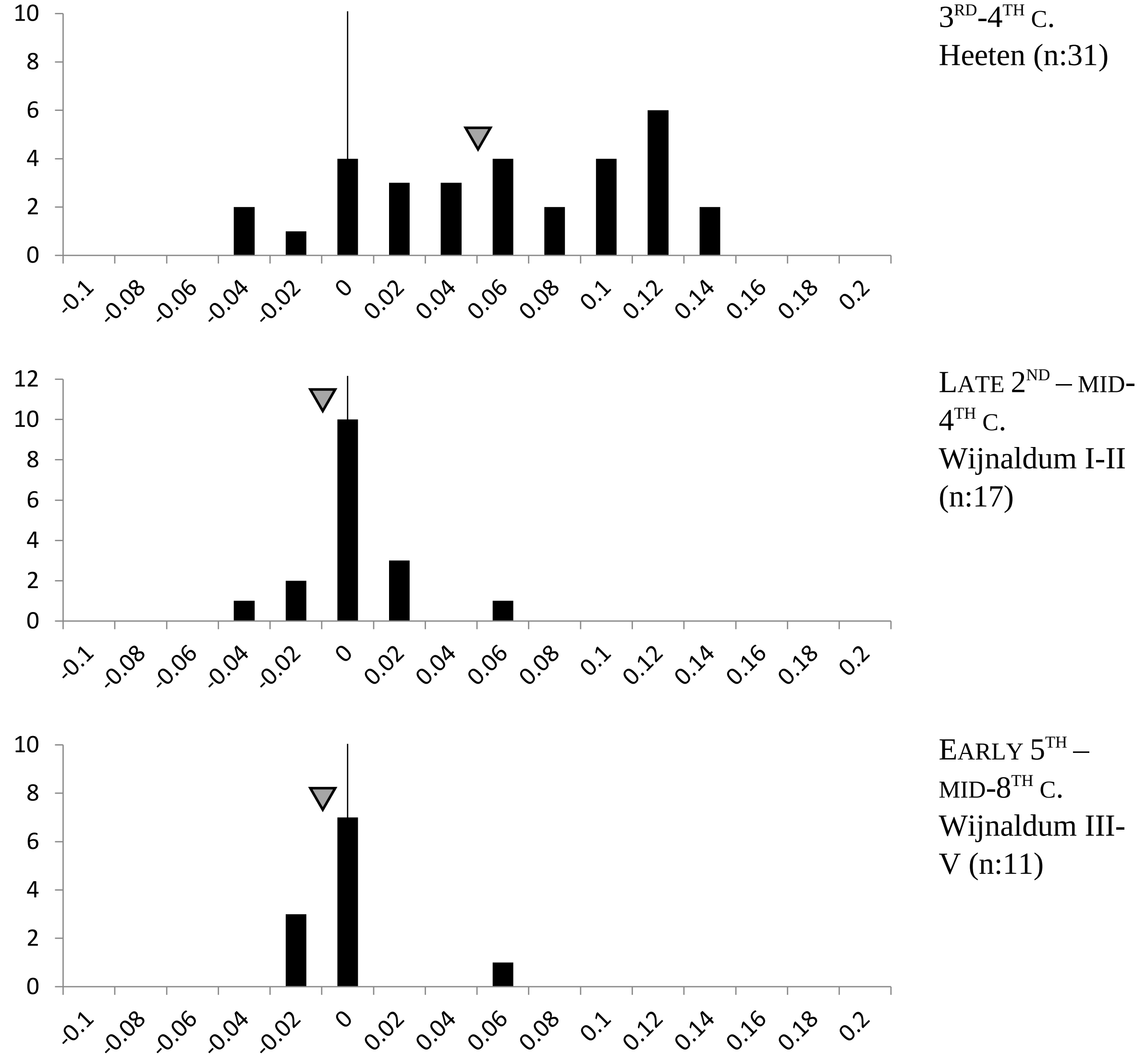


Fig. 6.4.19 Distribution of log ratio values of a selection of cattle bone depths from 3rd-4th c. Heeten, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

	DG	O	V	H	W1	W2
DG	-	< 0.01	< 0.01	0.76	< 0.01	< 0.01
O	< 0.01	-	0.52	< 0.01	0.16	0.15
V	< 0.01	0.52	-	< 0.01	0.37	0.31
H	0.76	< 0.01	< 0.01	-	< 0.01	< 0.01
W1	< 0.01	0.16	0.37	< 0.01	-	0.71
W2	< 0.01	0.15	0.31	< 0.01	0.71	-

Tab. 6.4.2 Results of the Student’s t-tests for cattle bone depths. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. DG: De Geer, O: Oegstgeest, V: Valkenburg, H: Heeten, W1: Wijnaldum I-II (late 2nd-mid-4th c.), W2: Wijnaldum III-V (early 5th-mid-8th c.).

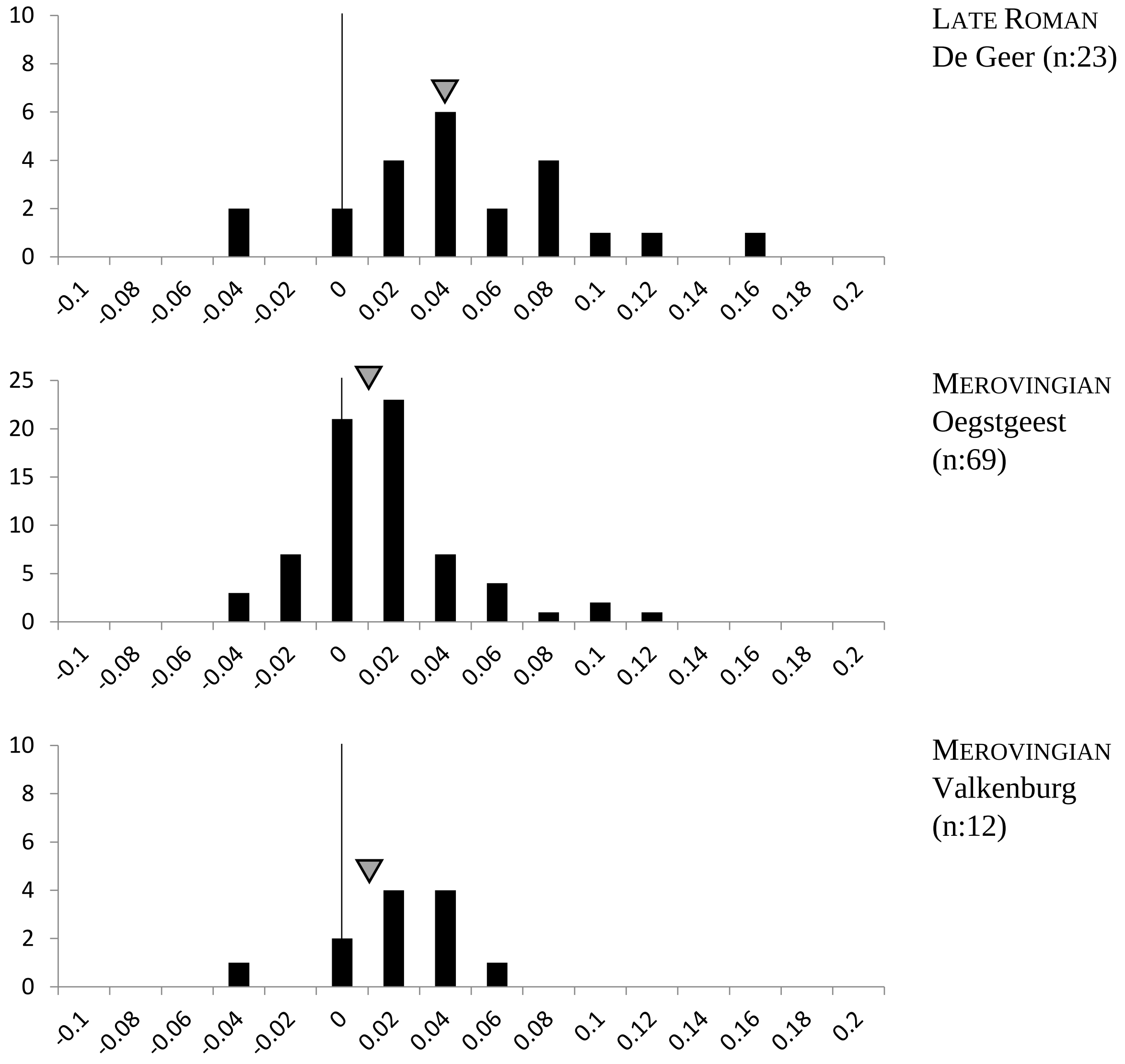


Fig. 6.4.20 Distribution of log ratio values of a selection of cattle bone lengths from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

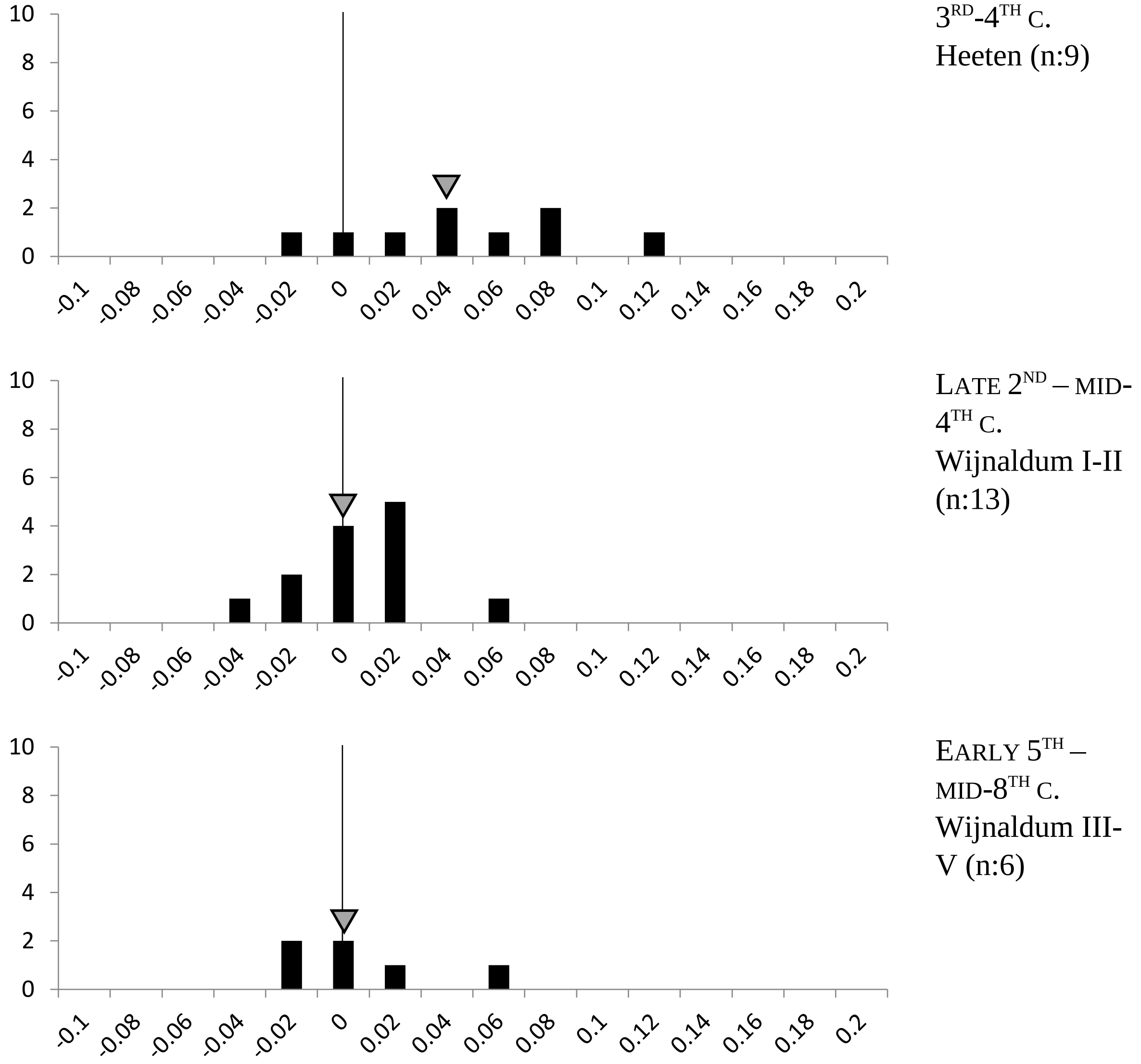


Fig. 6.4.21 Distribution of log ratio values of a selection of cattle bone lengths from 3rd-4th c. Heeten, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

	DG	**O**	**V**	**H**	**W1**	**W2**
DG	-	< 0.01	0.11	0.90	0.01	0.08
O	< 0.01	-	0.60	0.01	0.20	0.54
V	0.11	0.60	-	0.12	0.12	0.37
H	0.90	0.01	0.12	-	0.01	0.09
W1	0.01	0.20	0.12	0.01	-	0.79
W2	0.08	0.54	0.37	0.09	0.79	-

Tab. 6.4.3 Results of the Student's t-tests for cattle bone lengths. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. DG: De Geer, O: Oegstgeest, V: Valkenburg, H: Heeten, W1: Wijnaldum I-II (late 2nd-mid-4th c.), W2: Wijnaldum III-V (early 5th-mid-8th c.).

Tooth measurement analyses produced somewhat different results. Cattle M_3s from Late Roman De Geer seem slightly larger than those from Merovingian Oegstgeest and Valkenburg, although the ranges of values are similar (Fig. 6.4.22). No clear differences can be seen in the distributions of values from De Geer, Heeten, and the two assemblages from Wijnaldum (Fig. 6.4.23). In general, however, the small size of samples from De Geer and Wijnaldum invites caution in the interpretation of results.

The analyses of tooth widths confirm of absence of substantial differences between all groups of values (Figs. 6.4.24 and 6.4.25). The results of Student's t-tests broadly support this view, although producing significant differences between De Geer and the two Merovingian western sites, between Heeten and Valkenburg, and between this latter site and nearby Oegstgeest (Tab. 6.4.4), probably as a result of Valkenburg presenting the lowest average value.

Such inconsistency between the results from the biometrical analyses of postcranial bones and those of teeth may support the view of a common genetic origin of cattle populations from these site-periods, and for a post-Roman decrease in size of locally improved stock.

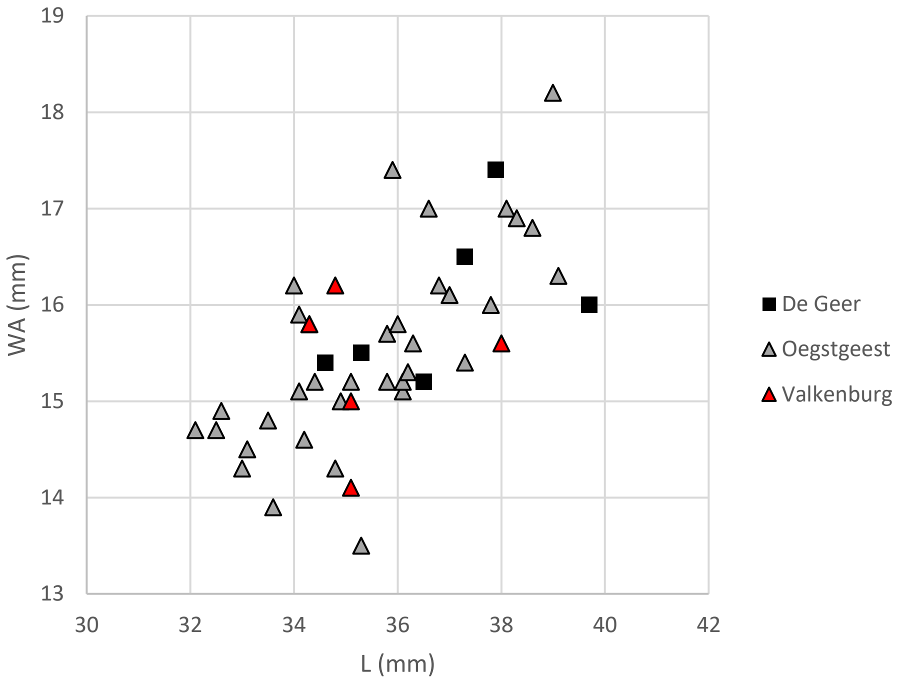


Fig. 6.4.22 Scatter plot of measurements from cattle M_3s (L *vs* WA) from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

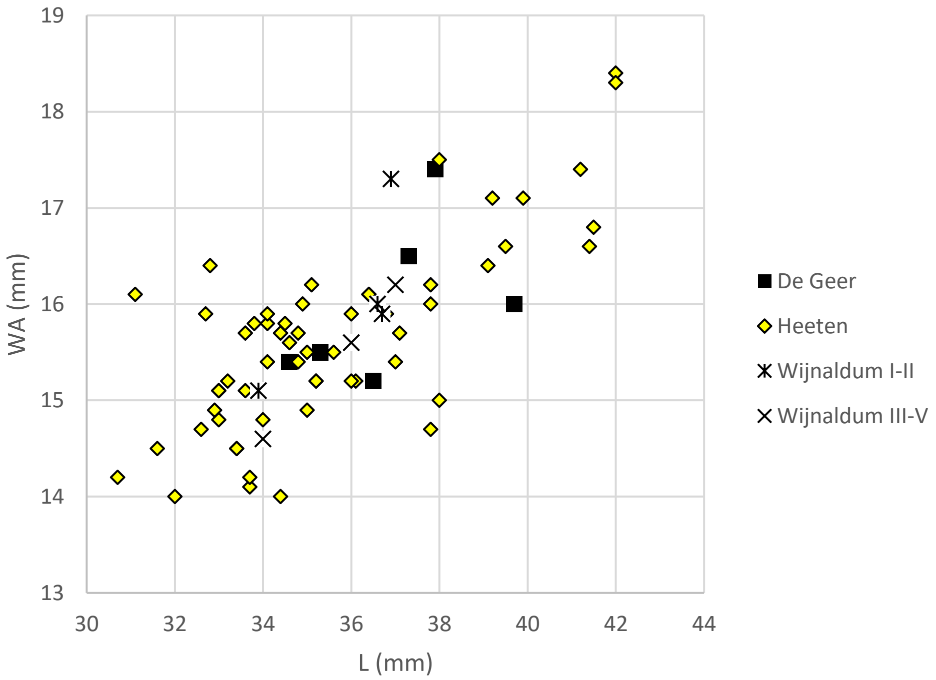


Fig. 6.4.23 Scatter plot of measurements from cattle M_3s (L *vs* WA) from Late Roman De Geer, 3rd-4th c. Heeten, and late 2nd-mid-4th c. (I-II) and mid-6th-mid-8th c. (III-V) Wijnaldum.

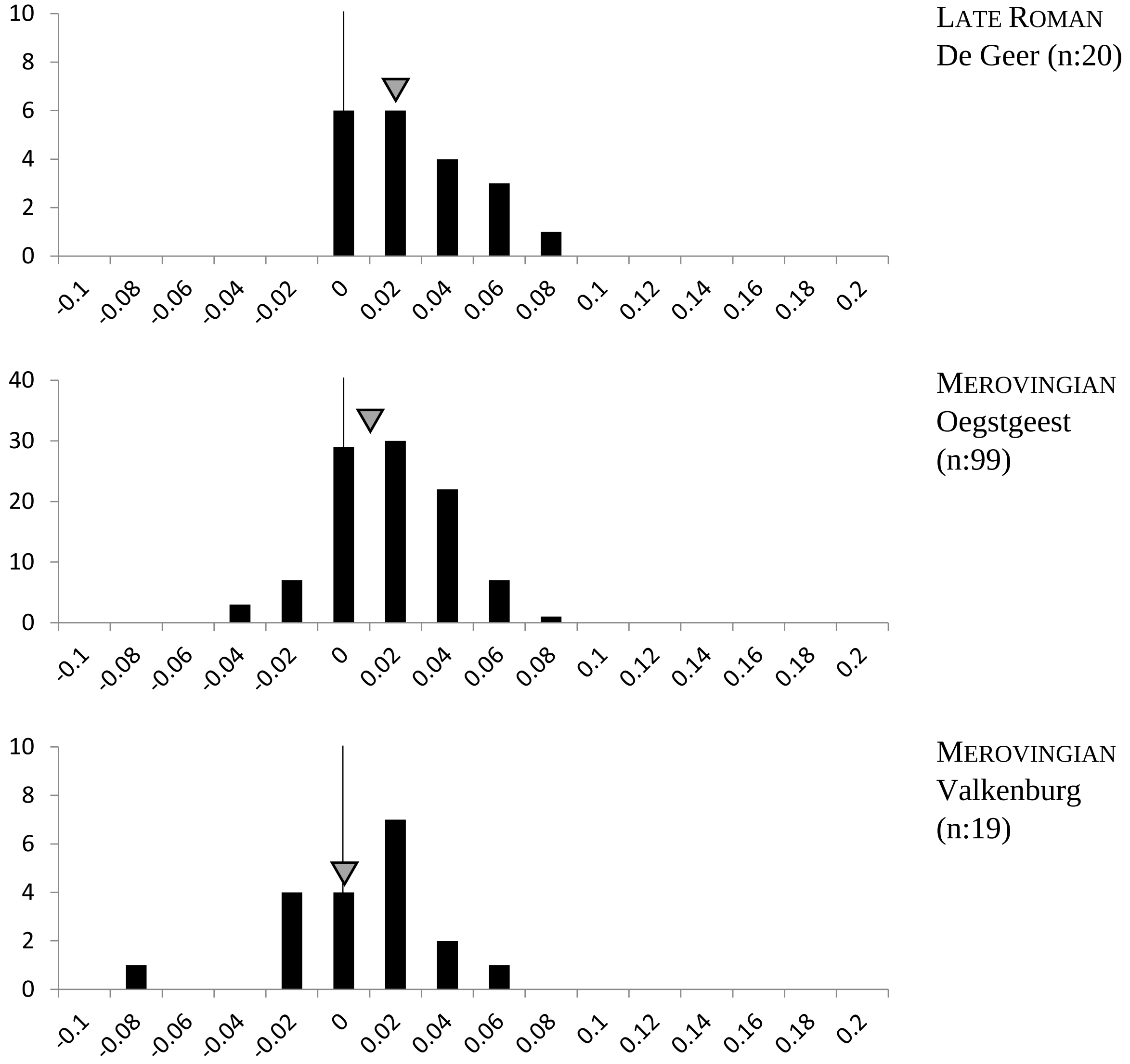


Fig. 6.4.24 Distribution of log ratio values of a selection of cattle tooth widths from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

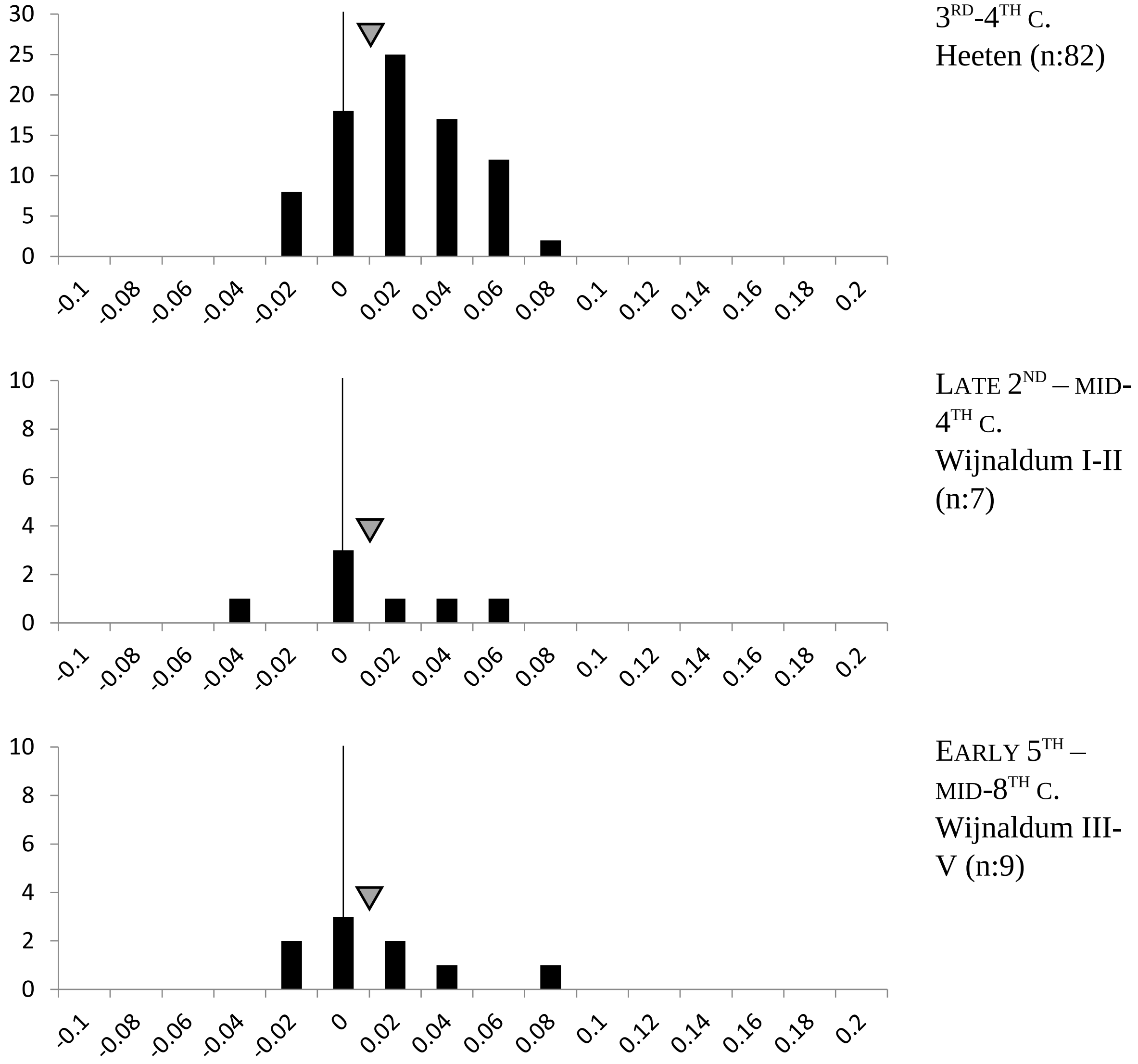


Fig. 6.4.25 Distribution of log ratio values of a selection of cattle tooth widths from 3rd-4th c. Heeten, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

	DG	O	V	H	W1	W2
DG	-	0.06	0.02	0.32	0.27	0.22
O	0.06	-	0.07	0.19	0.84	0.80
V	0.02	0.07	-	0.02	0.51	0.47
H	0.32	0.19	0.02	-	0.52	0.45
W1	0.27	0.84	0.51	0.52	-	0.99
W2	0.22	0.80	0.47	0.45	0.99	-

Tab. 6.4.4 Results of the Student's t-tests for cattle tooth widths. The *p* value indicates the chance that the two groups of values being compared are not statistically different. DG: De Geer, O: Oegstgeest, V: Valkenburg, H: Heeten, W1: Wijnaldum I-II (late 2nd-mid-4th c.), W2: Wijnaldum III-V (early 5th-mid-8th c.).

6.4.4.2 Caprines

Analyses of caprine bone and tooth size were limited by the dearth of remains of this taxon in the assemblages considered. Absolute measurements from tibiae and humeri do not highlight any substantial differences in the distribution and average size of sheep from Merovingian Oegstgeest, Valkenburg, and Wijnaldum (III-V) (Figs. 6.4.26 and 6.4.27). Sample sizes were increased by merging separately bone width, depth, and length measurements into log ratio histograms (Figs. 6.4.28-6.4.30). In all assemblages, caprines are only slightly larger than animals from Late Roman and Early Anglo-Saxon British sites, and all axes display no differences in size between site-periods. The results of Student's t-tests confirm this, with the exception of length values from Merovingian Oegstgeest and Wijnaldum (III-V) suggesting caprines from the latter site-period were smaller (Tab. 6.4.5).

