The zooarchaeology of cultural and economic change in Roman and late antique southeast Europe

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Abstract

Via meta-analysis of published zooarchaeological data from sites across modern Serbia, Bulgaria and Romania, spanning the late Iron Age to the early Byzantine period, this thesis explores spatial and temporal variation in animal exploitation, and evaluates the timing, pace and extent of wider cultural and economic change on both sides of the Danube limes in southeast Europe. Data are analysed from three regions subject to varying levels of direct Roman control — (a) the Balkan provinces, under long-term Roman occupation, (b) Dacia, a Roman province in the second and third centuries CE, and (c) regions to the northwest and northeast that remained beyond the Empire.

The study identifies little change in the extent of reliance on hunted resources and little change in livestock ratios in occupied regions in the early Roman period, indicating generalised husbandry practice and animal exploitation adapted to the local environment, showing continuity from the late Iron Age. There are clear changes in husbandry in the mid-Roman period, when the emergence of cattle-focused husbandry across the Balkan provinces and Dacia indicates the establishment of a specialised and integrated economic system. The period sees a clear increase in cattle and sheep/goat size. There is a slight decrease in cattle abundance in both regions in the late Roman period; livestock remain large in the Balkan provinces but decrease in size in Dacia. A continued Dacian cattle focus after Roman withdrawal demonstrates that the economic impact of Rome outlasted the period of occupation. In the early Byzantine period, increasing regionalisation in husbandry practice indicates declining economic integration concurrent with declining Roman political control. There is no further change in livestock size in occupied regions despite declining political and economic stability, suggesting that the earlier size increase was more likely achieved via a genetic change than predominantly via improved feeding regimes.

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Author's declaration

I declare that this thesis is a presentation of original work and that I am the sole author. This work has not previously been presented for a degree or other qualification at this, or any other, university. All sources are acknowledged as references.

1 Introduction

1.1 Research context

The political changes that characterised the period of Roman imperialism brought about diverse cultural and economic change both for communities living under Roman occupation within the borders of the Empire and for those in neighbouring regions. At the beginning of the third century BCE, the Roman Republic controlled a territory confined to the Italian peninsula. By the early second century CE, the region under Roman control reached from the Atlantic to the Black Sea, and from the North Sea to the north coast of Africa, bringing many more communities within the sphere of Roman influence. Subsequently, as the political power and coherence of the Empire declined, internal crises and external pressures led to increasing political fragmentation, and by the late fifth century only the eastern Empire remained. As the political power of Rome spread, fluctuated, and ultimately declined, alongside that of many smaller and less stable political units, a complex set of influences impacted the social, cultural and economic life of the Roman provinces and adjacent regions beyond the imperial border.

The nature, extent and impact of the influence of Rome has been the subject of much debate. By the evaluation of evidence for characteristically 'Roman' ways of life ('*Romanitas*') in the provinces, researchers have sought to quantify and understand the Roman contribution to provincial culture and practices, and thus to assess the extent of Roman influence in the occupied territories. Debate has focused on the extent to which provincial communities became culturally and economically 'Romanised' by their interaction and association with the imperial power, the processes by which this Romanisation occurred, and the pace and extent of social, cultural and economic change in the later imperial period as the political power of the Empire fluctuated and declined.

From early pro-imperialist works that emphasised the civilising influence of the Empire and lamented its decline (e.g. Gibbon 1776-1789 [2008]; Mommsen 1886 [2015]; Haverfield 1912 [2004]), to mid- and later twentieth-century studies that argued for the survival of pre-Roman cultures or proposed extended post-Roman cultural and economic continuity (e.g. Collingwood 1932; Pirenne 1937 [2001]; Brown 1971), the influence of the contemporary socio-political context on the debate is clear, and has been widely acknowledged (Webster 2001, 215; Ward-Perkins 2005, 3-10; Wickham 2005, 10; Mattingly 2007, 5; Hingley 2008,

437, 439). Alongside these broad trends, however, divergence of approach between contemporaries is evident, in particular in more recent decades (e.g. see Millett (1990) versus Webster (2001) with regard to Romanisation, Ward-Perkins (2005) versus Wickham (2005) on the later Empire). Factors such as disciplinary background have been cited to account for such divergence (Ward-Perkins 1997), though sparseness of evidence can also contribute to a lack of consensus, in some cases permitting opposing arguments regarding the extent of change on the basis of evidence from a single settlement (e.g. see Reece (1980, 78) versus Dark (2002, 142)).

In recent decades the framing of the debate has altered, as the legacy of earlier pro-imperialist approaches has been problematised. The social evolutionary opposition of 'Roman' and 'native' that such approaches imply has increasingly been called into question, as has the term 'Romanisation', due to the unidirectional transmission of culture that it implies, oversimplifying the complex processes of cultural interaction (Freeman 1997; Webster 2001; Revell 2009). While some have proposed new alternatives to earlier terminology to better express the concepts involved — 'Roman-ness' rather than '*Romanitas*' (Revell 2009; xi); 'creolisation' rather than 'Romanisation' (Webster 2001) — others have questioned the introduction of 'anodyne euphemism', arguing that concepts can be 'stripped of their [nationalist and colonialist] "baggage"' and retained, provided the complexity of the processes that they describe is acknowledged and understood (Keay and Terrenato 2001, ix; Harding 2017, 195-196). While the tone and character of the argument may thus have changed, the debate continues.

One aspect of the impact of Roman imperial expansion that has increasingly been explored in recent decades is the extent of change in patterns of animal exploitation and the productive economy under Roman occupation, evaluated via the analysis of zooarchaeological evidence (e.g. Teichert 1984; Lauwerier 1988; Lepetz 1996; Albarella *et al*. 2008; Lyublyanovics 2010; Colominas *et al*. 2013; Stanc and Bejenaru 2013; Grau-Sologestoa 2015; Groot 2017; Pigière 2017; Rizzetto *et al*. 2017; Trixl *et al*. 2017; Salvadori 2019; Vuković 2020; Groot and Albarella 2022; Rizzetto and Albarella 2022). The range of animal species, the types of animal products, and the characteristics of the individual animals exploited by past communities have been shown to be influenced by multiple social, cultural, economic and environmental factors (Albarella *et al*. 2008; Valenzuela-Lamas and Albarella 2017). Changes in patterns of animal exploitation can therefore provide a proxy for wider cultural

and economic change. Via the analysis of assemblages of archaeological animal remains, and the exploration of assemblage characteristics such as species composition, age distribution, and the morphology of the individual animals, zooarchaeological research can elucidate these patterns of animal exploitation. Zooarchaeological meta-analysis — the synthesis and analysis of faunal data from multiple archaeological sites and previous studies — facilitates the elucidation of these patterns on a regional or broader scale. As a relatively robust and regularly recovered category of archaeological material, animal remains enable the systematic evaluation of cultural and economic change.

Zooarchaeological studies of the Roman provinces have identified several key changes in animal exploitation following the imposition of Roman rule, each of which can be linked to wider social, cultural and economic developments. Agriculture was a key part of the pre-Roman, Iron Age economy (Haselgrove *et al*. 2019b, 5), and agricultural production became an important means of generating the revenue required to pay taxes to the Roman administration during the occupation (Alcock 2001, 137). The network of markets established during the Roman period provided an outlet for agricultural produce when cash payment of taxes was required, and