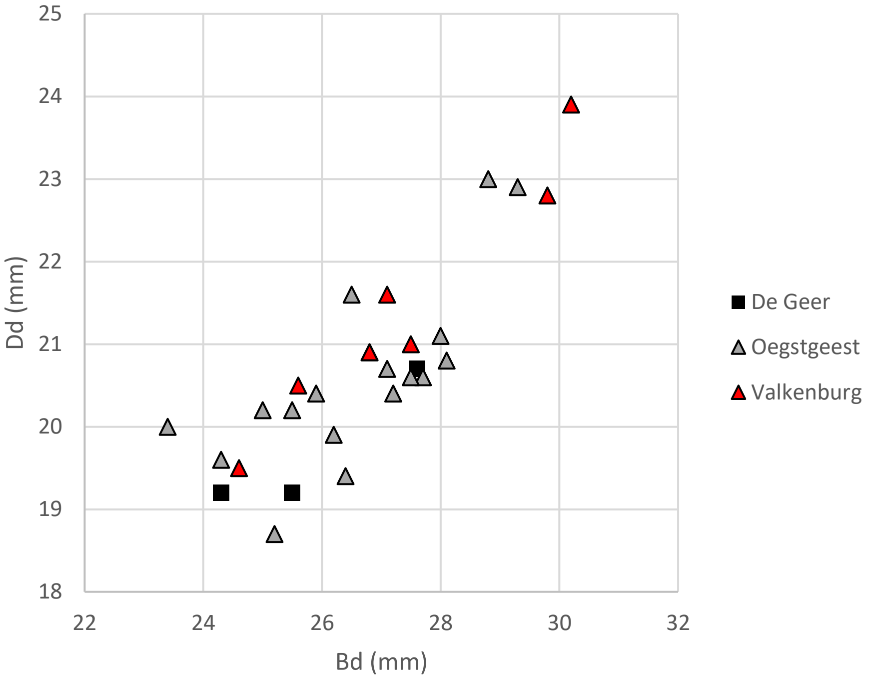


Fig. 6.4.26 Scatter plot of measurements from caprine tibiae (Bd *vs* Dd) from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

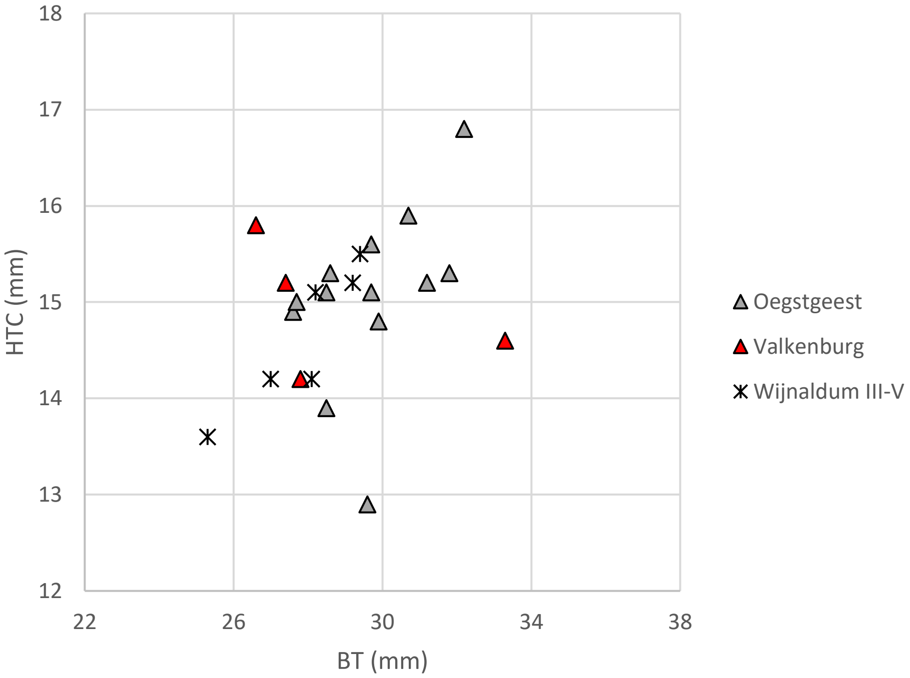
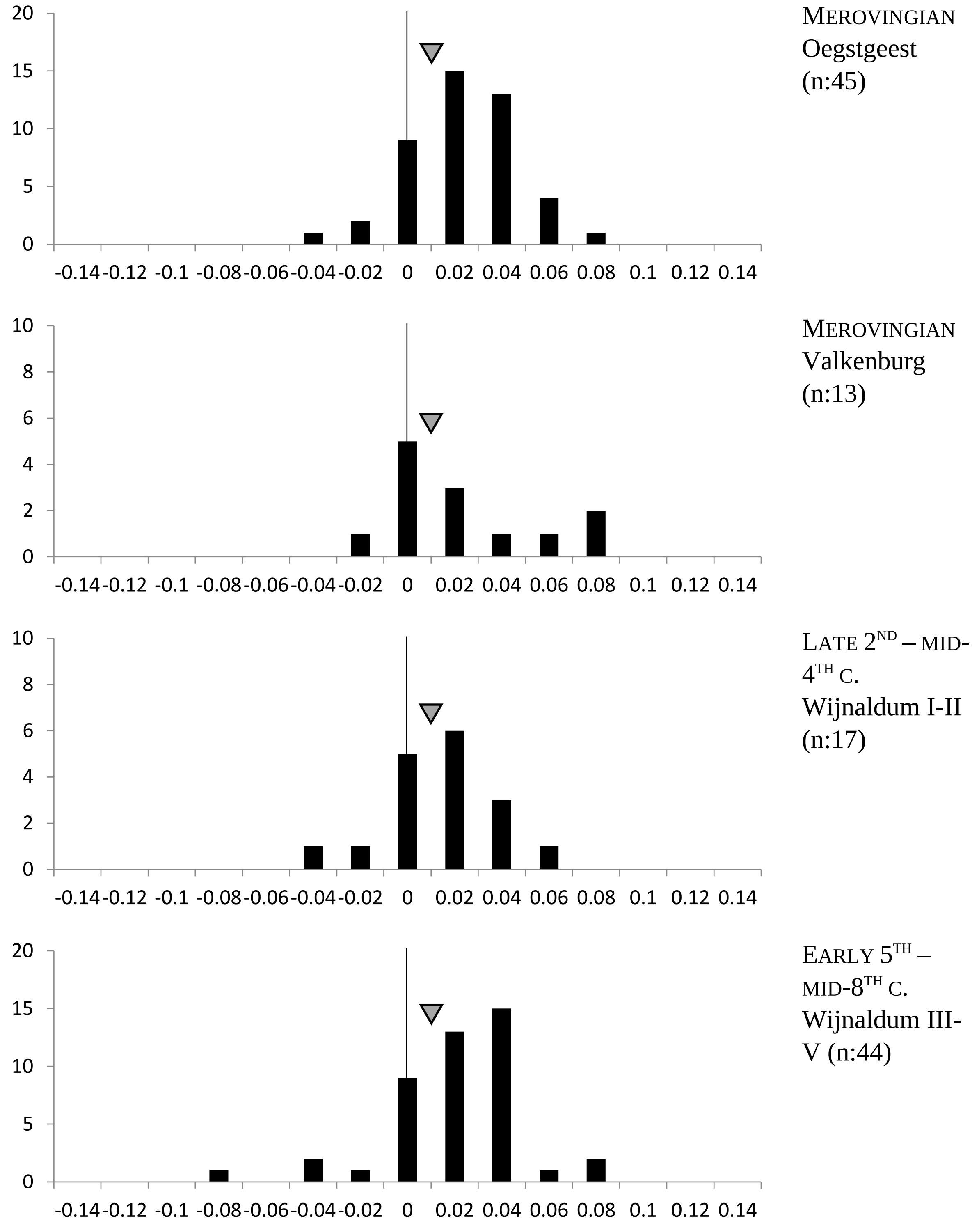


Fig. 6.4.27 Scatter plot of measurements from caprine humeri (BT *vs* HTC) from Merovingian Oegstgeest and Valkenburg, and mid-6th-mid-8th c. (III-V) Wijnaldum.



MEROVINGIAN
Oegstgeest
(n:45)

MEROVINGIAN
Valkenburg
(n:13)

LATE 2ND – MID-4TH C.
Wijnaldum I-II
(n:17)

EARLY 5TH – MID-8TH C.
Wijnaldum III-V (n:44)

Fig. 6.4.28 Distribution of log ratio values of a selection of caprine bone widths from Merovingian Oegstgeest and Valkenburg, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

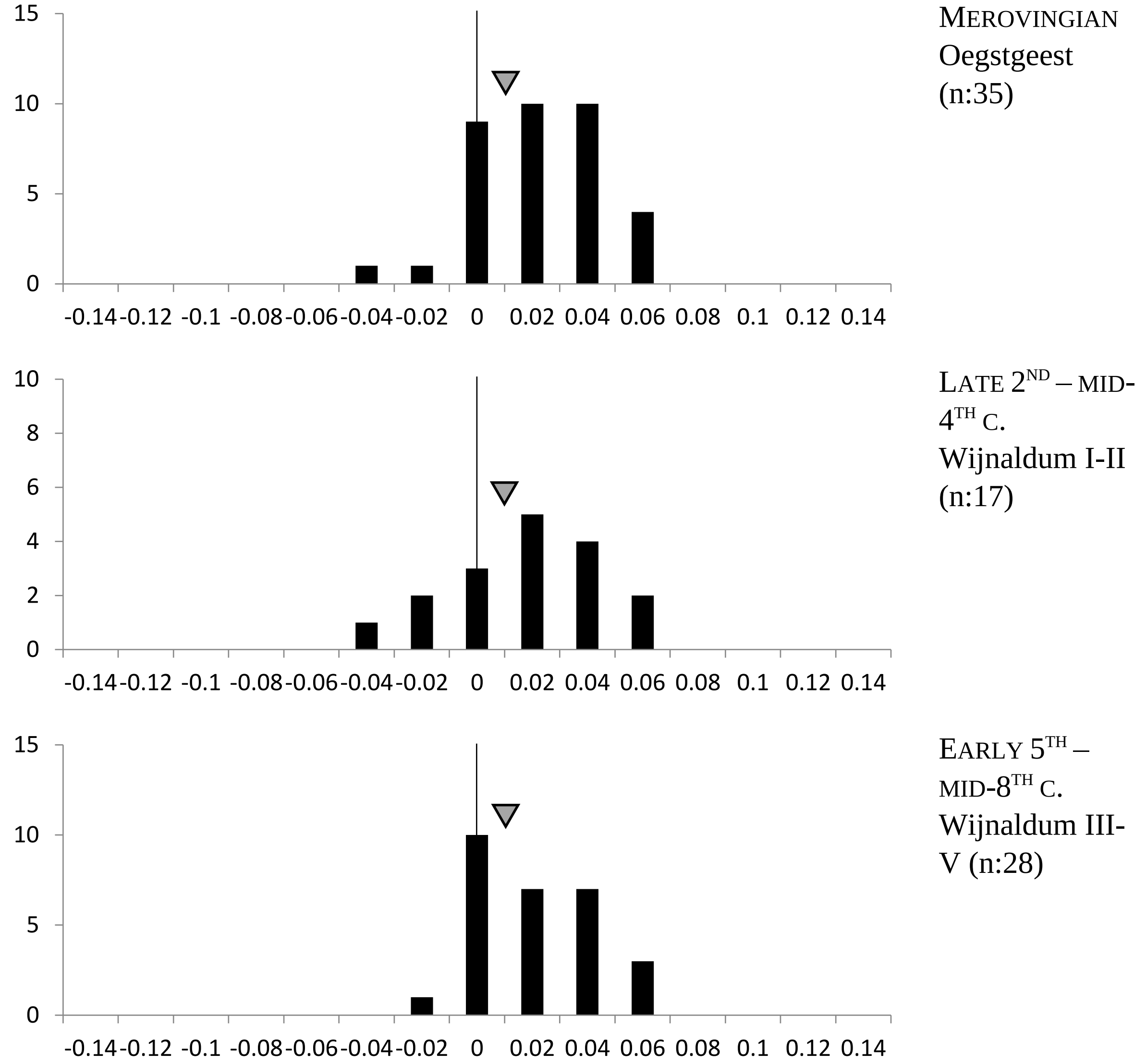


Fig. 6.4.29 Distribution of log ratio values of a selection of caprine bone depths from Merovingian Oegstgeest, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

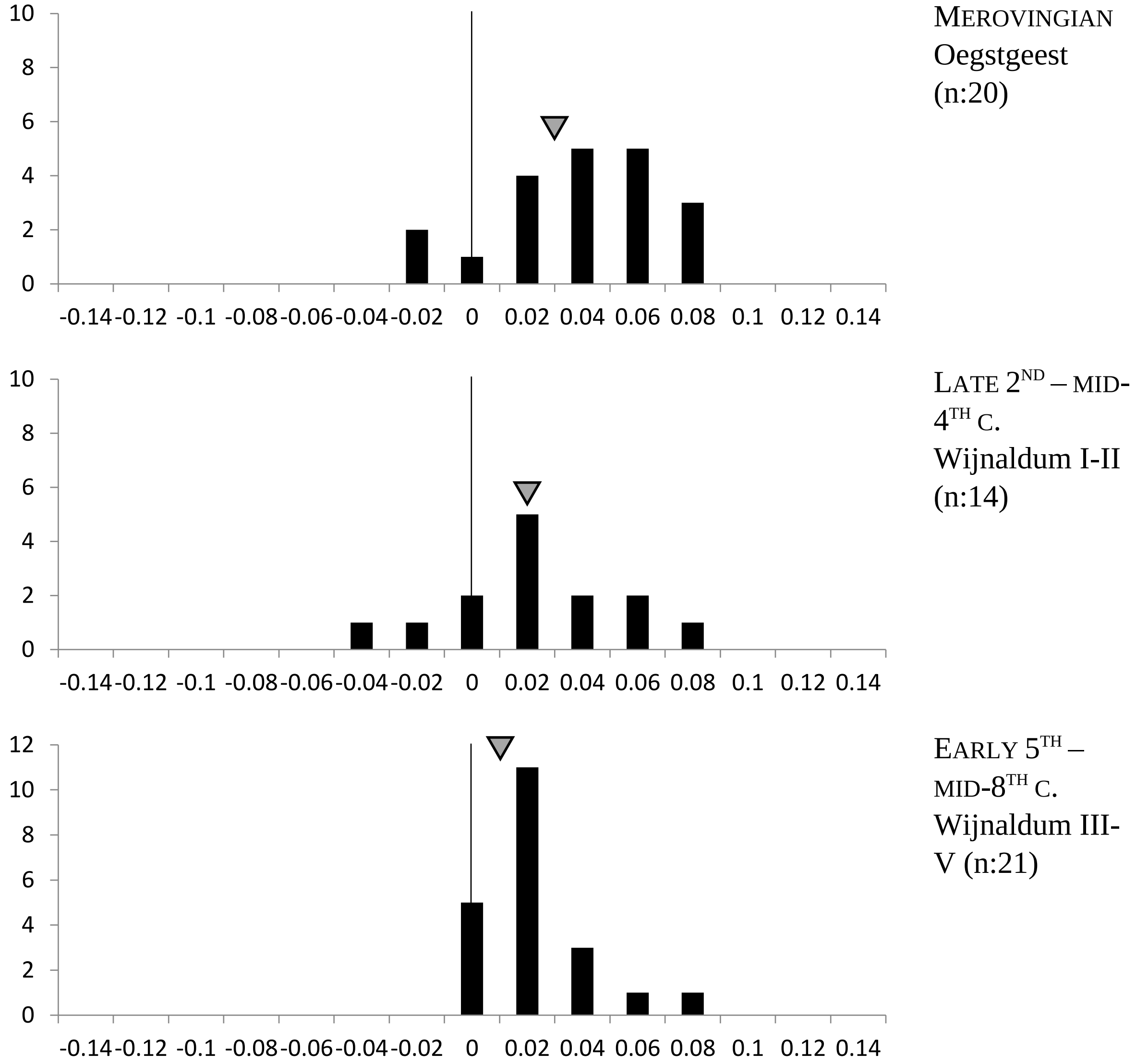


Fig. 6.4.30 Distribution of log ratio values of a selection of caprine bone lengths from Merovingian Oegstgeest, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

	O w	V w	W1 w	W2 w	O d	W1 d	W2 d	O l	W1 l	W2 l
O w	-	0.90	0.25	0.35	-	-	-	-	-	-
V w	0.90	-	0.40	0.50	-	-	-	-	-	-
W1 w	0.25	0.40	-	0.74	-	-	-	-	-	-
W2 w	0.35	0.50	0.74	-	-	-	-	-	-	-
O d	-	-	-	-	-	0.56	0.77	-	-	-
W1 d	-	-	-	-	0.56	-	0.53	-	-	-
W2 d	-	-	-	-	0.77	0.53	-	-	-	-
O l	-	-	-	-	-	-	-	-	0.19	0.03
W1 l	-	-	-	-	-	-	-	0.19	-	0.63
W2 l	-	-	-	-	-	-	-	0.03	0.63	-

Tab. 6.4.5 Results of the Student's t-tests for caprine bone measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. O: Oegstgeest, V: Valkenburg, W1: Wijnaldum I-II (late 2nd-mid-4th c.), W2: Wijnaldum III-V (early 5th-mid-8th c.), w: widths, d: depths, l: lengths.

Tooth measurement analyses confirm this lack of substantial differences in size between groups of values from Merovingian Oegstgeest and Valkenburg, and the two phases from Wijnaldum (Figs. 6.4.31 and 6.4.32), which is confirmed by the results of Student's t-tests (Tab. 6.4.6).

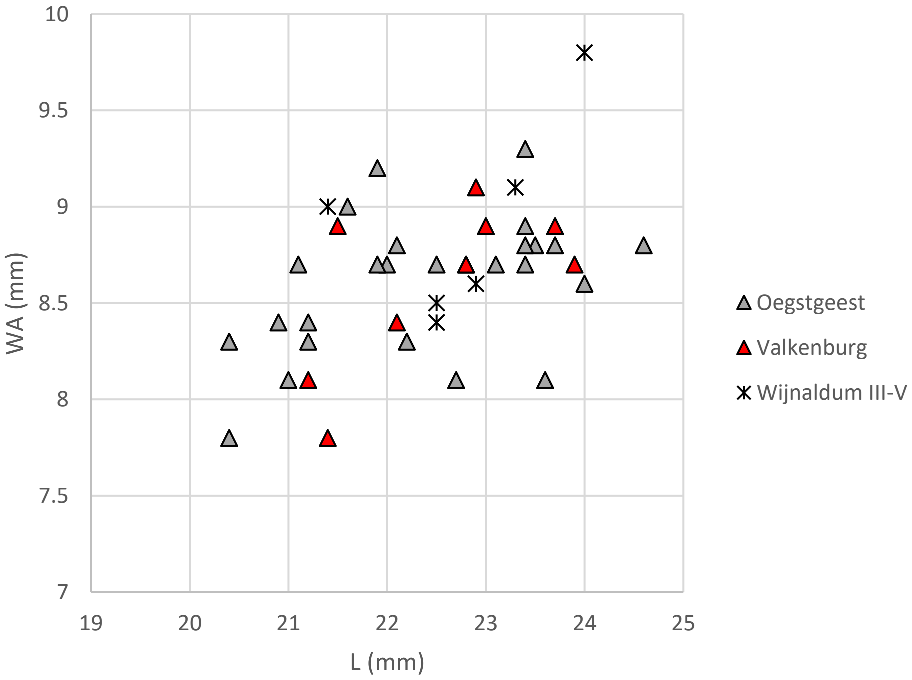
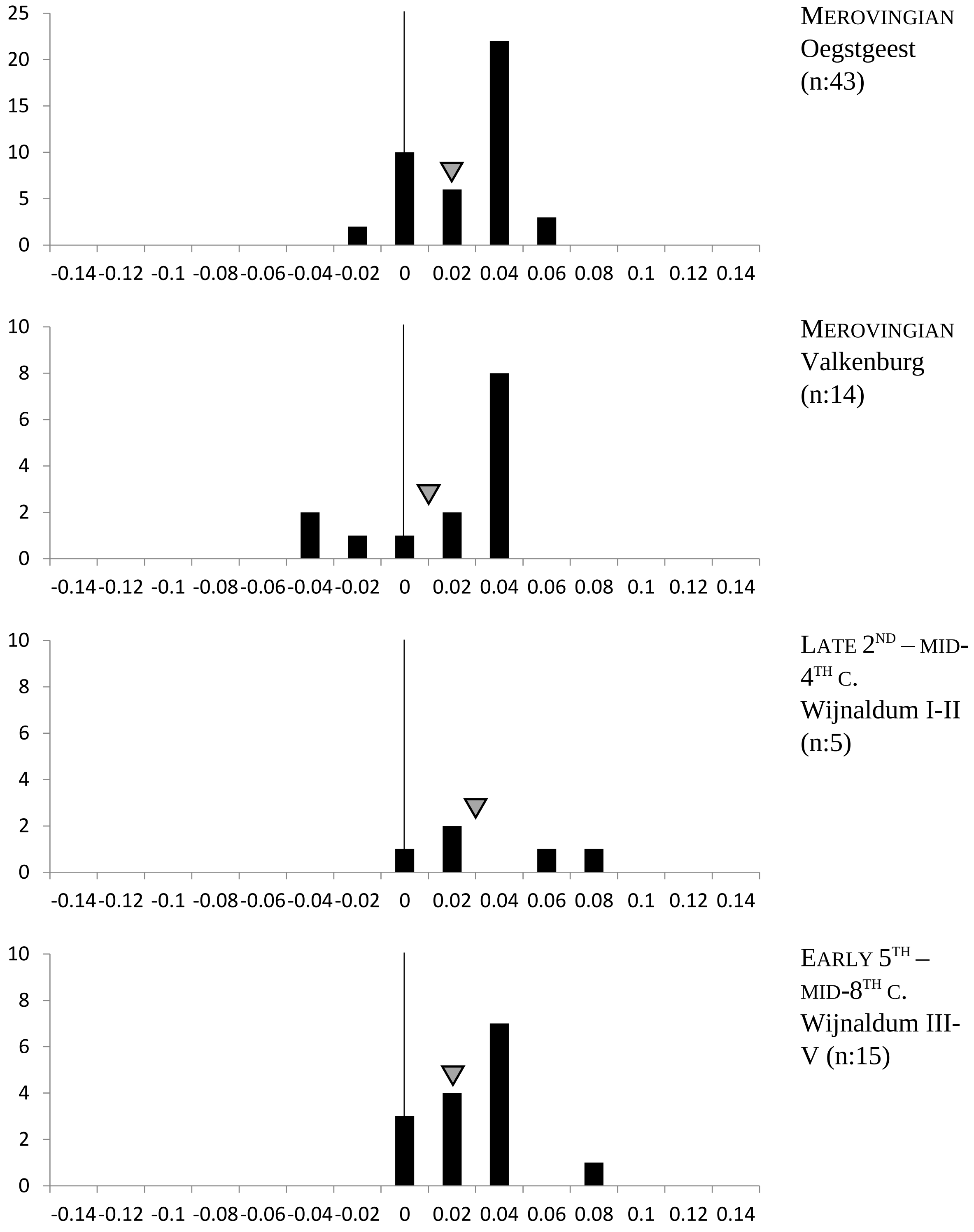


Fig. 6.4.31 Scatter plot of measurements from caprine M_3s (L *vs* WA) from Merovingian Oegstgeest and Valkenburg, and mid-6th-mid-8th c. (III-V) Wijnaldum.


MEROVINGIAN Oegstgeest (n:43)

MEROVINGIAN Valkenburg (n:14)

LATE 2ND – MID-4TH C. Wijnaldum I-II (n:5)

EARLY 5TH – MID-8TH C. Wijnaldum III-V (n:15)

Fig. 6.4.32 Distribution of log ratio values of a selection of caprine tooth widths from Merovingian Oegstgeest and Valkenburg, and late 2nd-mid-4th c. and mid-6th-mid-8th c. Wijnaldum.

	O	V	W1	W2
O	-	0.32	0.30	0.49
V	0.32	-	0.31	0.28
W1	0.30	0.31	-	0.64
W2	0.49	0.28	0.64	-

Tab. 6.4.6 Results of the Student's t-tests for caprine tooth widths. The *p* value indicates the chance that the two groups of values being compared are not statistically different. O: Oegstgeest, V: Valkenburg, W1: Wijnaldum I-II (late 2nd-mid-4th c.), W2: Wijnaldum III-V (early 5th-mid-8th c.).

6.4.4.3 Suids

The scatter plots of measurements from humeri and tibiae do not highlight any substantial differences in size between suid populations from Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, and Wijnaldum (III-V); the very large outliers from De Geer almost certainly belong to wild boar (Figs. 6.4.33 and 6.4.34).

Log ratio histograms of bone measurements broadly confirm this pattern, with the exception of 3rd-4th century Heeten, where the average size is higher (Figs. 6.4.35 and 6.4.36).

Tooth measurements partly confirm such lack of substantial differences in size (Fig. 6.4.38); the larger size of suid bones from Heeten is not reflected in tooth biometrical analyses, which suggest tooth size from this site is even smaller than in the other assemblages. Student's t-tests support the observations made above (Tab. 6.4.7).

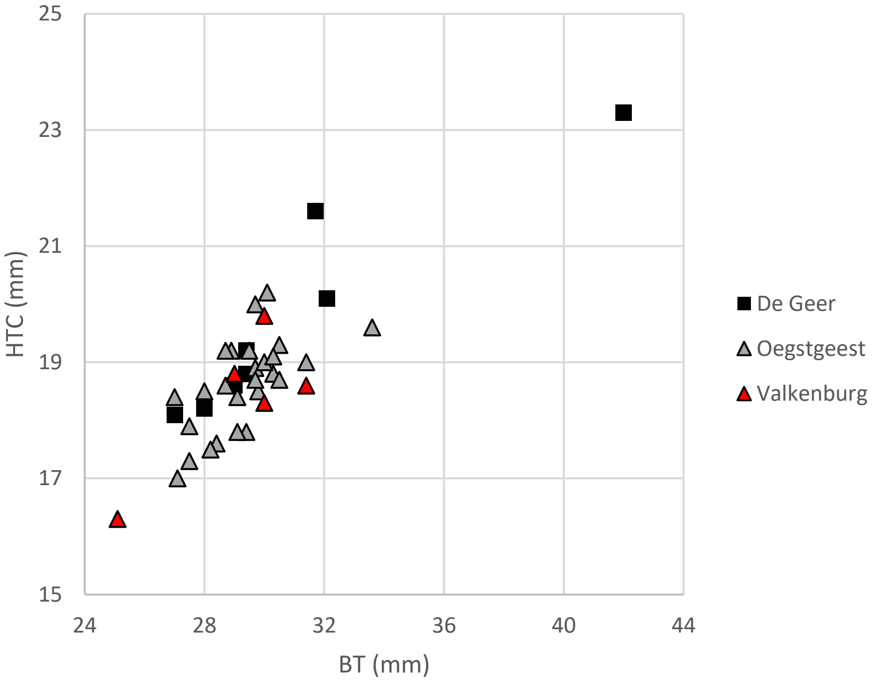


Fig. 6.4.33 Scatter plot of measurements from suid humeri (BT *vs* HTC) from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

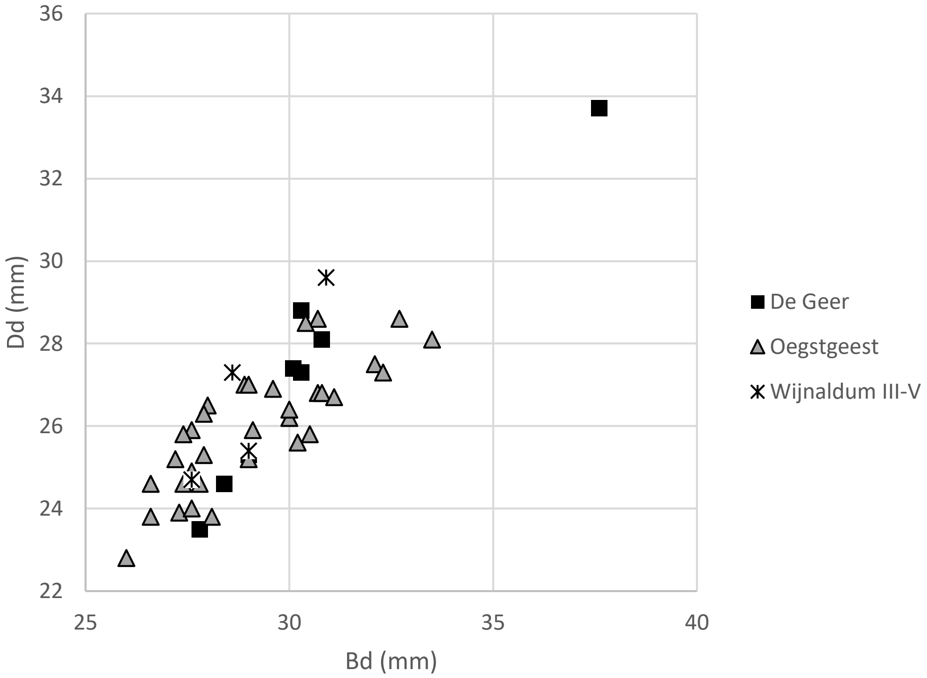


Fig. 6.4.34 Scatter plot of measurements from suid tibiae (Bd *vs* Dd) from Late Roman De Geer, Merovingian Oegstgeest, and mid-6th-mid-8th c. (III-V) Wijnaldum.

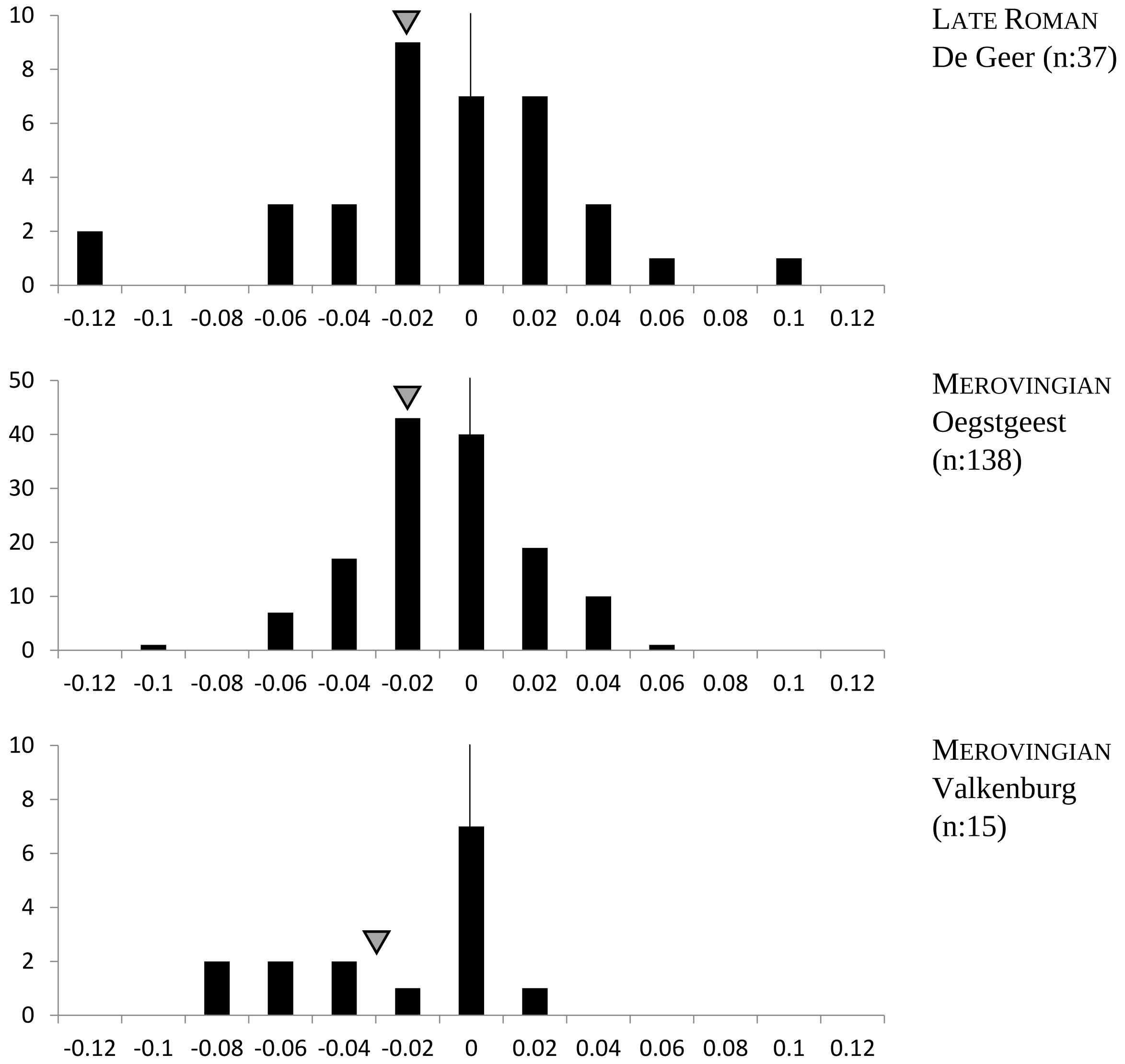


Fig. 6.4.35 Distribution of log ratio values of a selection of suid bone measurements from Late Roman De Geer, and Merovingian Oegstgeest and Valkenburg.

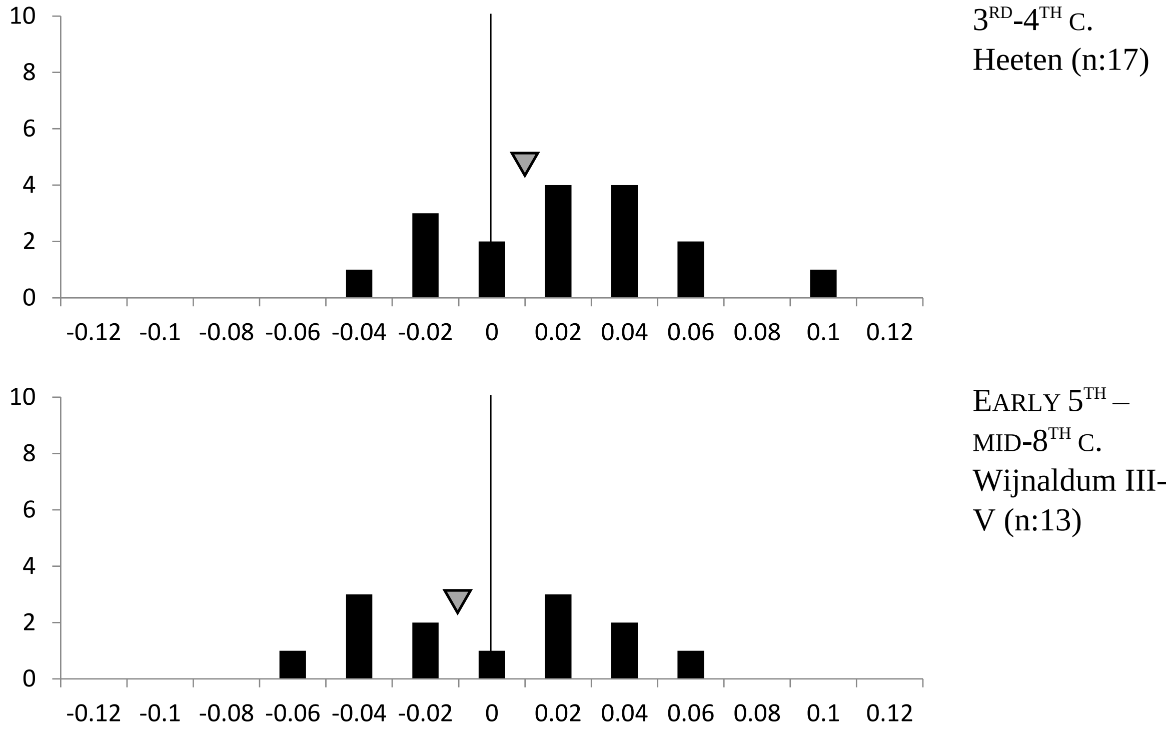


Fig. 6.4.36 Distribution of log ratio values of a selection of suid bone measurements from 3rd-4th c. Heeten, and mid-6th-mid-8th c. Wijnaldum.

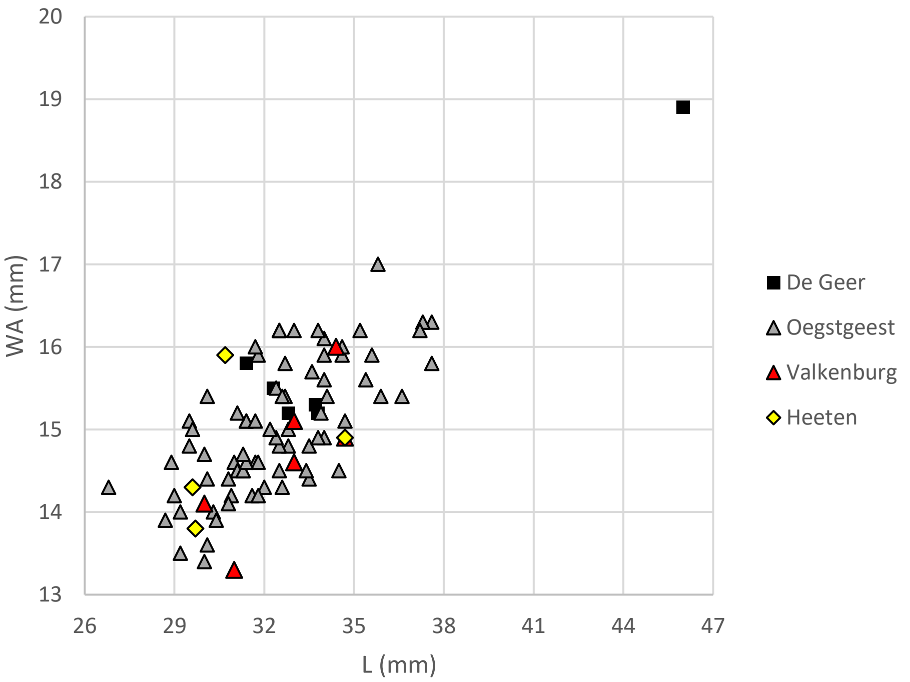


Fig. 6.4.37 Scatter plot of measurements from suid M_3s (L *vs* WA) from Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, and 3rd-4th c. Heeten.

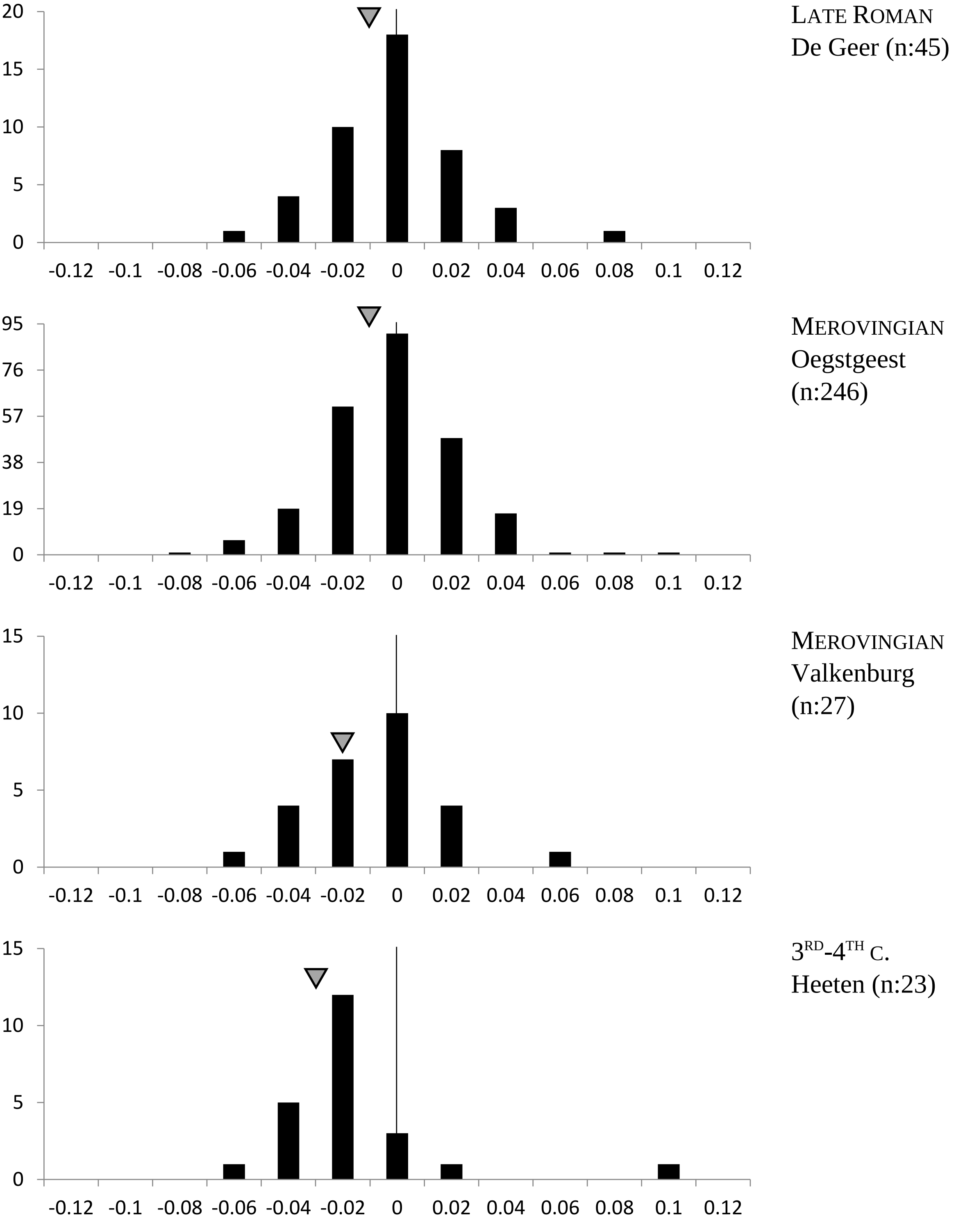


Fig. 6.4.38 Distribution of log ratio values of a selection of suid tooth widths from Late Roman De Geer, Merovingian Oegstgeest and Valkenburg, and 3rd-4th c. Heeten.

	DG b	O b	V b	H b	W2 b	DG t	O t	V t	H t
DG b	-	0.97	0.29	0.07	0.78	-	-	-	-
O b	0.97	-	0.03	< 0.01	0.53	-	-	-	-
V b	0.29	0.03	-	< 0.01	0.11	-	-	-	-
H b	0.07	< 0.01	< 0.01	-	0.10	-	-	-	-
W2 b	0.78	0.53	0.11	0.10	-	-	-	-	-
DG t	-	-	-	-	-	-	0.43	0.09	0.02
O t	-	-	-	-	-	0.43	-	0.16	0.01
V t	-	-	-	-	-	0.09	0.16	-	0.40
H t	-	-	-	-	-	0.02	0.01	0.40	-

Tab. 6.4.7 Results of the Student's t-tests for suid bone and tooth measurements. The *p* value indicates the probability that the difference between the means of the two groups is due to chance. DG: De Geer, O: Oegstgeest, V: Valkenburg, H: Heeten, W2: Wijnaldum III-V (early 5th-mid-8th c.), b: bone measurements, t: tooth widths.

6.4.5 Summary

The prevalence of cattle at the western sites of De Geer, Oegstgeest, and Valkenburg, as well as at the nearby eastern site of Heeten, is likely to reflect a local preference for this animal. Cultural and environmental variables may also account for the high incidence of suids in these sites, and for the prevalence of caprines at the Frisian site of Wijnaldum.

Cattle ageing analyses suggest the exploitation of this animal focused on traction at the 'western' sites and Heeten; many more immature animals were culled at Wijnaldum, highlighting a more generalised pattern of cattle use at this site. Caprine culling strategies were more generalised in all assemblages, but again with a greater incidence of immature animals at Wijnaldum. Specialised butchery products were rare at Late Roman De Geer, but have been recorded in large numbers at Merovingian Oegstgeest and Valkenburg.

Cattle is particularly large at Late Roman De Geer and at the eastern site of Heeten, possibly suggesting this latter fell within the sphere of influence of the Roman Empire and adapted/adopted Romanised practices of animal management. At these sites, cattle bones are on average larger than in most contemporary British assemblages. Post-Roman biometrical data indicate a considerable decrease in the size of cattle. Similarly to what has been seen for Roman Britain and Early Anglo-Saxon England, no substantial size differences can be noticed in the size of caprines and suids between Roman and post-Roman assemblages.

Ageing analyses, butchery, and, to some extent, biometry, contribute to highlight similarities in animal use between the 'western' sites of De Geer, Oegstgeest, and Valkenburg, and the nearby ‘eastern’ site of Heeten; in turn, animal husbandry practices at these sites considerably differ from those of the Frisian site of Wijnaldum.

6.5 Data from the literature and summary graphs

Data from the literature were collected from sites located in central-eastern and central England; they provide complementary information on species frequencies (NISP) and biometry. Additional species frequency and biometrical data were also collected from assemblages in the Lower Rhineland. Information on the sites used and references are provided in Tabs. 4.12 and 4.13, and their locations in Figs. 4.1 and 4.2 (§ 4.7).

6.5.1 Additional assemblages from England

6.5.1.1 Species frequency

The incidence of the three main domesticates varies, sometimes substantially, in the Late Roman and Early Anglo-Saxon assemblages from the literature (Figs. 6.5.1 and 6.5.2). However, it is possible to discern some trends which reflect the results from the material recorded for this study, as well as those from other works on Late Roman and early post-Roman zooarchaeology (§ 3.1 and 6.1-3).

Cattle prevails in most of the assemblages from the Late Roman period (Fig. 6.5.1), while the three main domesticates are more equally represented at the Early Anglo-Saxon sites (Fig. 6.5.2). 23 out of the 28 Late Roman assemblages are dominated by cattle, and in 20 of them the absolute majority of remains belong to this taxon; in 13 site-periods the frequency of cattle is over 60%, and in 7 over 80%. Conversely, cattle prevail in only 12 out of the 20 Anglo-Saxon site-periods, the rest being dominated by caprines; in 5 site-periods the incidence of cattle is over 60%, and only in 1 over 80%. In the Late Roman assemblages, pig is represented by slightly over 10% of the remains in only 7 cases; on the contrary, this happens in 14 Anglo-Saxon site-periods, with 5 of them getting very close or slightly over 20%.

No clear regional patterns are discernible for the Late Roman assemblages in terms of species frequency. Far from suggesting homogeneity in animal husbandry practices across Roman Britain (see § 3.1), this result may indicate that, within the central-eastern belt of southern Britain, the greater or lesser incidence of cattle was determined locally, depending on variables such as settlement density, proximity to urban or military sites, environmental conditions, or cultural choices; at the same time, taphonomic and recovery biases may have played a role as well. Anglo-Saxon assemblages, on the other hand, seem to display a greater degree of variability, and a regional pattern whereby the incidence of cattle is higher in the eastern sites.

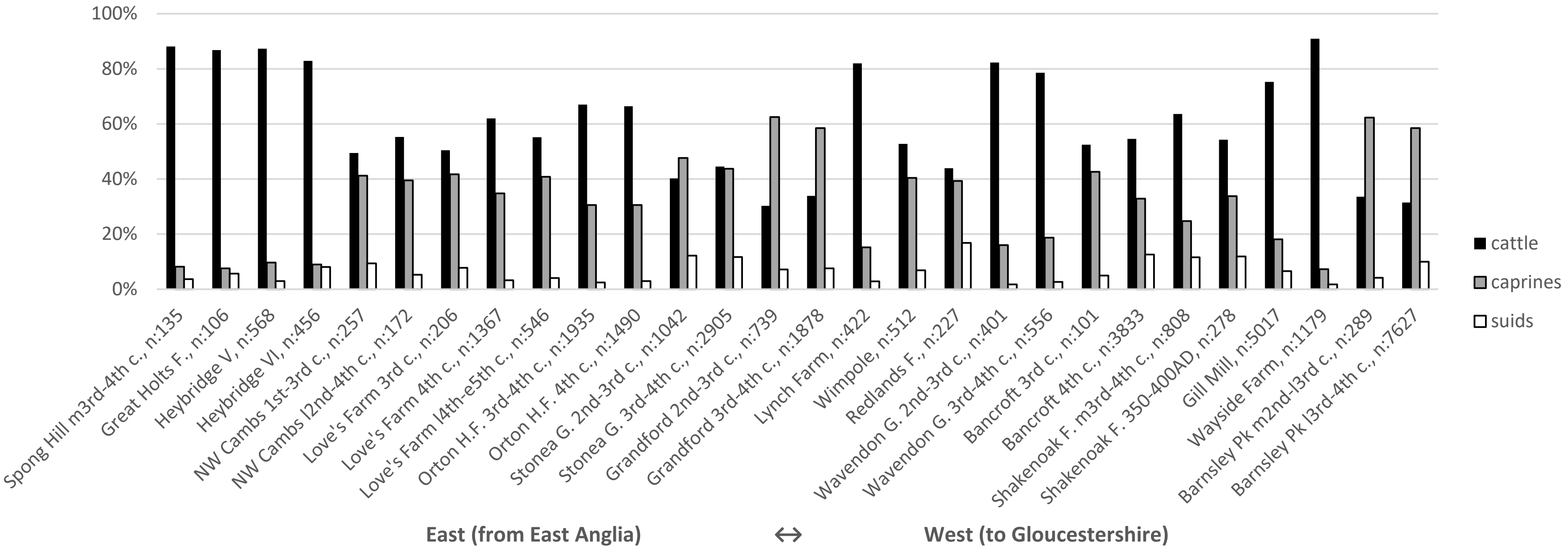


Fig. 6.5.1 NISP species frequencies for cattle, caprines, and suids in the Late Roman British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

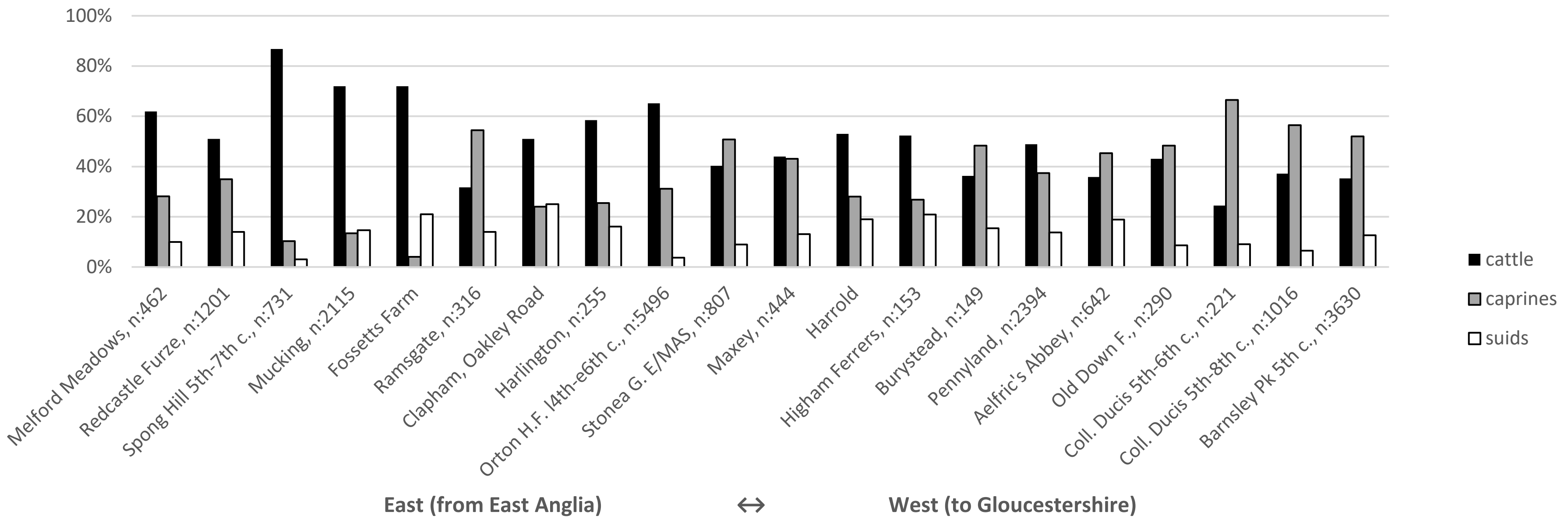


Fig. 6.5.2 NISP species frequencies for cattle, caprines, and suids in the Anglo-Saxon British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

6.5.1.2 Biometry

The distributions of cattle width, depth, and length measurements from the additional assemblages broadly confirm the results from the material recorded for this study. In almost all the Late Roman site-periods, the average values are higher than the Early Anglo-Saxon West Stow's standard, and often large and very large specimens are well represented (Figs. 6.5.3 and 6.5.5-6). Regional differences are difficult to detect, as not enough assemblages were available. However, the overall view is far from homogenous, and differences in the average size and value distribution are sometimes substantial. Great Holts Farm and Redlands Farm in particular, display very high values; other sites such as Heybridge, Wimpole, Bancroft, and Shakenoak Farm also present a high incidence of large specimens. Barnsley Park presents the lowest values, being similar in distribution and average to Early Anglo-Saxon West Stow; cattle size from this western site (Gloucestershire) most likely reflect the lack of improvement (and, more generally, 'Romanisation') of animal husbandry practices in western and northern Britain (§ 3.1). Differences in the average values of measurements on the three axes possibly indicate the existence of different cattle types; many Late Roman site-periods present a average value for lengths which are lower than those for widths and depths, suggesting the presence of more robust cattle than in Early Anglo-Saxon West Stow.

Inevitably, the sample sizes of additional assemblages from the Early Anglo-Saxon period are small. However, they consistently prove the presence of smaller cattle in post-Roman sites; these were similar or smaller than cattle from West Stow (Figs. 6.5.4 and 6.5.6). Robustness could only be assessed for Mucking: contrary to the Late Roman site-period assemblages, where smaller length averages suggest the presence of more robust cattle (e.g. Shakenoak Farm), at Mucking widths are smaller than lengths (which, in turn, remain smaller than Late Roman values), indicating a more gracile constitution of animals from this site.

Cattle tooth biometrical data were available from a smaller number of assemblages, all dated to the Late Roman period (Fig. 6.5.7). Within each site, the average values are smaller than for bone measurements, reflecting the smaller susceptibility of teeth to external changes and possibly suggesting that the larger size of Roman cattle was mainly, though not only, the result of local improvement. Despite this, differences in tooth size between Late Roman and Early Anglo-Saxon assemblages are not rare, and suggest a genuine genetic difference between many groups of Roman and post-Roman cattle.

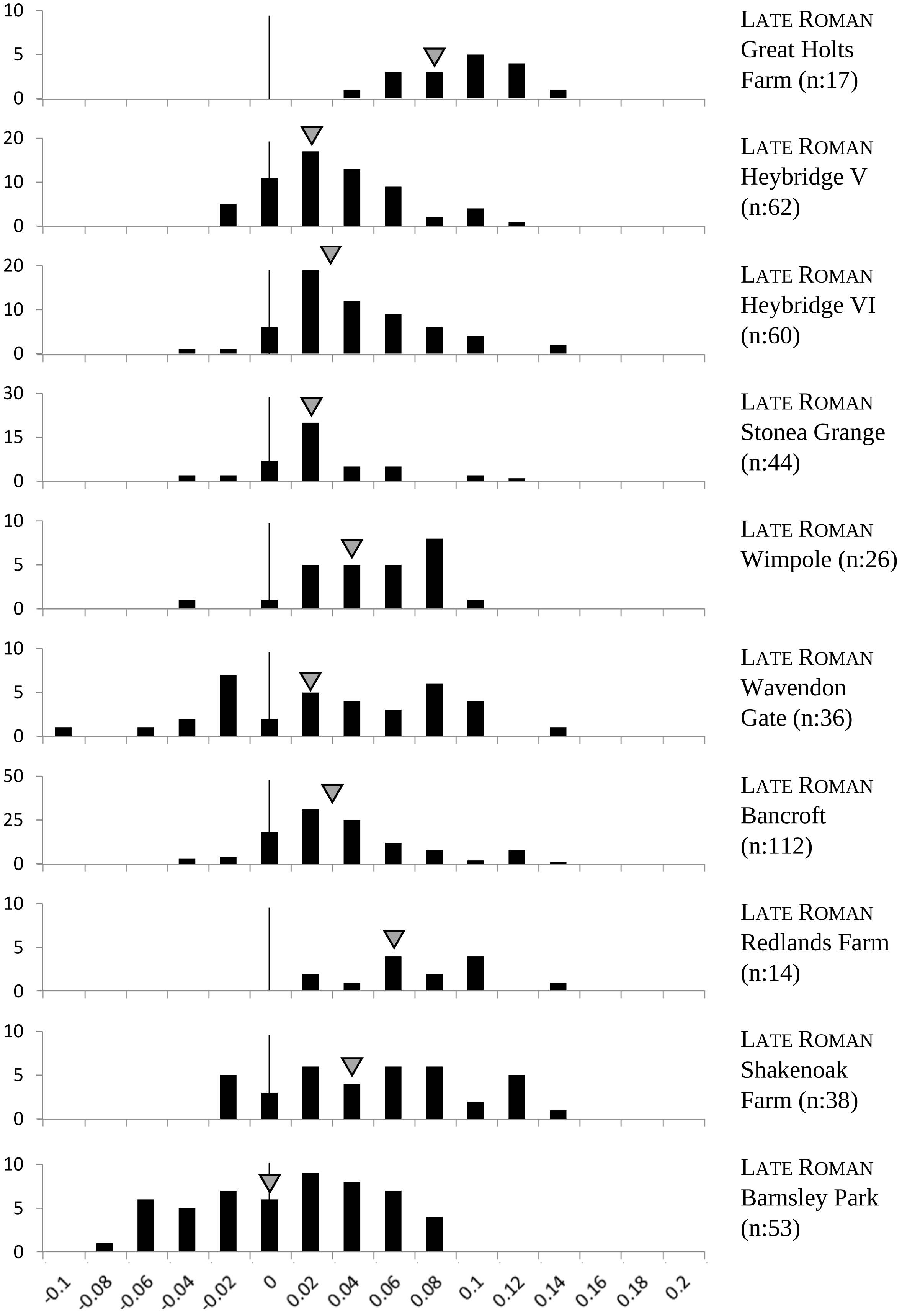


Fig. 6.5.3 Distribution of log ratio values of a selection of cattle bone widths from the Late Roman British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

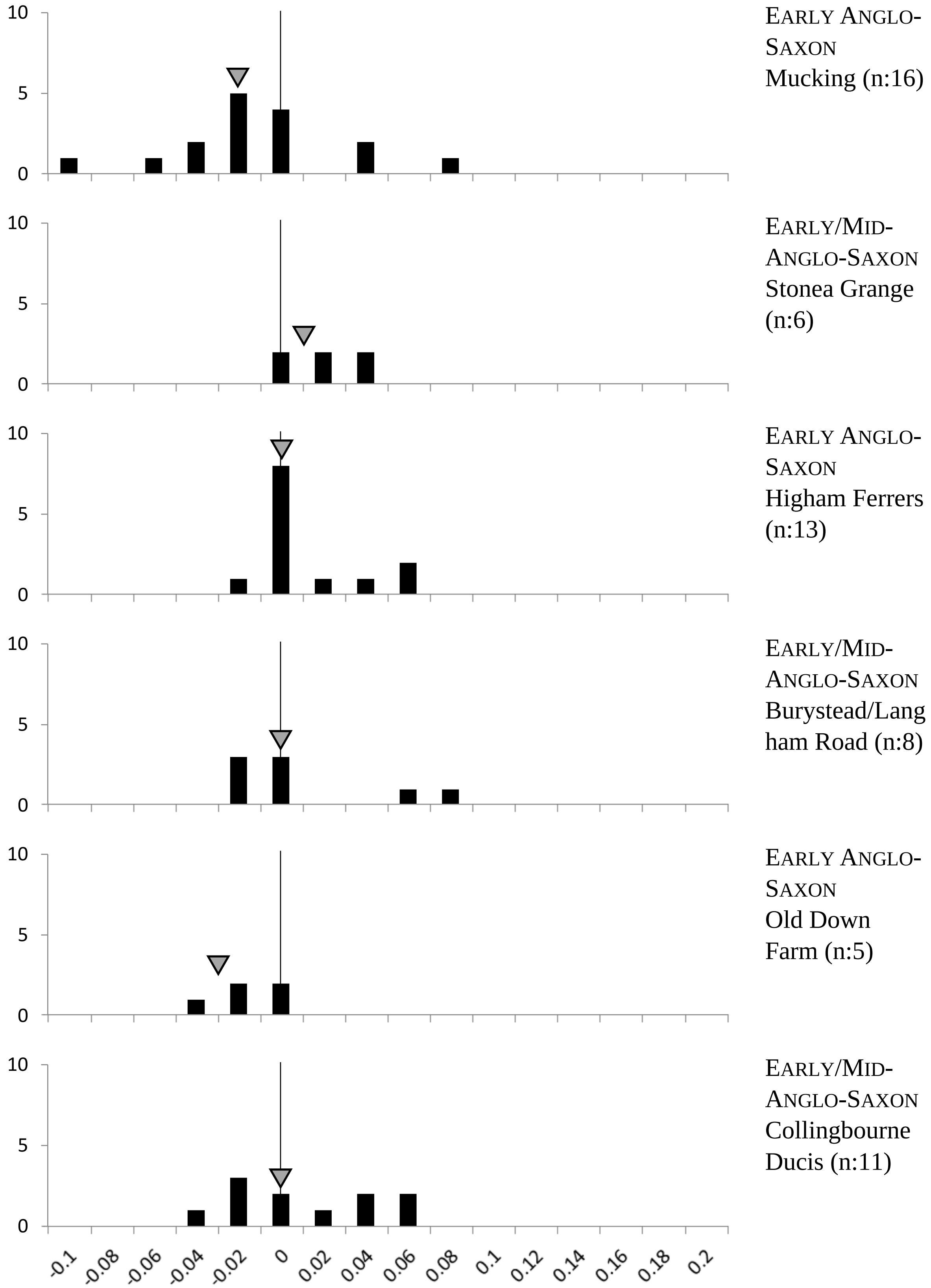


Fig. 6.5.4 Distribution of log ratio values of a selection of cattle bone widths from the Anglo-Saxons British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

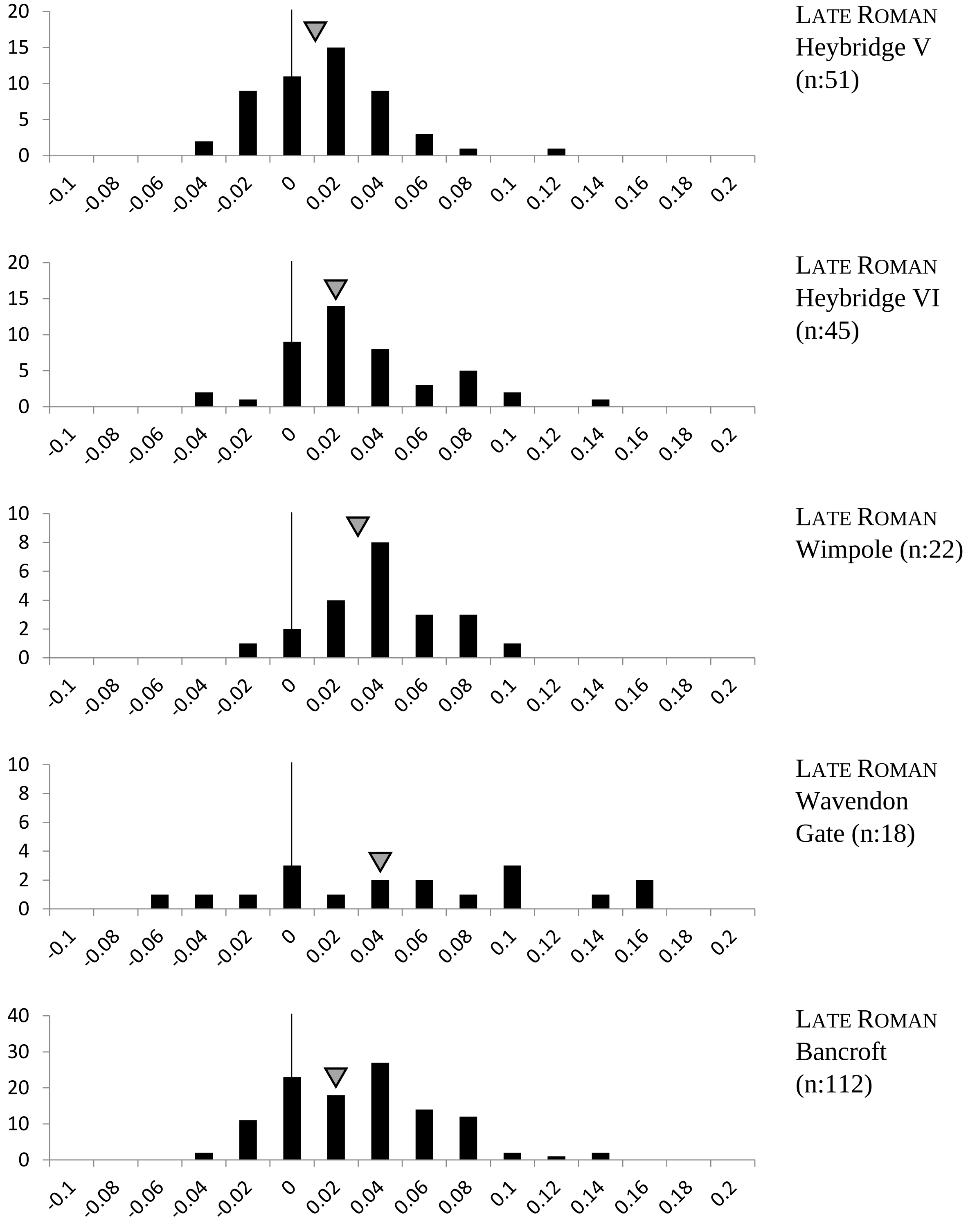


Fig. 6.5.5 Distribution of log ratio values of a selection of cattle bone depths from the Late Roman British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

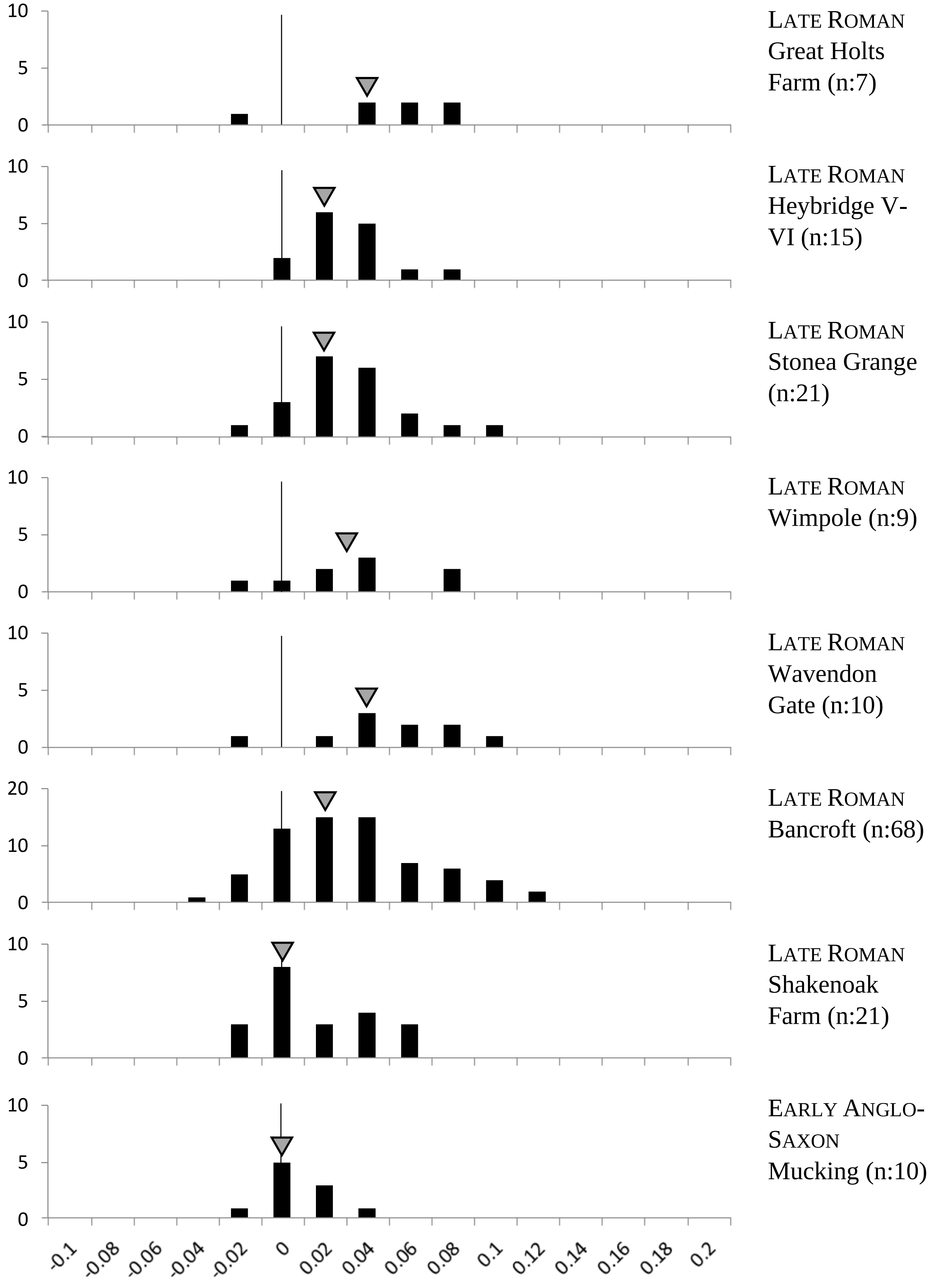
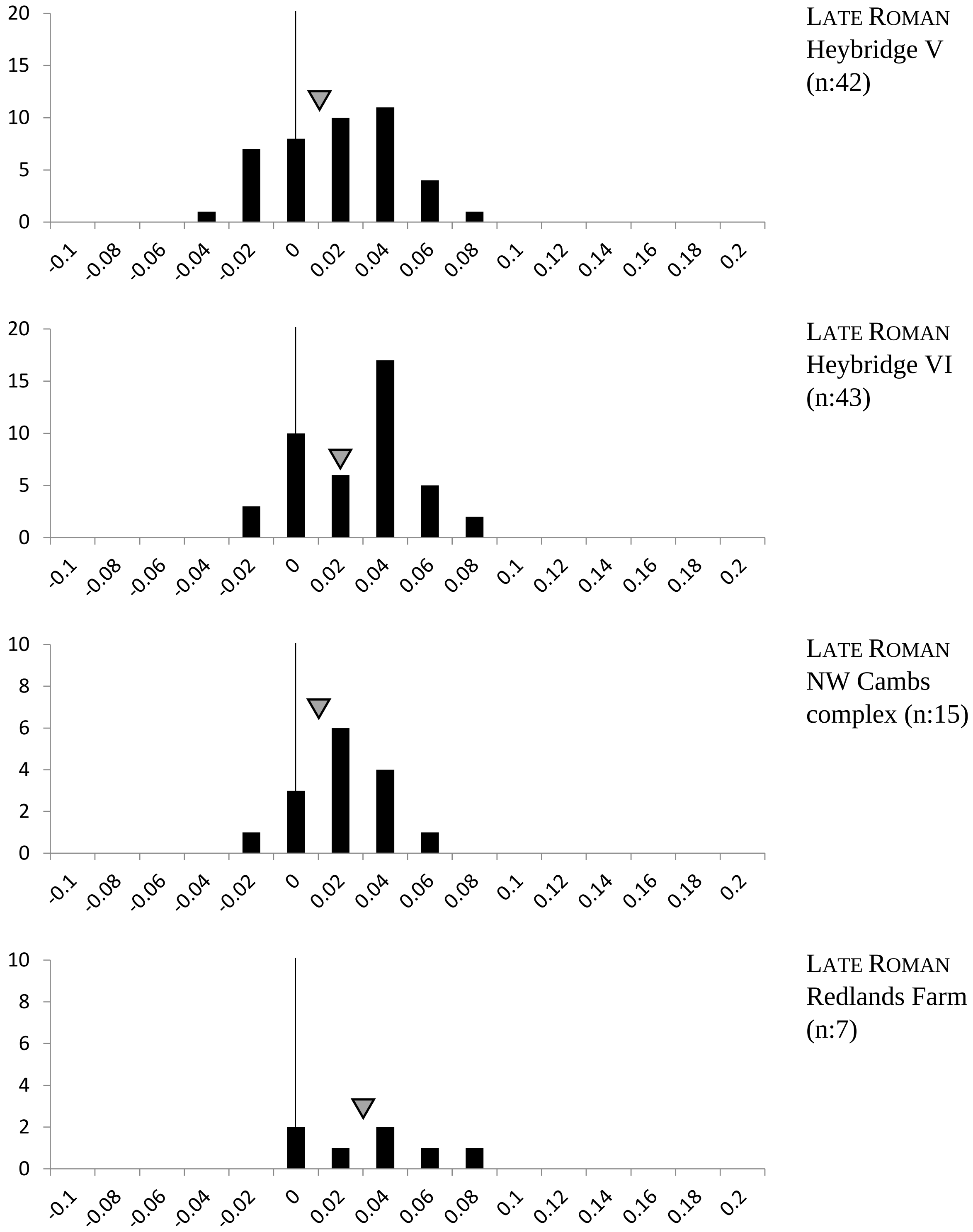


Fig. 6.5.6 Distribution of log ratio values of a selection of cattle bone lengths from the Late Roman and Anglo-Saxon British assemblages from the literature (ordered chronologically and east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.



LATE ROMAN Heybridge V (n:42)

LATE ROMAN Heybridge VI (n:43)

LATE ROMAN NW Cambs complex (n:15)

LATE ROMAN Redlands Farm (n:7)

Fig. 6.5.7 Distribution of log ratio values of a selection of cattle tooth widths from the Late Roman British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

Similarly to cattle, the average sizes and distributions of caprine values from the additional Late Roman site-periods are quite variable (Fig. 6.5.8). In general, sheep from these sites seem to have been of the same size as or smaller than animals from Early Anglo-Saxon West Stow, with only three site-periods presenting an average width value slightly higher than the standard. The assemblages with caprine width averages smaller than the West Stow's standard include Bancroft and Shakenoak Farm, where cattle bones, on the other hand, were particularly large. The very small size of caprines from the western site of Barnsley Park (Gloucestershire), however, fits well the result from cattle biometrical analyses.

Despite the small samples, the sizes of caprines from Anglo-Saxon Ramsgate and Stonea Grange reflect those from Late Roman assemblages (Fig. 6.5.9). Other contemporary site-periods are characterised by lower values; however, these sites are all located at the western end of the region here considered, where domesticates are likely to have been much less affected by Roman improvement, and where smaller sheep would have survived into the early post-Roman period.

The analyses of caprine tooth widths support the fact that, if improved in Roman times, sheep largely retained its size in some parts of Early Anglo-Saxon England (Fig. 6.5.10). Averages from the additional Late Roman site-periods are very similar to the West Stow's standard, reflecting the results obtained from the assemblages recorded for this study.

Pig bone and tooth measurements from the additional site-periods show a similar variability to that observed in the material from the recorded assemblages (Figs. 6.5.11 and 6.5.12). The large size of most suid bones from Late Roman Heybridge, coupled with the smaller average size of teeth, might suggest the presence at this site of locally improved pigs. In general, however, the dearth of Roman British assemblages with good-sized samples of measurable suid remains, as well as the many variables affecting suid body size, make the interpretation of results rather problematic; biometrical data from pig remains will be discussed in detail in Chapter 7.

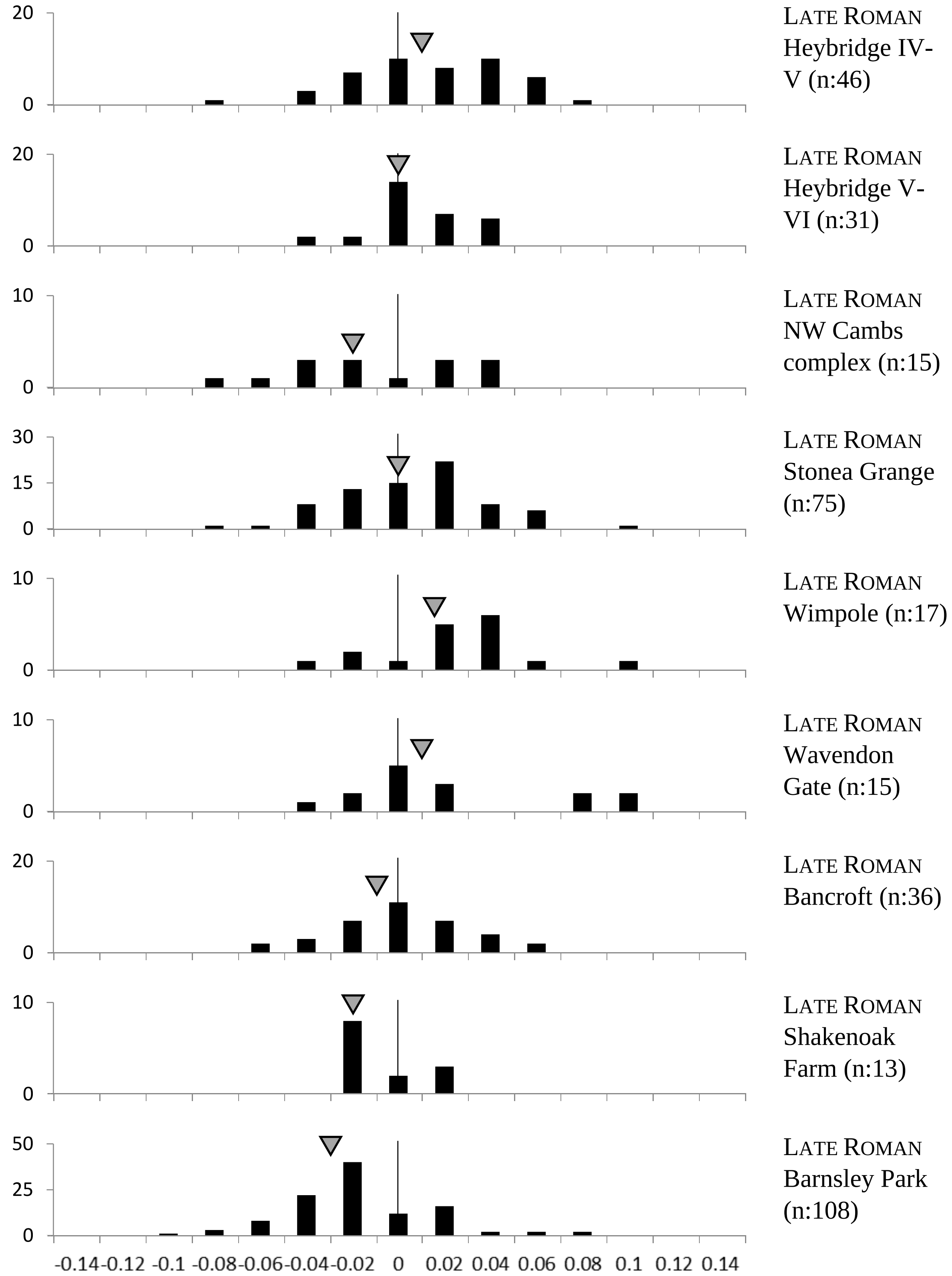
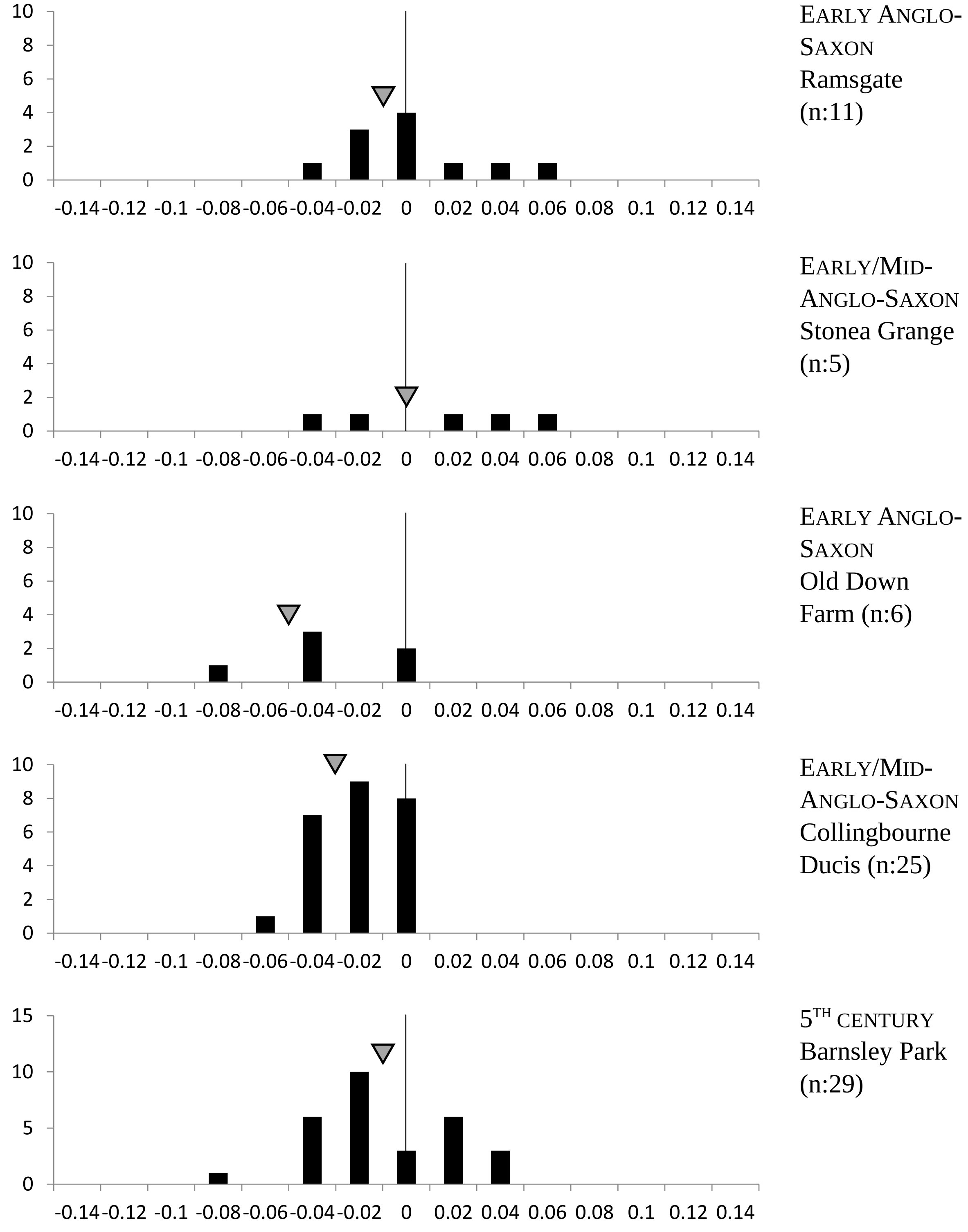


Fig. 6.5.8 Distribution of log ratio values of a selection of caprine bone widths from the Late Roman assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.



EARLY ANGLO-SAXON Ramsgate (n:11)

EARLY/MID-ANGLO-SAXON Stonea Grange (n:5)

EARLY ANGLO-SAXON Old Down Farm (n:6)

EARLY/MID-ANGLO-SAXON Collingbourne Ducis (n:25)

5TH CENTURY Barnsley Park (n:29)

Fig. 6.5.9 Distribution of log ratio values of a selection of caprine bone widths from the Anglo-Saxon British assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

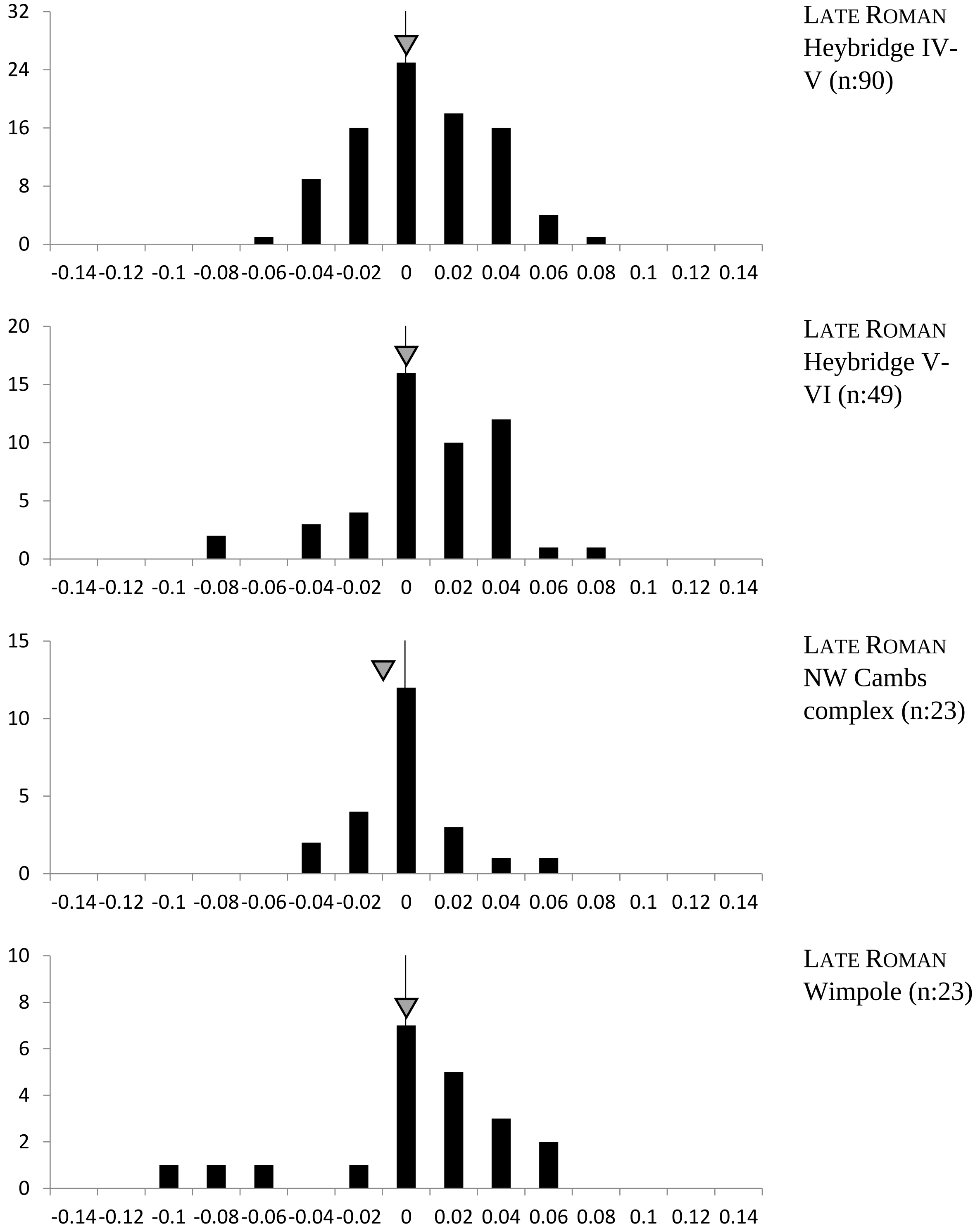


Fig. 6.5.10 Distribution of log ratio values of a selection of caprine tooth widths from the Late Roman assemblages from the literature (ordered east to west). For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

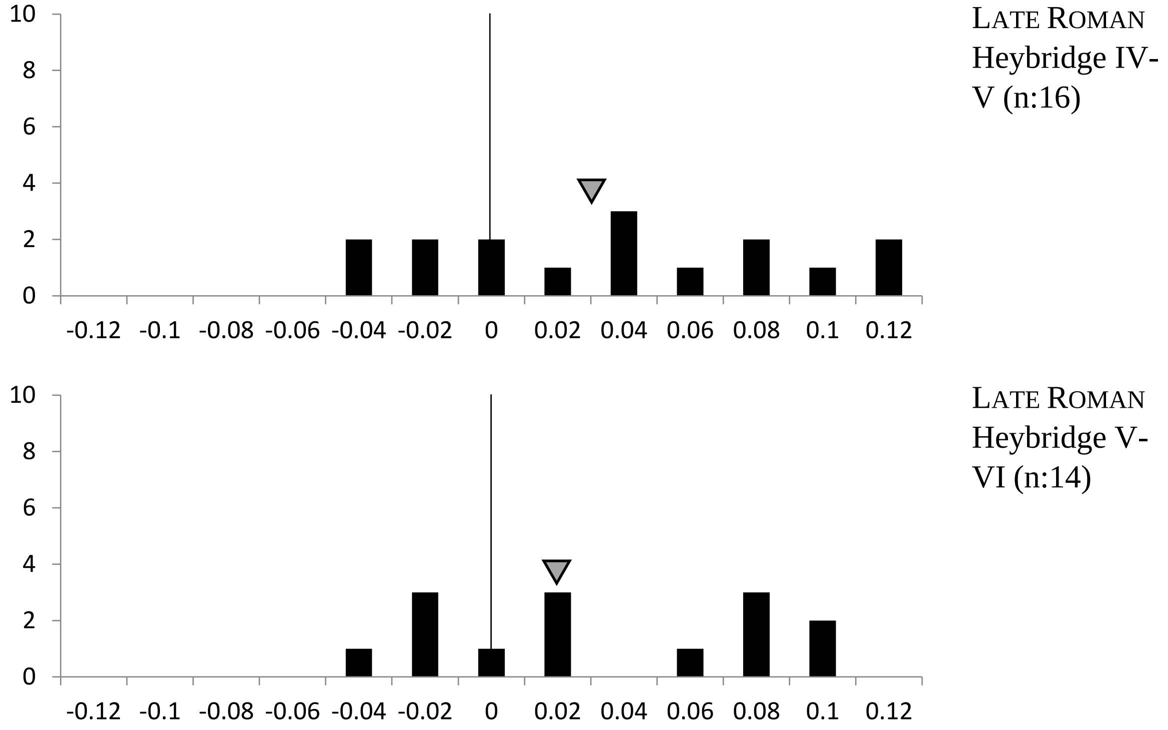


Fig. 6.5.11 Distribution of log ratio values of a selection of suid bone measurements from Late Roman Heybridge. For information on site location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

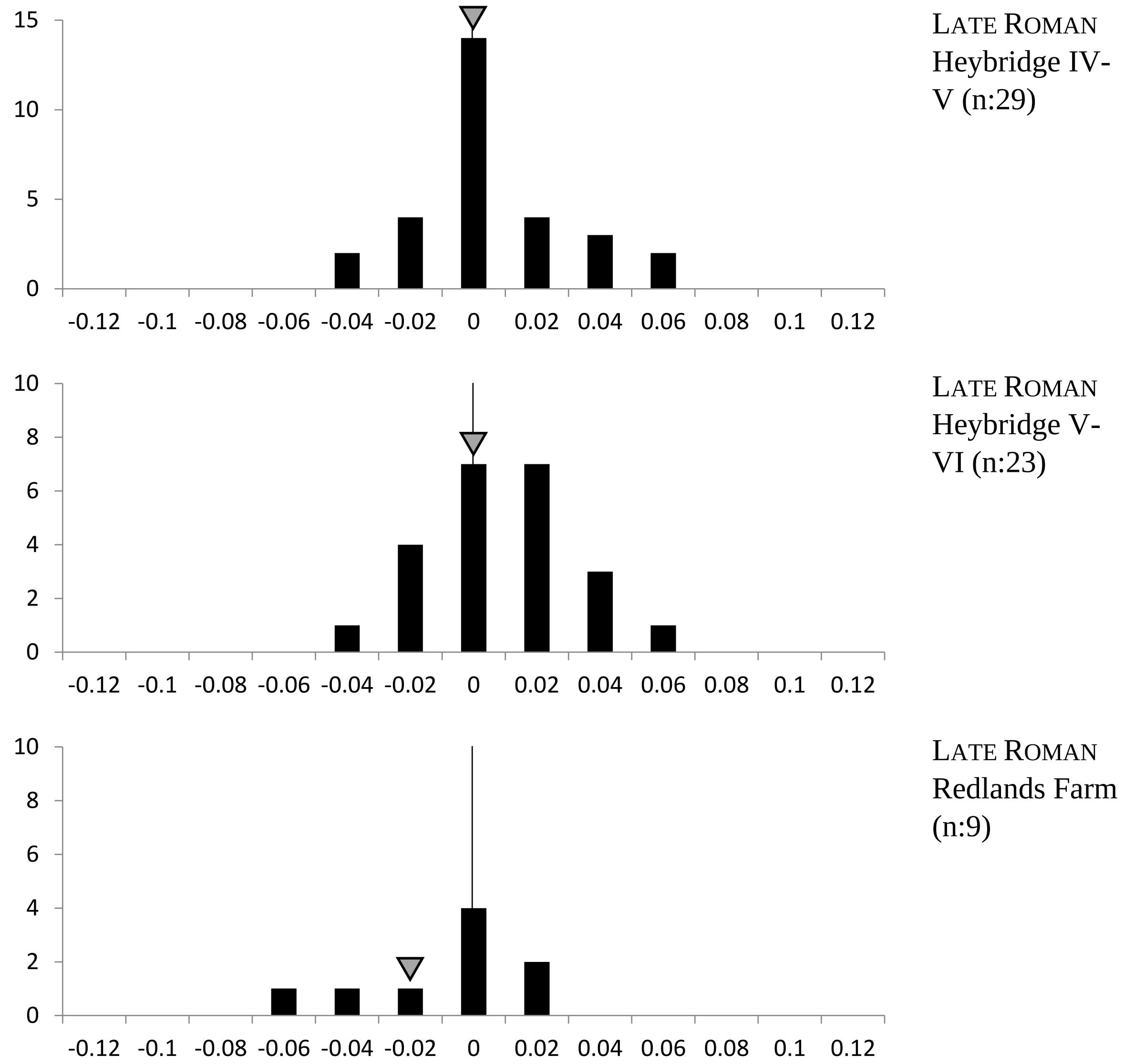


Fig. 6.5.12 Distribution of log ratio values of a selection of suid tooth widths from the Late Roman from the literature. For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

6.5.2 Additional assemblages from the Lower Rhineland

6.5.2.1 Species frequency

All additional assemblages from the Lower Rhineland are dated to the Late Roman period. Most of them were collected from rural sites from the region south-west of the *limes,* with the exception of the military site of Nijmegen Valkhof, the rural site of Naaldwijk, located west of the Rhine in Roman territory, and Ferwerderadeel-Oosterbeintum, a rural site located in Friesland. The sites from the border region, including the military site of Nijmegen, reveal a consistent and neat predominance of cattle, whose frequencies are always over 60%, and over 70% in 5 assemblages out of 9 (Fig. 6.5.13). Pig is well represented at these sites, with an incidence in all cases close to or beyond 20%; conversely, caprines are often barely represented, with only one site displaying a frequency beyond 10%. The more westerly site of Naaldwijk presents a similar pattern, though the frequencies of suids and caprines are inverted. Similarly to Wijnaldum, the assemblage from the Frisian site of Ferwerderadeel shows a much higher incidence of caprines, which are the most represented taxon, followed by cattle; pig is barely present.

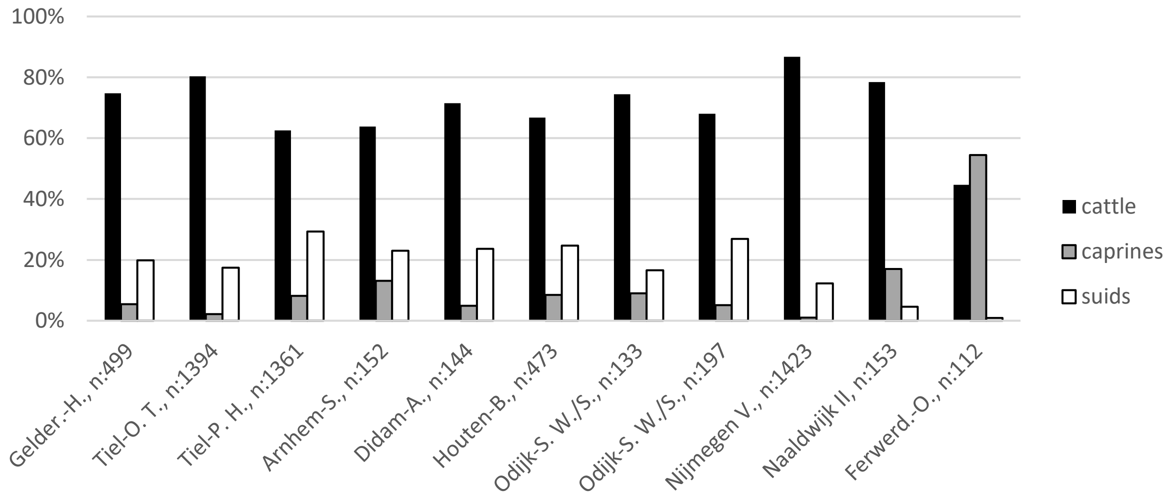
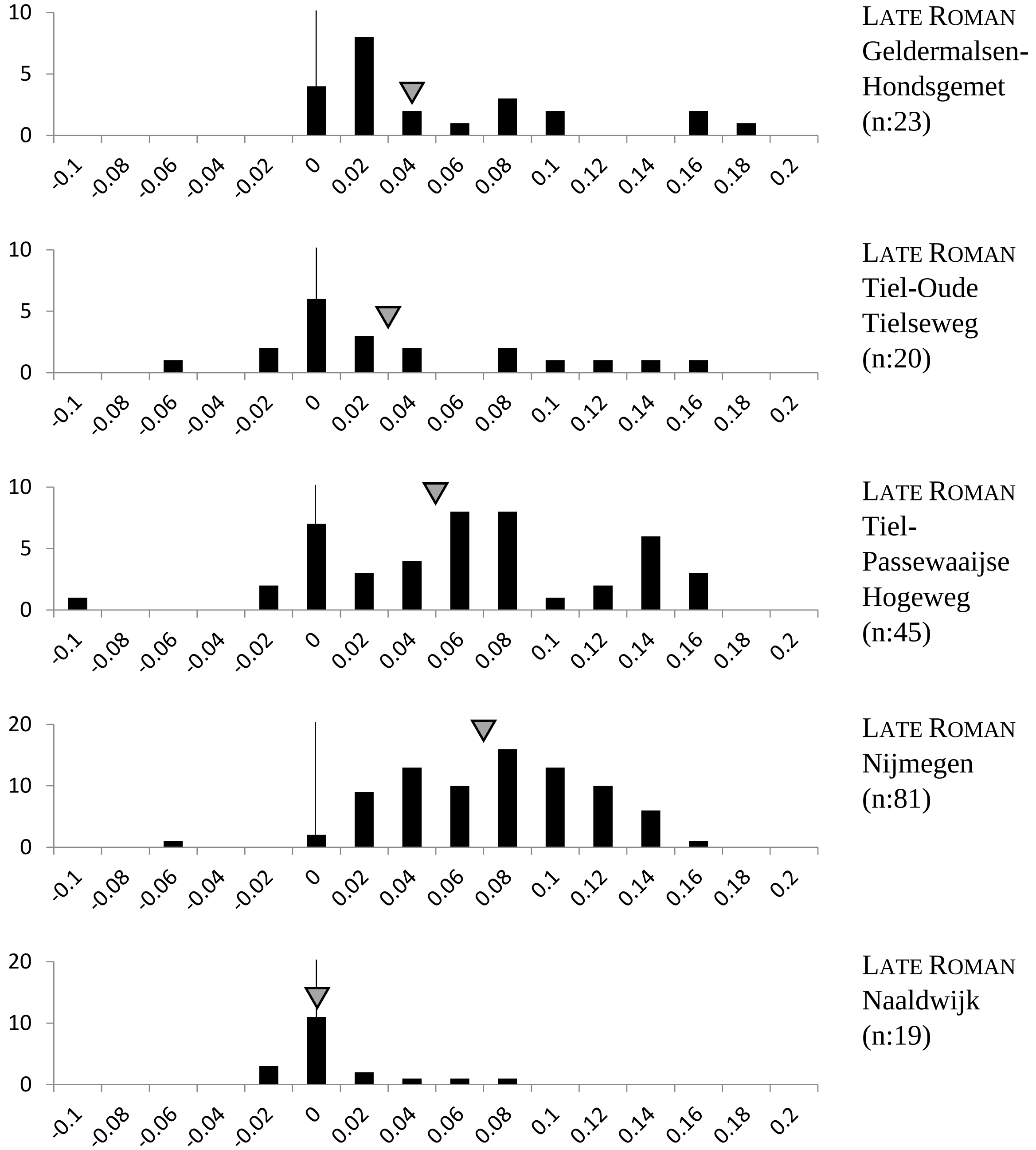


Fig. 6.5.13 NISP species frequencies for cattle, caprines, and suids in the Late Roman Lower Rhenish assemblages from the literature. For complete names of sites, location, chronology, settlement type and references see Tab. 4.13 in Chapter 4: Sites and materials.

6.5.2.2 Biometry

Cattle bone measurements from the Lower Rhenish additional sites indicate that animals from the region of the *limes* were particularly large in all assemblages, and similar in size to those from Late Roman De Geer and from 3rd-4th century Heeten (Figs. 6.5.14 and 6.5.15; § 6.4.4.1). The average sizes and distributions from two of the sites (Tiel-Passewaaijse Hogeweg and Nijmegen), similarly to those from De Geer and Heeten, compare well to the averages and distributions from Late Roman Great Holts Farm and Redlands Farm, which present the highest values from British sites; the other two sites (Geldermalsen-Hondsgemet and Tiel-Oude Tielseweg) display only slightly smaller values, being similar in average size and distribution to Late Roman Heybridge, Wimpole, Bancroft, and Shakenoak Farm (§ 6.5.1.2). The much smaller size of cattle from Late Roman Naaldwijk suggests some degree of variability in the extent of animal improvement in the region; this may be the result of the site's isolation in comparison to the denser settlement area of the border, as well as of its smaller sample size.

Measurements from pig bones display a similar degree of variability to that detected in British assemblages, and values close to those from the material from Lower Rhenish sites recorded for this study (Fig. 6.5.16; § 6.4.4.3). No clear chronological or geographical differences are discernible.



LATE ROMAN
Geldermalsen-Hondsgemet
(n:23)

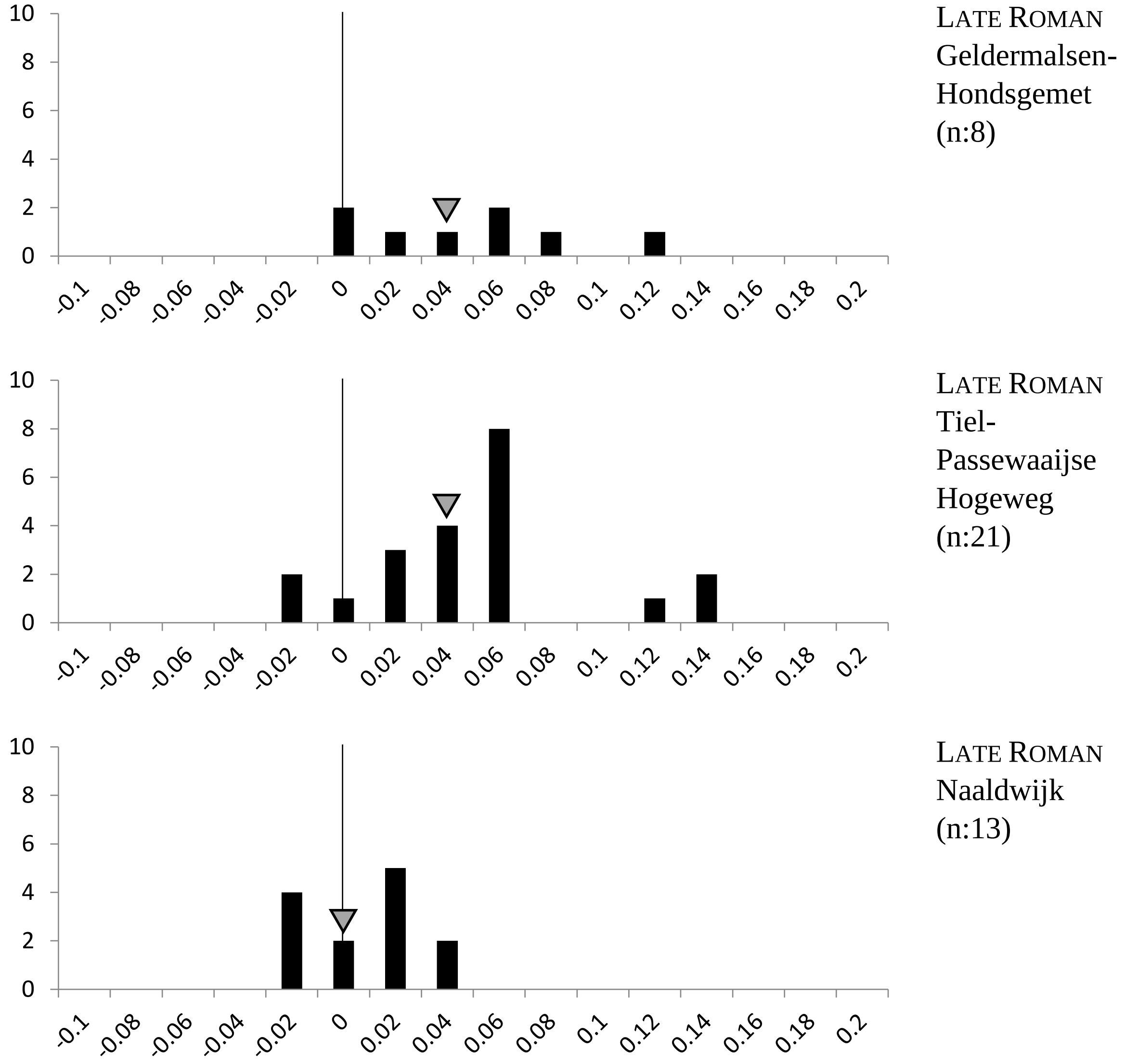
LATE ROMAN
Tiel-Oude Tielseweg
(n:20)

LATE ROMAN
Tiel-Passewaaijse Hogeweg
(n:45)

LATE ROMAN
Nijmegen
(n:81)

LATE ROMAN
Naaldwijk
(n:19)

Fig. 6.5.14 Distribution of log ratio values of a selection of cattle bone widths from the Late Roman Lower Rhenish assemblages from the literature. For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.



LATE ROMAN
Geldermalsen-Hondsgemet
(n:8)

LATE ROMAN
Tiel-Passewaaijse Hogeweg
(n:21)

LATE ROMAN
Naaldwijk
(n:13)

Fig. 6.5.15 Distribution of log ratio values of a selection of cattle bone lengths from the Late Roman Lower Rhenish assemblages from the literature. For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

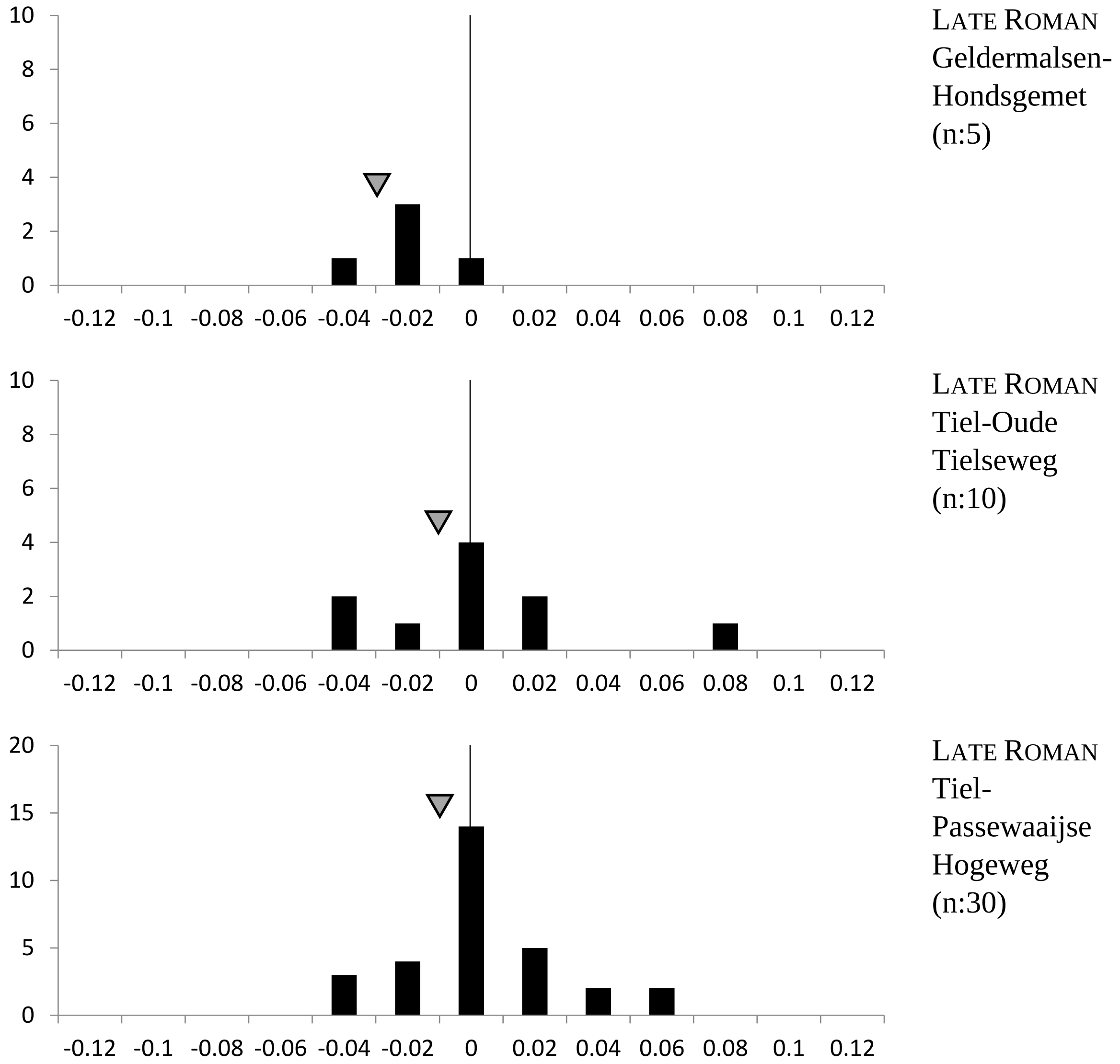


Fig. 6.5.16 Distribution of log ratio values of a selection of suid bone measurements from the Late Roman Lower Rhenish assemblages from the literature. For complete names of sites, location, chronology, settlement type and references see Tab. 4.12 in Chapter 4: Sites and materials.

6.5.3 Summary graphs

The following ternary plots and boxplots summarise the evidence from the material analysed for this study as well as from the additional assemblages from the literature. The chronological and geographical differences summarised in these graphs will be discussed in Chapter 7.

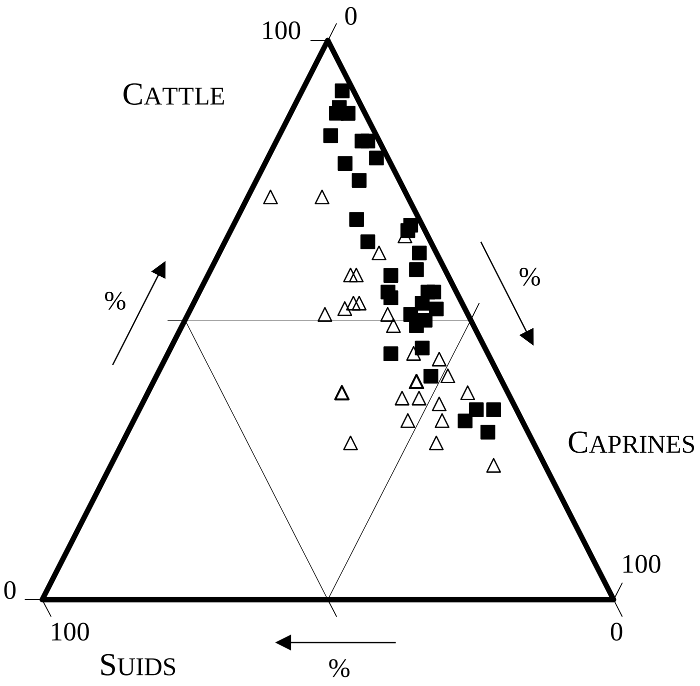


Fig. 6.5.17 Ternary plot for the NISP frequencies of cattle, caprines, and pigs in the British Late Roman and Early Anglo-Saxon site-periods analysed for this study. Black squares: Late Roman, white triangles: Early Anglo-Saxon.

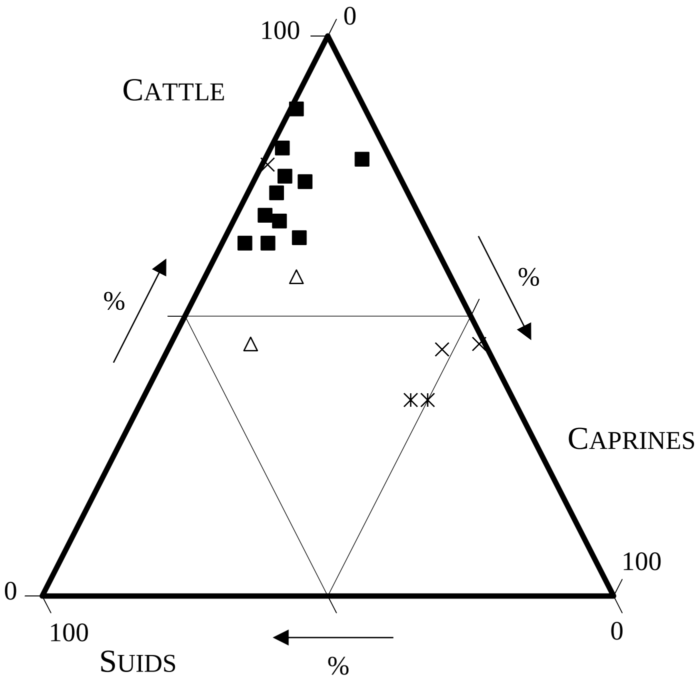


Fig. 6.5.18 Ternary plot for the NISP frequencies of cattle, caprines, and pigs in the Lower Rhenish Late Roman and Merovingian site-periods analysed for this study. Black squares: Late Roman site-periods located in Roman territory, white triangles: Merovingian site-periods in former Roman territory, crosses: Late Roman site-periods in Germanic territory, stars: Merovingian site-periods outside the former borders of the Roman Empire.

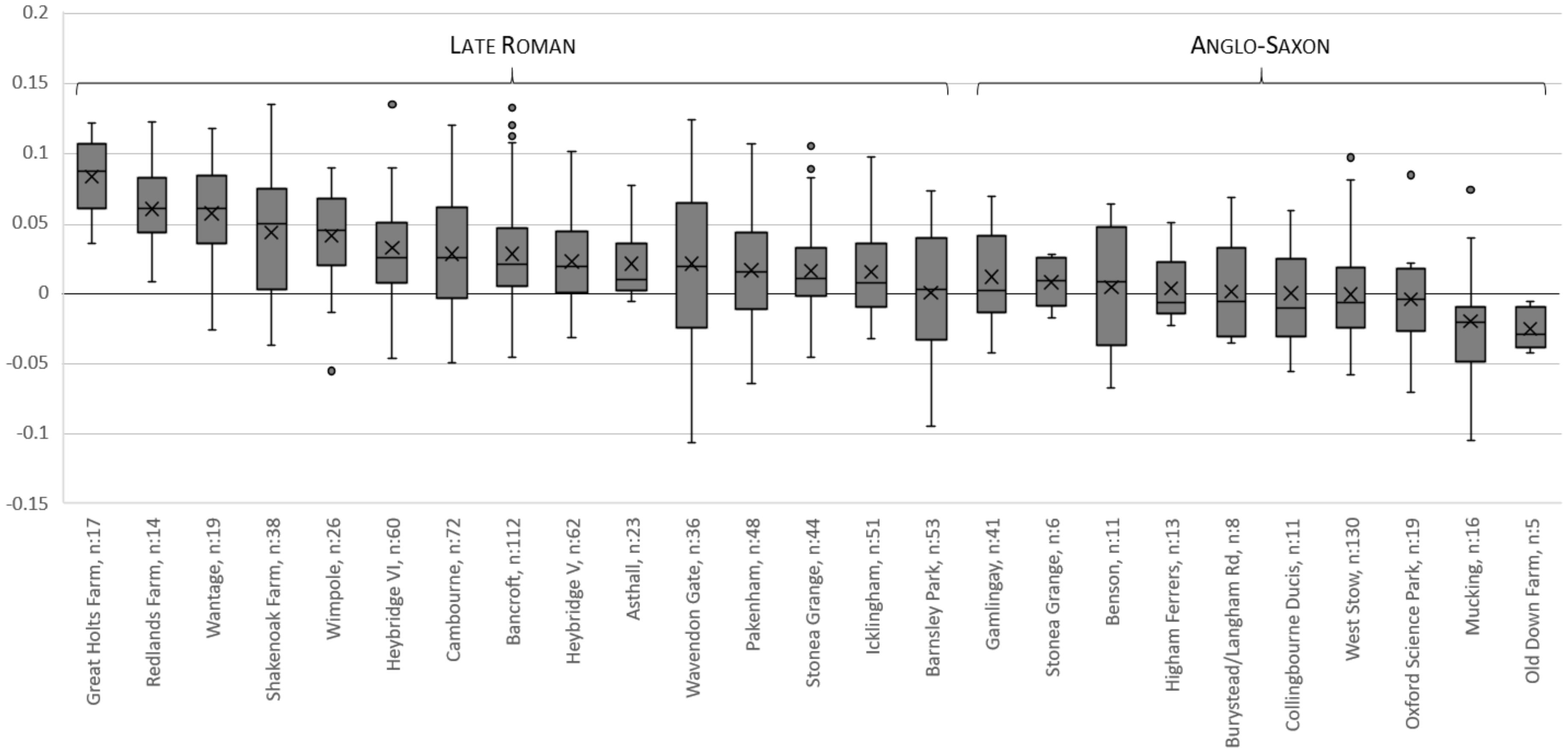


Fig. 6.5.19 Boxplots with whiskers and outliers of **cattle bone width** log ratio values from Late Roman and Early/Mid-Anglo-Saxon British assemblages. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

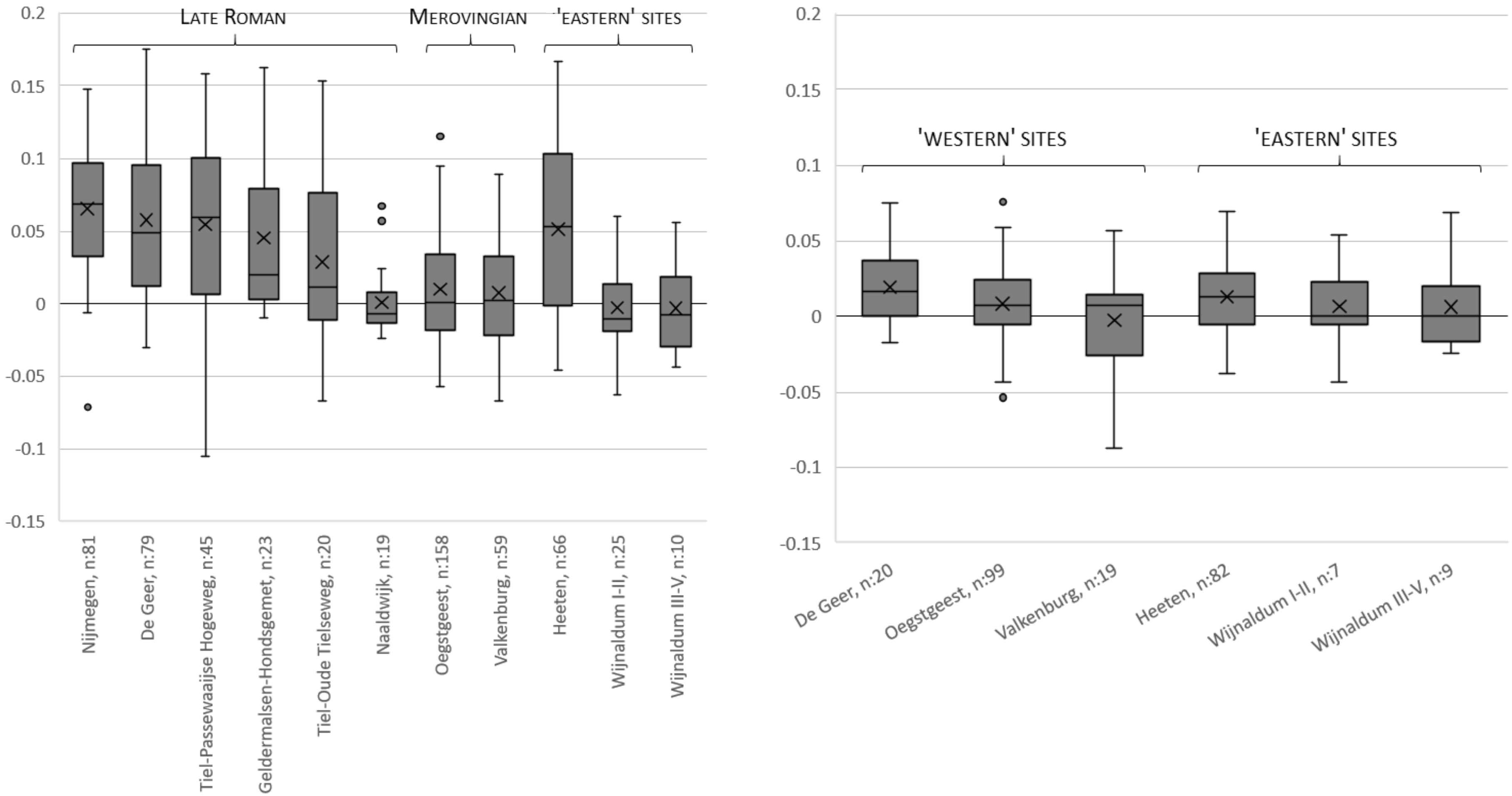


Fig. 6.5.20 Boxplots with whiskers and outliers of **cattle bone width** (left) and **tooth width** (right) log ratio values from Late Roman and Merovingian assemblages from the Lower Rhineland. ‘Western’ refers to sites located west of the Rhine, in former Roman territory, while ‘eastern’ to those located east of the Rhine, in Germanic territory. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

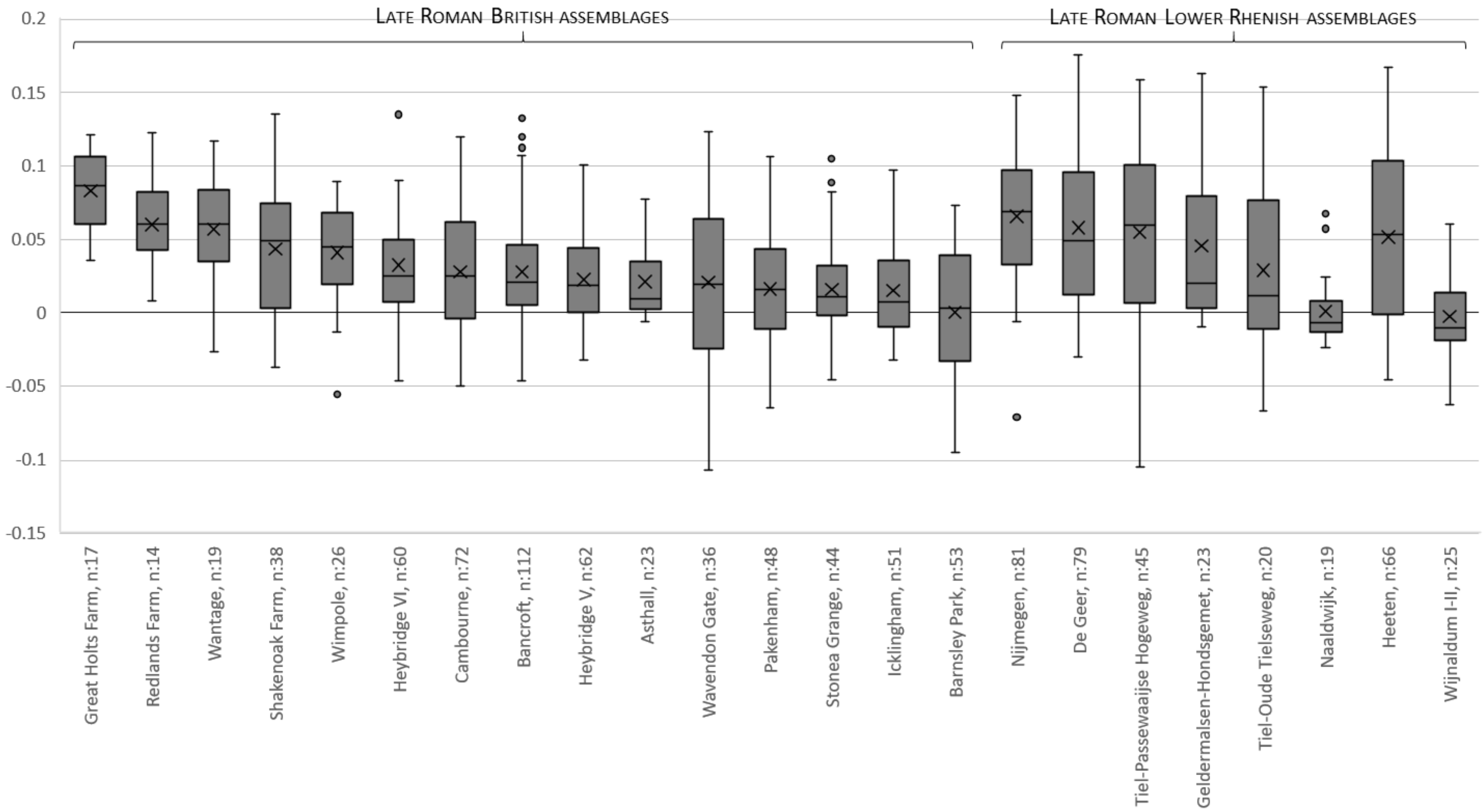


Fig. 6.5.21 Boxplots with whiskers and outliers of **cattle bone width** log ratio values from Late Roman British and Lower Rhenish assemblages. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

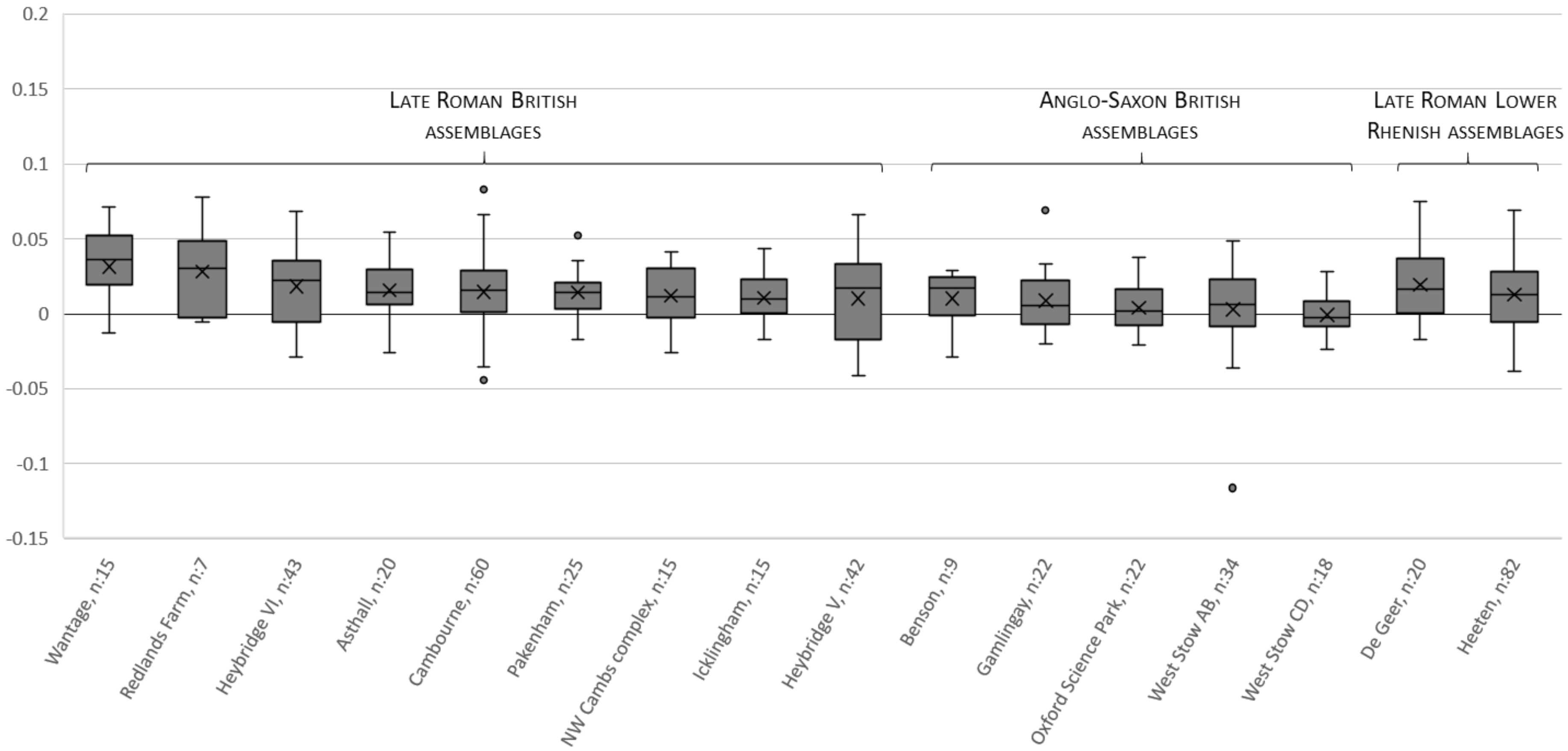


Fig. 6.5.22 Boxplots with whiskers and outliers of **cattle tooth width** log ratio values from Late Roman and Early/Mid-Anglo-Saxon British assemblages, and from Late Roman assemblages from the Lower Rhineland. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

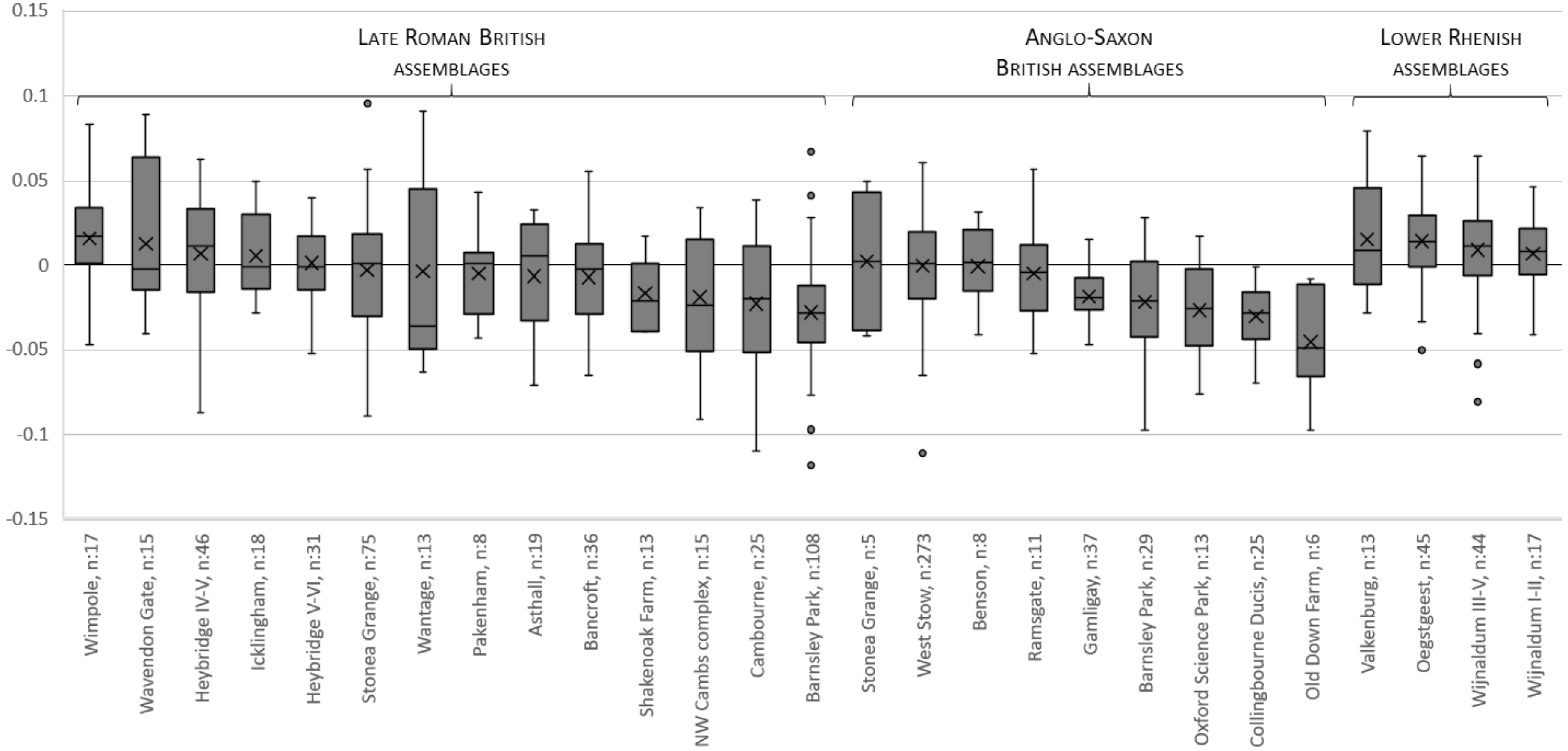


Fig. 6.5.23 Boxplots with whiskers and outliers of **caprine bone width** log ratio values from Late Roman and Early/Mid-Anglo-Saxon British assemblages, and from Lower Rhenish assemblages. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

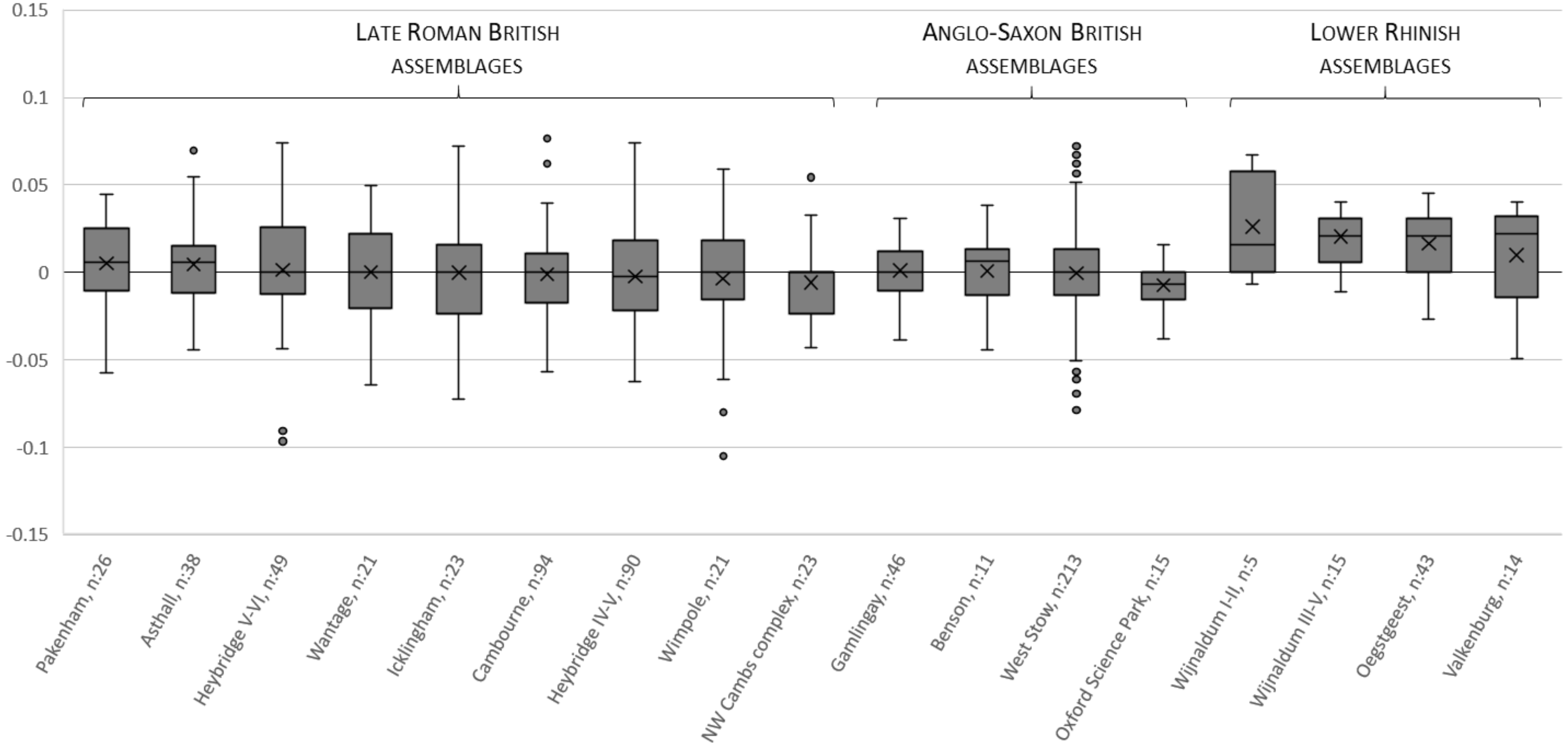


Fig. 6.5.24 Boxplots with whiskers and outliers of **caprine tooth width** log ratio values from Late Roman and Early/Mid-Anglo-Saxon British assemblages, and from Lower Rhenish assemblages. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

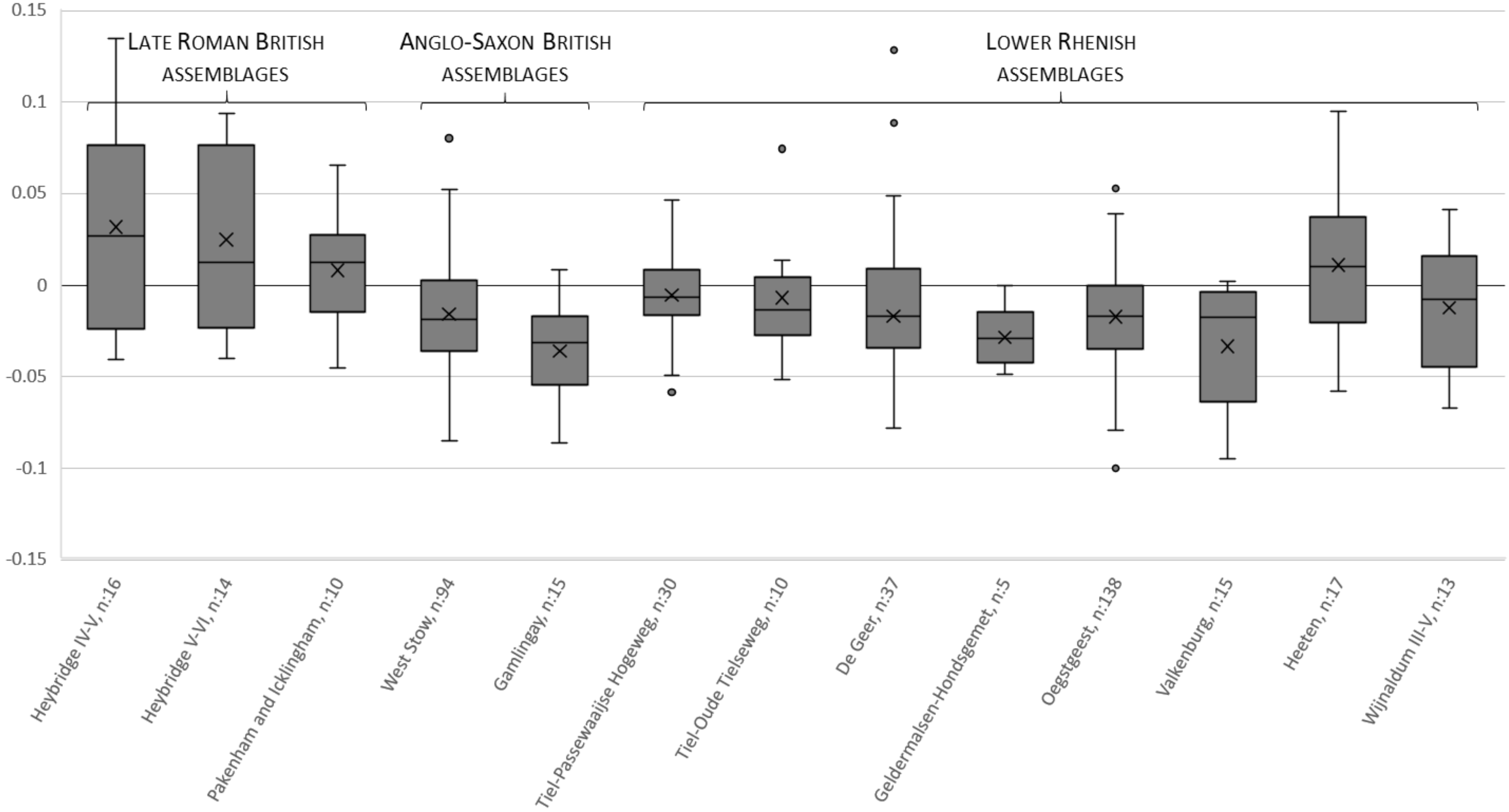


Fig. 6.5.25 Boxplots with whiskers and outliers of **suid bone width** log ratio values from Late Roman and Early Anglo-Saxon British assemblages, and from Lower Rhenish assemblages. Crosses: average values, bars: median values.

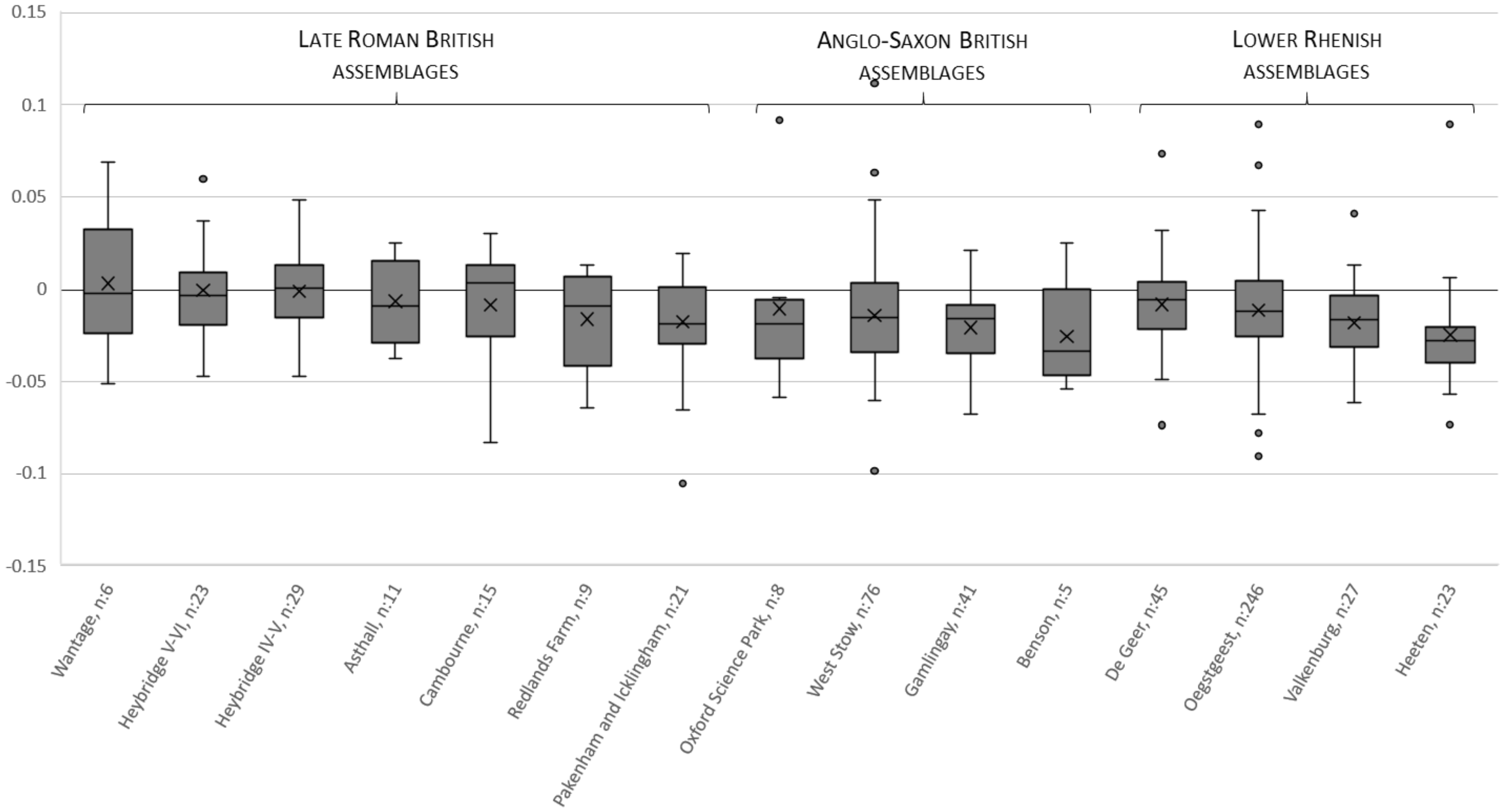


Fig. 6.5.26 Boxplots with whiskers and outliers of **suid tooth width** log ratio values from Late Roman and Early Anglo-Saxon British assemblages, and from Lower Rhenish assemblages. Within each group, site-periods are organised from largest to smallest average value. Crosses: average values, bars: median values.

CHAPTER 7

Discussion

The first part of the following discussion takes into consideration the nature of animal husbandry practices in Late Roman Britain, and the inferences that can be drawn from it about the economy of this province in the 3rd-4th centuries AD. In the second section, differences and similarities with animal exploitation in Early Anglo-Saxon England are discussed, in order to investigate how patterns of continuity and discontinuity can inform us about the changing nature and aims of early post-Roman food production practices. References to results from the Lower Rhenish assemblages are used to complement and support interpretations of the evidence from the sites from England.

7.1 Late Roman Britain: the persistence of an intensive food economy

The Roman conquest of Britain impacted greatly on animal husbandry practices. Some evidence of change can already be detected in the Late Iron Age; in the southern site of Owslebury, for example, cattle start increasing in size before the arrival of the Romans (Valenzuela-Lamas *et al.* in prep.), and cattle mobility (in the form of animal trade or supply) increases as well (Minniti *et al.* 2014). Imports at this and other sites point to increasing contacts with the Continent, and economic strategies which started challenging the previous models of food production (Cunliffe 2005; Eckardt *et al.* 2014; Lodwick 2014). A similar phenomenon had characterised animal husbandry practices in pre-Roman Gaul, when increasing economic complexity and trade since the Middle La Tène period prompted an initial increase in the size of cattle and pig (Duval *et al.* 2013; 2018; Frémondeau *et al.* 2017); similarly, pre-Roman improvements in the size of cattle and sheep have recently been detected in Iron Age northern Italy (Trentacoste *et al.* 2018). However, since the mid-1st century AD, zooarchaeological studies on British material have revealed changes that are more radical, widespread, and paralleled by complementary developments in other sectors of food production and of the economy more generally; the scale and nature of change imply the advent and overarching influence of a new agent, namely the direct control of the Roman State over food production and redistribution strategies. Esmonde-Cleary (1989) highlighted that, throughout the Roman Empire, the impact of change would have been greater in areas where pre-Roman economic systems were entirely different (e.g. where taxation was absent or very rudimentary). Despite the pre-Roman developments outlined above, therefore, the sharp contrasts between Late Iron Age and Roman husbandry practices in Britain could partly be explained with the radical changes in food production strategies imposed on the island by the Roman state (Esmonde Cleary 1989).

Changes in the economy were supported by the rapid development of a functional settlement hierarchy, as well as of infrastructures which allowed faster and more efficient communication and transport of people and resources (including animals). Yet, change in Britain (and in the north-western provinces more generally) was not developed in similar ways to other parts of the Empire; rather, it was adapted to meet local environmental conditions and to better exploit the advantages brought about by the presence of extensive, fertile, and well-watered lowlands (see Chapter 4). At the same time, such developments were also influenced by cultural preferences (both native and imported) as well as regional differences.

Different husbandry strategies aimed at the maximisation of outputs from primary and secondary animal products spread relatively quickly to different parts of the province. The zooarchaeological analyses of the Late Roman assemblages included in this study support the continuity of such ‘Romanised’ animal husbandry practices during the 3rd and 4th centuries AD, namely, up to the very end of Roman Britain. Although it was not possible to analyse material strictly dated to the last decades of Roman rule in the island, the high degree of consistency of available data, as well as the clear prevalence of traits typical of Romanised husbandry practices, suggest no substantial changes occurred before the end of the 4th century. So far, no zooarchaeological studies have managed to highlight exceptions to this trend in the south- and central-eastern parts of Britain. A recent study by Duval and Albarella (sub.) suggests an initial, slight decrease in cattle height which might have started already in the 4th century in some inland sites of the centre-east and southern East Midlands. However, such change was not substantial and, as also shown by this study, some of the largest animals continued to exist in considerable numbers in the region, while a major significant decrease only occurred from the 5th century onwards (Duval and Albarella sub.; see below).

Such continuity of ‘Romanised’ husbandry practices implies that the increasing politico-military instability initiated with the 3rd-century crisis did not heavily impact on British animal economies. The combined effects of internal warfare and Barbaric invasions at the end of the Severan dynasty caused severe money debasement, undermining the efficiency of money taxation and salary payments to the soldiers. Taxation in kind, therefore, became the preferred way to provide supplies to towns and army; this implied that the need for peasants to produce a surplus, in terms of agricultural and animal products, remained largely unchanged. Indeed, Constantine’s reorganisation of the army and Diocletian’s administrative reforms aimed at accommodating the new taxation system, by bringing control closer to the source of exploitation and facilitating direct, short-distance supplies to the new, smaller army units (Esmond-Cleary 1989; Faulkner 2000). At a first sight, the evidence from animal husbandry partly contrasts with other lines of archaeological enquiry: after the Middle Roman period, Romano-British towns largely lost their centralised administrative function, urban trade declined, and the whole process of ‘Romanisation’ was halted (Reece 1980; Burnham and Wacher 1990). However, this was largely a reflection of the new exploitation strategies set up by the reforms mentioned above: control over agricultural activities was now held by smaller towns and rural villas scattered throughout the countryside, where closer control could be exercised over surplus production (de la Bédoyère 1999; Speed 2014).

The situation in Britain, however, differs from other regions of the Western Empire. In Gaul, the size of cattle, as well as its robustness, starts decreasing in the 4th century (Lepetz 1996; Lepetz and Yvinec 1998; Duval and Clavel 2018); in Catalonia, where cattle and sheep size had been substantially improved with the Roman conquest, there also seems to be a size decrease starting at about the same time (Colominas and Saña 2009); in Italy, the size of cattle and the extent and timing of improvement vary considerably between regions, but there was a widespread halt in the process of size increase in the 4th century (MacKinnon 2010), or even a slight decrease in size (Salvadori 2011). Although each province followed different developments, and phasing overlaps makes it often difficult to clearly separate Middle from Late Roman material at many sites, there seems to have been a greater continuity in animal husbandry practices in 3rd-4th century Britain (Duval and Albarella sub.). The politico-military and economic troubles of the 3rd and 4th centuries did not spare Britain entirely (§ 2.2); in Gaul and Iberia, on the other hand, major economic crises, continuous invasions and the semi-permanent settlement of Barbaric tribes might have compromised long-established animal husbandry practices, and food production strategies more generally, implying that it was not anymore possible and/or viable to maintain large cattle in those regions. From a geographic point of view, the relative isolation of Britain could have contributed to the preservation of Romanised patterns of animal exploitation for at least another century. In this context, the 600 ships of grain demanded by the emperor Julian from Britain for his campaigns in the Rhineland, however biased and exaggerated the story might be, would support the viability of the British food economy during the 4th century (Faulkner 2000).

When the results from Late Roman assemblages are compared to the Early and Middle Roman period, it seems that, not only were all aspects of husbandry practices maintained, but some were even reinforced. The incidence of cattle increases constantly at most multi-phase sites (Albarella in press), and some of the largest cattle are found in Late Roman contexts (e.g. Great Holts Farm, Redlands Farm, Wantage). The vast majority of cattle survived well into adulthood, being exploited as workforce in the fields; although this could have implied a greater number of (large) oxen at some sites, biometrical analyses of tooth measurements in all regions, and of the postcranial elements less affected by sexual dimorphism in Suffolk and Cambridgeshire, indicate a genuine higher incidence of large animals in Late Roman assemblages. The presence of typical butchery practices and widespread production and consumption of specific beef products (e.g. cured shoulders, marrow, horns) are also elements of continuity which contrast clearly with pre- and post-Roman patterns of animal exploitation in Britain. At the same time, however, the degree of variability in the extent of Romanisation of husbandry practices in different regions remains high until the very end of Roman rule. The zooarchaeological changes observed in the assemblages included in this study are far less pronounced in the north and west of Britain: in most cases, sheep remains better represented than cattle, and the size improvement of both is very limited or absent; if an increase in the frequency of cattle, and in the size of cattle and sheep do occur, they happen at a later stage than in the centre and south-east of the province (Aniceti and Rizzetto in prep.).

Such geographical variability in Roman Britain is paralleled in Gaul, where large cattle concentrate in the centre-east and north, with the west (especially Brittany) maintaining the very small cattle of the Late Iron Age (Lepetz and Matterne 2018). In general, chronological and spatial variability remains evident within the context of cattle size improvement promoted in Roman times (Duval *et al*. 2013). In addition, the lower impact of the Roman conquest in the north and west of Britain is supported by other lines of archaeological evidence, showing little or no change from pre-Roman production strategies and traditions (Evans 1990 and references therein).

Environmental, cultural, and economic variables may all have played a role in shaping such differences. The need for large and robust cattle to plough the heavier clayey soils of the south and centre-east of Britain could have contributed to such regional variations (Figs. 4.22-4.24).

For example, the fact that cattle from the Late Roman site of Icklingham (Suffolk) are among the smallest of the Roman samples here analysed, may indeed reflect the location of the site at the edge of the Breckland – an area with lighter, sandy soils whose exploitation would have not required the use of particularly robust cattle; contemporary cattle from nearby Pakenham, established on the East Anglian claylands, were instead slightly larger (§ *6.1.7*; Fig. 4.22). However, the way in which domesticates were improved in the centre-south may better explain larger-scale geographical differences. The appearance of substantially larger cattle in the south-east and the parallel increase in tooth size suggest that in Britain, differently from Gaul (Frémondeau *et al*. 2017), improvement was fostered by the introduction of larger stock, presumably from nearby provinces in the Continent (Albarella *et al*. 2008; Duval and Albarella sub.). As shown by this study, particularly large stock was available from the Lower Rhineland, whence it could be supplied following the well-established trade route across the Channel; most of the assemblages from the region display similar mean values and size ranges to a small number of sites from Britain, including Late Roman Great Holts Farm (Essex), Redlands Farm (Northamptonshire), and as far west as Wantage (Oxfordshire), suggesting that, still in the 3rd-4th century, size improvement through interbreeding in the south and centre-east was being promoted in some key sites, and from there spread to facilitate the improvement of local stock in nearby regions. The persistence of tooth mean values as high as, or even higher (e.g. Redlands Farm and Wantage themselves) than those found in Early (and Middle-Late) Roman Heybridge, where improvement was suggested to have occurred (Albarella *et al*. 2008), supports the combined role of interbreeding and local improvement in the size increase of Romano-British cattle. The wide range of bone biometrical data shown by some of the Late Roman assemblages with large mean values, including very small and larger cattle (e.g. at Wavendon Gate, Shakenoak Farm, and Bancroft), suggests that improvement was probably still being sought in the 3rd-4th century and that, at the same time, smaller breeds of cattle survived to the end of the Roman period. If interbreeding with imported large livestock contributed substantially to size improvement, this could have been less successfully and much less often applied to regions further away from the Continent, such as indeed the north and far west of Britain. Imports to the island via the North Sea could have occurred only sporadically, contrary to animal movement via land in mainland Europe; in addition, and despite localised evidence for pre-Roman Continental influence, most of the imports from the Continent and consequent size improvement in Britain arrived later than in nearby Gaul and Rhineland, as the conquest of the island only started almost a century after that of Gaul, with the annexation of the far west and north continuing into the AD 70s and 80s (§ 2.2). Therefore, the weaker improvement of cattle and sheep in the north and west, would have been affected by such geographical and chronological variables, and probably had to largely rely on the improvement of local stock, by implementing better feeding strategies and controlled breeding; larger imported stock might have been supplied, though in smaller numbers compared to the south-east, and at a much later date. As mentioned above, environmental constraints on the productive potentials of upland territories and cultural variables may have also contributed to exacerbate the 'improvement gap'. Interestingly, archaeobotanical data seem to parallel the variability in the incidence of cattle and sheep: where the former prevail (mainly the lowlands), spelt wheat is the dominant cereal, probably reflecting extensive farming practices relying on animal-drawn tillage; a higher incidence of sheep, instead, has been associated with the cultivation of barley (Allen and Lodwick 2017).

These conditions allowed strong regional differences to persist into the Late Roman period. The comparison between strongly 'Romanised' regions and those which were less successfully influenced by new husbandry practices does not simply reveal the limitations of Roman influence in food production strategies. Rather, it reveals, on one hand, the adaptability of such influence, which was functionally and strategically shaped to meet local potentials and needs; on the other, it contrasts with and highlights the more radical, 'successful' developments in agriculture and animal husbandry practices in the study-regions here considered, namely the south- and centre-east of Britain.

Cattle was the first species to be successfully improved in Roman Britain, as it could contribute immediately to the need for an agricultural workforce and large-scale meat production. The size of the other main domesticates was improved as well; however, these appear to have been later, secondary developments (Albarella *et al*. 2008). Such improvements would have spread more unevenly through Britain (e.g. for sheep: Maltby 2010; Aniceti and Rizzetto in prep.). These changes are more challenging to detect in archaeological assemblages, hence chronological and regional patterns are more difficult to reconstruct. In addition, the remains of caprines, suids, equids, and domestic fowl are often less well represented than those of cattle, and large enough samples of biometrical data are rarer. Caprine biometrical data from Late Roman assemblages highlight a considerable degree of variability among regions and individual sites; some assemblages, however, present similar values to Heybridge, where an improvement of caprines was attested in the Middle Roman period (Albarella *et al*. 2008). Such variability might imply that, similarly to cattle (Duval and Albarella sub.), different breeds characterised by different sizes were present in Late Iron Age and Roman Britain. Although the smallest sheep was recorded at Barnsley Park (Gloucestershire), some sites from the centre-eastern part of Britain also had small sheep, making it difficult to detect regional trends. At Castleford (West Yorkshire) there is a slight increase in the size of sheep in the Middle and Late Roman phases, paralleled by larger ranges of values which suggest a greater heterogeneity of flocks in the area, with the possible introduction of larger sheep; however, the average size remains smaller than at Heybridge and other southern sites (Aniceti and Rizzetto in prep.). In general, therefore, it seems that the improvement of sheep was a limited phenomenon, which did not spread throughout the province in the same way as cattle size improvement; the weaker efforts in the improvement of caprines, coupled with the presence of particularly small breeds, can explain the reasons behind such variability.

Developments in the size of suids, equids, and domestic fowl are even more difficult to detect. While for all these taxa sample sizes are often too small to be used on their own, the analysis of pig remains proves even more difficult: most individuals were slaughtered as subadults, resulting in a very limited number of measurements from mature pigs; in addition, the presence of just a few measurements from wild boar remains can easily bias the statistical analyses of small samples. So far, the improvement of pig has only been attested for the Middle Roman phase at Heybridge, at the same time as the improvement of caprines, equids, and domestic fowl (Albarella *et al*. 2008).

The next section will show that the Roman retreat from Britain impacted on animal husbandry practices at least as much as the conquest itself did in the mid-1st century AD. The nature and reasons behind differences and similarities between Roman and Early Anglo-Saxon animal exploitation are explored and contextualised within the changing socio-political and economic conditions of 5th-7th-century England.

7.2 The ‘happy degrowth’ of the Early Anglo-Saxons

In the last few decades it has become ever clearer that most of the typical traits of Roman husbandry practices in Britain (prevalence of cattle, specialised butchery practices, improvement of the main domesticates) did not survive the collapse of the Empire (Crabtree 1989a; 1991; 1996; 2014; Holmes 2014a; 2014b; 2016; 2017; O’Connor 2014). The Early and Early/Mid-Anglo-Saxons assemblages analysed in this study highlight an overall shift towards more generalised, relaxed husbandry practices. The clear predominance of cattle gave way to a more equal representation of the main domesticates, often with a major incidence of sheep;

mortality profiles do vary, but within each subregion (Suffolk, Cambridgeshire, and, to some extent, Oxfordshire) the exploitation of cattle and sheep seems much less specialised (i.e. it did not focus on specific products), with larger numbers of excess lambs culled to meet less efficient stalling facilities and foddering; evidence for specialised, large-scale butchery practices, including the production of specific beef products, disappear. There is a degree of variability among sites; cattle still dominate some assemblages, and evidence for intensive butchery is occasionally recorded. Similarly, the presence of a small number of large cattle and sheep in some Early Anglo-Saxon assemblages has been interpreted as the survival of large stock from Roman times (Crabtree 1991; Holmes 2014b). While in the Roman period variability was largely the result of centralised strategic choices, in the Early Anglo-Saxon period it was dictated by strictly local needs and environmental constraints.

Cattle decreases in size, with all Early Anglo-Saxon sites displaying lower average values for bone and tooth width measurements than most Late Roman assemblages. The analyses of less sex-dependent measurements from post-cranial bones confirm the decrease in size was genuine, rather than driven by differences in the sex ratio. Only cattle bones from Barnsley Park show a mean and value distribution similar to those of most post-Roman material; however, the western location of the site, in Gloucestershire, suggests that cattle may have not been as much improved as in sites located in the centre-east of the island (§ 3.1). Cattle biometrical data from Roman Wroxeter, Shropshire, provide a similar example; here, cattle remained as small as in Late Iron Age Heybridge, and indeed their size does not decrease in the post-Roman phase (Hammon 2011). In addition to an overall decrease in average values, distribution ranges change as well: very large cattle almost disappear, and the ranges of values are narrower; while the much smaller sample sizes from Early Anglo-Saxon assemblages certainly contribute to this, the consistency of such patterns and the support of statistical tests argue for a widespread decrease in the size of cattle. Cattle measurements from Mucking (Essex) also suggest animals were more slender, with width values being much smaller than lengths; while it is tempting to see a move away from the robust cattle of Roman times, such evidence is limited to Mucking: the standard used for cattle log ratio histograms is that of West Stow itself, where animals are smaller than those from Late Roman sites, but equally robust.

Other provinces of the Western Roman Empire experienced a similar decrease in the size of cattle, further supporting the evidence detected for post-Roman Britain. The Merovingian sites of Oegstgeest and Valkenburg (Lower Rhineland) analysed in this study present much lower average values for bone measurements, and slightly lower average values for tooth widths, compared to the Late Roman assemblages from the region, and similar values to those of unimproved cattle from Late Roman and Merovingian Wijnaldum (Frisia). Bone value distributions also show that large cattle are almost absent in the Merovingian assemblages where, similarly, low tooth width values prevail. Potential effects of different kill-off patterns and sex ratios on cattle bone size at Oegstgeest and Valkenburg are comfortably excluded: most animals survived into adulthood at both sites, and the smaller size of cattle, compared to Late Roman De Geer, can be detected on measurements from the astragalus, a less sex-dependent element. Similarly, cattle decreases in size through the 5th to 7th centuries in the Belgian and Dutch loess region, south-west of the Dutch River Area; here, the collapse of the Roman economy and climatic deteriorations would have led to a decline in crop production and the disappearance of intensive agriculture (Pigière 2009; Pigière and Goffette 2019). In this region, as well as in the Dutch River Area, new approaches and techniques of cattle breeding during the Merovingian period were driven by the changing needs and aims of post-Roman animal husbandry, and led to the spread of smaller and less robust cattle (Audoin-Rouzeau 1998).

In Gaul, a decrease in the size of cattle is attested since the 4th century (§ 7.1), though it becomes more prominent since the 6th century; on the contrary, the size improvements of sheep and pig are maintained in the Late Roman period, and largely lost only since the 6th century (Yvinec 1991; 1997 (for the north and east of Gaul); Lepetz 1996; Lepetz and Yvinec 1998; Clavel and Yvinec 2010). Exactly the opposite has been detected for central and northern Spain: the size of cattle, which was improved in Roman times, is maintained in the 6th-7th centuries, with a decrease occurring only from the 8th century onwards; on the contrary, the size of caprine and pig bones slightly decreases in the post-Roman period (Grau-Sologestoa 2015). In Switzerland, the frequency and size of cattle decrease in the early medieval period (Breuer *et al*. 1999; Schibler and Schlumbaum 2007); however, increased variability in the average size of this animal is already detectable in the 4th century (Akeret *et al*. 2019), when in the north-west of the country cattle start decreasing in size (Frosdick 2014). A similar decrease in the frequency and size of cattle in the post-Roman period has also been detected in Italy (Salvadori 2011). In Hungary, where cattle and sheep had been improved in Roman times, both taxa undergo a process of size decrease during the Migration period (Bökönyi 1971).

The nature and the extent of impact of the fall of the Roman Empire on animal husbandry strategies varied from province to province. The evidence reported above on the frequency and size of cattle, however, seems a common trend characterising most of the regions of the former Western Empire. In Roman Britain as elsewhere, large cattle were required for intensive exploitation in the fields, where surpluses had to be produced to fuel the taxation cycle; at the same time, meat had to be produced on a large scale to feed the army and city dwellers. In many instances, culling profiles and the presence of specialised butchery products fully support this view. The 'fall of cattle' of post-Roman times, when the frequency and size of this animal decrease almost everywhere is likely to be a reflection of the major role that the Roman state had directly and indirectly played in shaping the economy of food production in western Europe.

It is possible that Early Anglo-Saxon herders lacked the skills or resources (or both) to maintain the large size of cattle from Roman times. However, the abandonment of such improvements could have also been a deliberate choice, resulting from a lack of need of particularly large and robust cattle. Indeed, when the Roman state collapsed, the need to constantly produce a surplus to supply urban and military settlements and to feed the taxation cycle disappeared with it. Freed from this burden, early post-Roman communities, such as the Anglo-Saxons, could engage in more relaxed and less specialised agricultural and animal husbandry practices, which, often, had the only aim of sustaining the community itself. This interpretation finds support in the study by Lewit (2009), where the author compares economic conditions in western Europe and in the eastern Mediterranean during the 5th-6th centuries; the decline of trade and state driven production, resulting from the collapse of the Western Empire, resulted in more diversified, generalised farming practices in the west, while in the Eastern Empire the survival of central control and economic structures promoted the expansion of rural settlement, more intensive land use, and important changes in oil and wine press technology.

Such discontinuity and the reasons behind change, including the role of the Roman state in shaping British economic models, are supported by other lines of archaeological evidence. Hopkins (1980) and Esmonde-Cleary (1989) highlighted that most aspects of the Romano-British economy, including those driven by private initiatives, would have ultimately depended upon the interregional flows of money and goods fuelled by the Roman taxation system. In the 5th century, the decline of large-scale imports and, in most areas, of local Romano-British pottery types and modes of production, suggest a generalised collapse of trade (Evans 1990). Some exceptions exist; grave goods imported from the Continent are found in burials from Early Anglo-Saxon Kent, whence they were occasionally traded to other parts of Britain (Huggett 1988); glass production shows some sort of continuity (via recycling old Roman glass and continued long-distance imports) up to the mid-6th century, when natron glass becomes adulterated with the use of wood ash due to the breakdown of trade (Freestone *et al*. 2008); in the west, long-distance trade of goods and movement of people continued, to some extent, into the post-Roman period (Fulford 1989; Arnold and Davies 2000; Hemer *et al*. 2013). Clearly, the transition did not imply a black-and-white, chronologically limited process of 'decline', and the nature and extent of change would have varied through Britain (Reece 1980; 1989; Cooper 1996). However, the abundant evidence for discontinuity has often been associated with the collapse of taxation, which the local elite could not manage to maintain after the end of Roman rule over Britain (Evans 1990; Millett 1990).

Zooarchaeological data from other domesticates provide further evidence and details of how new economic models were shaped in post-Roman Britain. Caprines remained largely represented by sheep. Bone measurements suggest this animal was, on average, larger than the Early Anglo-Saxon West Stow standard in only two Late Roman sites (Wimpole and Wavendon Gate), and slightly larger in two others (Mid-Late Roman Heybridge and Icklingham). Average values from these Roman sites, as well as the presence of some particularly large animals, are also found in the Merovingian assemblages of Oegstgeest and Valkenburg, as well as in the Late Roman and Merovingian phases at the Frisian site of Wijnaldum. On the other hand, tooth width values are much higher in the Merovingian Lower Rhenish assemblages, suggesting the presence of different sheep types/breeds in the two regions. If, as it seems, sheep size was improved in Roman Britain, this was probably achieved by importing animals from other parts of the Continent, or largely through the improvement of local herds. Alternatively, tooth width values from these Merovingian sites have been altered in the post-Roman period through interbreeding with imported, larger animals; such interbreeding, and consequent improvement, could have been carried out in order to increase the quantity and quality of wool, whose production and processing became a central feature of the Merovingian economy in this part of the kingdom (Heidinga 1997).

The rest of British Late Roman assemblages, including Late Roman Heybridge, present similar or lower average values than the West Stow standard. Mean values from the other Early Anglo-Saxon assemblages are similar to or lower than that from West Stow, and fully comparable to those from several Late Roman assemblages. Where possible, biometrical analyses of the less sex-dependent measurements from post-cranial bones indicate that this trend was not affected by substantial changes in the sex-ratio, which indeed are not suggested by the comparisons of culling profiles. The only appreciable difference is the dearth of very large animals in Early Anglo-Saxon assemblages, which are instead present at Late Roman Wimpole, Wavendon Gate, and Wantage. The size of sheep varies among the regions considered in this study

(Suffolk, Cambridgeshire, Oxfordshire, and nearby counties), with animals being larger in the east and smaller as we move westwards, probably reflecting pre-Roman differences in size in these regions; however, within each study-area, values from all bone axes suggest the size of sheep did not change in the transition from the Late Roman to the Early Anglo-Saxon periods. Tooth width values provide even stronger support for a lack of substantial size changes: all Late Roman and Early Anglo-Saxon British assemblages present average values very close to the West Stow standard, without clear regional differences.

It has been highlighted that sheep size was improved in Roman Heybridge (Albarella *et al*. 2008). Average values and the dearth of very large animals in Early Anglo-Saxon assemblages, as shown by bone and tooth biometrical data, suggest no further increase was attempted in post-Roman Britain. However, diachronic similarities in bone and tooth size within each study-region indicate that the improvement of Roman times was maintained, or that at least, for the more western regions, no size decrease occurred. Such lack of decrease in sheep size contrasts with what observed in early medieval Gaul (Lepetz 1996; Clavel and Yvinec 2010), central-northern Spain (Grau-Sologestoa 2015), and Hungary (Bökönyi 1971), where animals become smaller. The reasons behind the maintenance of Roman sheep improvement or, at least, the absence of a decrease in size, might lie on the very nature and aims of Early Anglo-Saxon animal husbandry strategies. While large cattle were not anymore needed, post-Roman animal exploitation in Britain placed a greater emphasis on sheep; this species, found in higher frequencies in this period, could provide a set of primary and secondary products, mainly meat, milk, and wool, which fitted well the generalised requirements of Early Anglo-Saxon communities. At West Stow, a shift towards the culling of older sheep is attested in the second subphase (mid-5th-mid-6th centuries); at the same time, the incidence of weaving implements found in the deposits from sunken-featured buildings increases exponentially, suggesting a greater focus on wool and textile production (West 1985a). Sheep are also much smaller than cattle: they can be kept in higher numbers, hence diversifying the risk of losses and minimising the economic impact of casualties. Sheep carcasses being smaller provided another advantage: when an animal was culled and processed for meat, it could be more easily redistributed within a household or a small community than the large carcass of a cow, which indeed could only be viable within the large-scale redistribution system of Roman times.

The slightly higher frequencies of pig detected at most post-Roman assemblages could be interpreted in a similar way. Pigs represent a prolific, fast-growing and hence reliable source of meat, and do not require as much labour as the other main domesticates: they can be easily grown on human food waste, and/or be kept free-range in nearby woods to feed on roots and fruits. For these reasons, the particularly high frequency of pig in the first subphase at West Stow (5th century) has been interpreted as an effort to provide a reliable and abundant source of food during the initial period of settlement at the site (Crabtree 1989a). The biometrical analyses of suid bones and teeth from the sites considered in this study are affected negatively by the dearth of remains from this taxon. The few assemblages which provided sufficient pig bone measurements, however, indicate that suids were much larger at British Late Roman sites compared to Early Anglo-Saxon and Lower Rhenish (both Late Roman and Merovingian) ones; the distribution ranges at Middle and Late Roman Heybridge also argue for a larger size of pigs from this period, while the few very large outliers from bone and tooth widths most likely represent the remains of wild boar. Tooth width values were available from a larger number of sites, and broadly display a similar pattern; Late Romano-British assemblages and the Lower Rhenish ones, however, present lower tooth values compared to bones, and differences in tooth widths are overall mitigated. This evidence might suggest that, if pig were improved at all in Roman Britain, as suggested in Albarella *et al*. (2008), this might have occurred through the improvement of local animals. The high incidence of pig slaughtered as adult animals in Suffolk and the Lower Rhineland, however, indicates that such potential improvement was not paralleled by a shortening of the period required by pig to reach its optimum weight – when slaughter is likely to occur. In sum, similarly to cattle and differently from sheep, therefore, there is evidence to suggest that pig decreased in size in parts of Early Anglo-Saxon England. A similar size reduction of post-Roman pigs has been noticed in Gaul (Lepetz 1996; Clavel and Yvinec 2010) and Spain (Grau-Sologestoa 2015). In Early Anglo-Saxon animal husbandry, pigs certainly played a secondary role compared to sheep; however, an increase in the frequency of suids is recorded in almost all post-Roman sites, where pork would have represented a reliable, complementary source of food. The reason behind the decrease in size of this animal might lie on its fertility: differently from sheep, pig litters are very numerous and grow relatively fast; this, in combination with the lower labour costs of pig keeping, could have led Early Anglo-Saxon herders to prefer rearing large numbers of pigs, rather than focussing on maintaining particularly large sizes.

The incidence of horse[2] is very low in both Roman and Early Anglo-Saxon assemblages; the clear prevalence of adult individuals and near-absence of butchery marks suggest horses were

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[2] The analyses of equid and chicken remains recorded for this study have been included in two separate articles (Benkert and Rizzetto in prep.; de Groene *et al*. 2020).

mainly kept for transport and their traction force. The size of horse had been improved in Roman times (Johnstone 2004; Albarella *et al*. 2008). The analyses of withers heights and width measurements indicate that such improvement was largely maintained in Early Anglo-Saxon times, although animals become slightly more robust; the only exception is represented by West Stow, where horses are smaller (Benkert and Rizzetto in prep.). However, the range of values, is much narrower for the Early Anglo-Saxon period. The wider range of values from Roman assemblages might reflect the presence of donkeys and mules, whose remains have never been recorded in early post-Roman sites. Donkeys and equid hybrids, however, were very rare in Roman Britain as well (Johnstone 2010), and it is more likely that the much wider range of Roman values actually represents the presence of different breeds, from large-sized, possibly imported horses, to the pony-sized type of the British Late Iron Age.

It has been recognised that the Romans did indeed breed a variety of horses suited to specific tasks, such as riding and traction (Johnstone 2004); it seems, therefore, that Early Anglo-Saxon herders were less interested in maintaining such diversity, or did not have the skills or resources to do so, while at the same time they did manage to preserve the larger size of horses from Roman times. The introduction of horses from the Anglo-Saxon homeland is recorded in the *Anglo-Saxon Chronicle*, written in the late 9th century (Clutton-Brock 1976); zooarchaeological analyses in this region, however, indicate that horses were smaller than in Roman Britain (Reichstein 1991): if horses were introduced from here to England in Early Anglo-Saxon times, this is likely to have occurred in small-enough numbers to not impact on the average size of British horses (Benkert and Rizzetto in prep.). The maintenance of improved Roman horses in Early Anglo-Saxon England might reflect more than just the economic viability of this animal (transport and traction), and has also been attested in northern Gaul (Clavel 2001); horses played a major role in Germanic communities, in military operations and ritual practices alike (Clutton-Brock 1976; Crabtree 1995; Bond and Worley 2006; Fern 2007; Cross 2011). Much more than for the other main domesticates, therefore, the socio-cultural, religious, and military importance of horses should be taken into account when contextualising zooarchaeological evidence from this animal.

Zooarchaeological data from chicken remains suggest this animal was a valued complementary source of food in Early Anglo-Saxon England. At West Stow, its exploitation was gradually optimised, with hens being spared for egg production and males culled as young individuals for their meat. Combined analyses of biometrical data and medullary bone suggest the presence of different breeds, including particularly large animals (de Groene *et al*. 2020). The comparison of width values from Roman and Early Anglo-Saxon assemblages suggests that, differently from northern Gaul (Clavel *et al*. 1996), the size improvement achieved in Roman times (Albarella *et al*. 2008) was largely retained in the early post-Roman period (de Groene *et al*. 2020).

In sum, zooarchaeological data support the evidence from other lines of archaeological and historical research (§ 2.3, 2.4, and 3.1), highlighting substantial changes in animal husbandry practices at the transition between Late Roman Britain and Early Anglo-Saxon England. While the persistence of variability in animal husbandry practices across sites, as well as the partial retainment of size improvements, might suggest some degrees of continuity in animal exploitation, the reasons behind such similarities reveal completely different economic strategies and cultural preferences.

Biometrical investigations play an important role in this study as they represent a useful tool to assess and interpret such developments. As large and robust cattle were no longer needed to support intensive agricultural practices and the production of surpluses, controlled breeding and management aimed at the maintenance of a particularly large size became redundant. Sheep, which had been improved by the Romans to optimise meat production, however, were more important than cattle in Early Anglo-Saxon subsistence practices; sheep could provide a range of useful primary and secondary products, it was reared in numbers, and therefore there would have been a direct interest in retaining the large size achieved in Roman times. Pig was important too, but the optimisation of pork production could be more easily achieved by increasing numbers, rather than investing in size improvements. Chicken was an important provider of complementary animal proteins, in the form of eggs and meat, while horse played a key economic, cultural, and military role; the size of both these animals, which had been improved in Roman times, was fully preserved.

Changes and similarities in species preferences, culling profiles, carcass processing, and indeed biometrical characters of the main domesticates contribute to review the long-standing idea of decline typically associated with early post-Roman Britain. Early Anglo-Saxon herders were not passively coping with adverse economic conditions, but actively and functionally adapting to different needs, namely those of self-sufficient communities engaging in smaller-scale strategies of animal husbandry. Developments in animal exploitation in Middle Anglo-Saxon England and Carolingian Gaul provide further support to the interpretation of data presented in this study; since the 8th century, increased economic complexity and centralisation favoured again the rise of more intensive and specialised animal husbandry practices, with an increase in the frequency and size of cattle, and a focus on wool production (Clavel and Yvinec 2010; Crabtree 2014; Holmes 2014b). Sandwiched between two different but very important periods in the formation of medieval and modern Europe, Early Anglo-Saxon communities could, within the several limitations of their time, experience and arrange their lives outside the burdens of centralised political and economic control.

CHAPTER 8

Conclusions

This study has shown the potentials of comparing zooarchaeological data from the two sides of the Roman-Anglo-Saxon transition in Britain. The substantial changes in the nature and scale of economic operations and socio-political organisation, which are known to spread in England with the demise of the Roman Empire, inevitably impacted on animal husbandry strategies; the characters of such impact contribute, along with other lines of archaeological enquiry, to define how the transition occurred. This study has highlighted two main issues:

- the continuity of 'Romanised' animal husbandry practices into the Late Roman period in Britain: most 3rd and 4th century assemblages consistently suggest a major interest in cattle, which were intensively exploited in agricultural works and improved by increasing and/or maintaining their size. The persistence of such characters suggests that the politico-military upheavals and economic crisis of the Late Empire affected Britain differently from other provinces; at the same time, it highlights the key role played by the Roman State in shaping the economy of the island for almost four centuries, through the imposition of taxation and the need to supply urban and military settlements;

- the nature and reasons behind differences and similarities in animal husbandry practices between the Late Roman and Early Anglo-Saxon periods argue for substantial discontinuity in the aims and scales of food production. Nonetheless, change did not result from a passive adaptation of early post-Roman communities to 'declined' economic conditions; rather, zooarchaeological data suggest a more deliberate strategy of adaptation whereby some elements of improvement were maintained, as they bore important advantages to the more generalised animal exploitation practices of Early Anglo-Saxon herders.

The different characters of Roman and Early Anglo-Saxon archaeology in Britain pose a series of limitations that must be dealt with. Lower visibility and the dearth of archaeological contexts dated to the early post-Roman period represent a serious issue in Britain, as well as in the rest of western Europe. Most of the Early Anglo-Saxon assemblages analysed in this study were much smaller than those from Late Roman sites; however, when data from individual assemblages are presented side-by-side and compared to Roman material, it becomes possible to detect meaningful patterns. Nevertheless, more data from the post-Roman side of the transition are certainly needed.

The search for complementary, additional data can be also pursued in a different, possibly more feasible direction, namely by increasing the amount of information obtainable from the available material. Analytical techniques such as geometric morphometrics, ancient DNA, and stable isotope analyses are no longer novelties in archaeological research, and they can inform on issues such as animal breeding strategies, animal movements and management more generally; they have been successfully applied to Romano-British material, and the inclusion of more Early Anglo-Saxon studies employing these techniques would provide useful complementary information on changes in animal management on both sides of the Channel.

Finally, a deeper and more comprehensive understanding of the complex, multi-faceted dynamics which transformed Europe between the 3rd and 7th centuries AD can only be achieved by looking at the wider picture; while each region shaped its specific trajectories in socio-cultural and economic developments, a better definition of the characters of such developments rests in the detection and interpretation of similarities and differences between the former provinces of the western Empire.

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Appendix 1 – Recording protocol for mammal and chicken remains

The recording system basically follows Davis (1992), although there are a number of substantial changes and the system is also adapted for a computerized database. Further information about the recording system can be found in Albarella and Davis (1994).

The system is based on two main database structures, one for teeth and one for bones. An additional database for ribs and vertebrae is also used.

The following parts of the skeleton are recorded when more than half of the specified area is present (countable elements underlined):

Mammals:

Horncore (with a complete transverse section), Upper teeth occlusal surface (pig only), Maxilla (with at least one tooth), Lower teeth occlusal surface, Mandible (with at least one tooth), Cranium (zygomaticus), Atlas, Axis, Scapula glenoid cavity, Humerus distal, Humerus proximal head, Radius distal, Radius proximal, Ulna proximal articulation, C3 or C2+3, Metacarpal distal, Pelvis (acetabulum, ischial part), Femur distal, Femur proximal head, Tibia distal, Tibia proximal, Astragalus, Calcaneum (sustentaculum), Scaphocuboid, Metatarsal distal, Metapodial distal, Phalanges 1, 2 and 3 proximal.

Chicken:

Scapula articular end, Coracoid distal, Coracoid proximal, Humerus distal, Humerus proximal, Radius distal, Ulna proximal, Carpometacarpus proximal, Sternum anterior articulation, Femur distal, Femur proximal, Tibiotarsus distal, Tibiotarsus proximal, Tarsometatarsus distal, Tarsometatarsus proximal.

The presence of medullary bone is assessed in the femora, tibiotarsi and tarsometatarsi.

If a pig skull fragment has both a zygomaticus and teeth, these are recorded independently but reference to the other record is made in comments. If a jaw has teeth on both the left and right side, as many different teeth as possible are recorded as they were on just one side, then the exact situation is explained in comments. For instance, a jaw that has P4, M1 and M2 on the left side and P3 and P4 on the right side will be recorded as ‘left’ with P3, P4, M1 and M2. If a deciduous tooth and the permanent tooth placed beneath are both present and visible, only the deciduous tooth is recorded.

For proximal and distal long bone ends is meant either the epiphysis or the unfused diaphysis. If recordable elements of the radius and ulna are fused together, they are recorded separately and then reference to each other will be made in comments.

‘Non countable’ elements are those which are not used for any quantitative analysis and include bones such as horncores and antlers (with a complete transverse section), loose maxillary teeth, and all other elements or parts of elements which are not included in the list of regularly recorded teeth and bones, but are worth recording (e.g. rarer species, anomalous size, interesting butchery marks or abnormalities). All ‘non countable’ elements are recorded as ‘OTH’ and the part of the body – if known – is specified in ‘comments’. The exceptions are represented by horncores and antlers, which are recorded as HC.

Vertebrae and ribs are recorded in a separate table into size groups (large, medium and small); only presence by context or any other identified archaeological unit is recorded. Large = cattle/horse size; Medium = sheep/pig size.

Side is recorded for all elements apart from phalanges.

Measurements are taken on teeth only when there is sufficient enamel preserved to be able to do so. Fused, fusing and unfused bones are all measured. For all foetal and neonatal bones a length (GL without epiphyses) and minimum width of the shaft (SD) are taken. For a description of how measurements are taken see Albarella and Davis (1994), Albarella and Payne (2005), Davis (1992; 2002), von den Driesch (1976), Payne and Bull (1988), Salvagno and Albarella (2017). All measurements are taken in millimetres, with one decimal point (i.e. approximated to the tenth of millimetre), with the exception of those taken in a measuring box, which have no decimal point (i.e. approximated to the millimetre).

The following measurements are taken:

TEETH

Equids: L_1, W_a and W_d (as in Davis 2002) (only teeth which can be positioned, i.e. we know which tooth it is) (W_d is only taken on molars)

Cattle and caprines: dP_4W, M_1W, M_2W, M_3L, M_3W (all maximum widths and lengths)

Pig: dP^4 (L,WP), M^1, M^2 & M^{12} (L, WA,WP), M^3 (L,WA,WC), dP_4 (L,WP), M_1, M_2 and M_{12} (L,WA,WP), M_3 (L,WA,WC, WP), H.

BONES

Mammals

Horncores: min and max diameter of the base; greatest length

Atlas (pig only): H, BFcr

Scapula: SLC, LG, BG, GLP

Humerus: GLC, BT, HTC, SD

caprines: GLC, BT, Bd, HTC, BE, BEl, SD

Radius: GL, SD (when GL is taken)

caprines: GL, SD, Bp, BFp, Dp

Ulna (caprines only): BPC, DPA, SDO

Metacarpal: cattle: GL, SD, BatF, Bd, a, b, 1, 2, 3, 4, 5, 6

caprines: GL, SD, Bd, a, b, 1, 2, 3, 4, 5, 6

pig: GL

horse: GL, SD, Bd, Dd

Pelvis: LAR

Femur: GL, SD (when GL is taken), DC

Tibia: GL, Bd, Dd, SD

caprines: GL, SD, Bd, Dda, Ddb

Astragalus: cattle: GLl, GLm, Bd, Dl

caprines: GLl, GLm, Bd, Dl, H

pig: GLl, GLm

equids: GH, GB, BFd, LmT

Calcaneum: GL, GD

caprines: GL, GD, c, d, DS, B

Metatarsal: cattle: GL, SD, BatF, Bd, a, b, 1, 2, 3, 4, 5, 6

caprines: GL, SD, Bd, a, b, 1, 2, 3, 4, 5, 6

pig: GL

horse: GL, SD, Bd, Dd

Phalanx 1: equids: GL, Bp, Dp, SD, Bd, Dd

Chicken

Coracoid: GL, Lm

Humerus: GL, SC, Bp, Bd

Ulna: GL, Bp, Dip, SC

Carpometacarpus: GL, Bp

Femur: GL, Lm, SC, Bp, Dp, Bd, Dd

Tibiotarsus: GL, La, SC, Bd, Dd, Dip.

Tarsometatarsus: GL, SC, Bp, Bd.

The sheep/goat distinction is attempted on the following elements: horncore (non countable), dP_3 & dP_4, distal Humerus, proximal Radius, distal Metacarpal, distal Tibia, Astragalus, Calcaneum, distal Metatarsal, 1st, 2nd and 3rd Phalanges.

Appendix 2 – Standard measurement values for cattle (West Stow)

Element	Measurement	Mean value	Number of records
SCAPULA	SLC	43.8	9
	LG	51.9	12
	BG	42.9	18
	GLP	62.6	9
HUMERUS	BT	66.8	13
	HTC	29.3	23
METACARPAL	GL	187.7	7
	SD	29.2	8
	BatF	49.5	13
	Bd	53.6	13
	a	25.8	12
	b	25.0	13
	3	26.7	10
	6	26.6	11
PELVIS	LAR	60.4	13
TIBIA	Bd	56.7	23
	Dd	42.5	22
ASTRAGALUS	GLl	60.1	38
	GLm	55.4	40
	Dl	34.0	39
	Bd	38.8	39
CALCANEUM	GL	130.3	9
	GD	49.7	9
SCAPHOCUBOID	GB	52.3	15
METATARSAL	BatF	47.4	12
	Bd	51.1	11
	a	25.0	12
	b	23.5	11
	3	27.1	11
	6	27.4	10

dP$_4$	WP	12.5	24
M$_1$	WA	13.4	14
	WP	14.4	12
M$_2$	WA	15.0	14
	WP	15.1	13
M$_3$	L	35.6	18
	WA	15.3	24
	WC	14.1	24

Appendix 3 – Standard measurement values for caprines (West Stow)

Element	Measurement	Mean value	Number of records
Atlas	H	37.5	6
SCAPULA	SLC	18.1	61
	LG	25.2	23
	BG	19.3	24
	GLP	31.4	25
HUMERUS	SD	14.6	14
	BT	27.8	66
	Bd	29.8	55
	HTC	14.2	71
RADIUS	GL	151.0	8
	SD	16.4	8
	Bp	30.1	33
	BFp	27.6	35
	Dp	15.5	32
METACARPAL	GL	128.2	24
	SD	13.8	24
	BatF	24.4	21
	Bd	24.9	27
	a	11.6	26
	b	11.4	28
	3	13.8	24
	6	13.7	27
PELVIS	LAR	27.0	33
FEMUR	DC	19.9	5
TIBIA	SD	14.7	21
	Bd	26.3	44
	Dda	20.2	42
	Ddb	16.7	41
ASTRAGALUS	GLl	28.1	51
	GLm	26.6	52

	Dl	15.7	54
	Bd	18.3	48
CALCANEUM	GL	55.2	11
	GD	22.6	8
SCAPHOCUBOID	GB	22.9	10
METATARSAL	GL	134.7	14
	SD	12.2	13
	BatF	23.9	18
	Bd	23.7	19
	a	11.2	19
	b	10.4	20
	3	13.5	21
	6	13.5	20
dP$_4$	WP	6.5	98
M$_1$	WA	7.2	56
	WP	7.4	50
M$_2$	WA	8.1	42
	WP	7.8	38
M$_3$	L	21.9	58
	WA	8.3	79
	WP	7.8	78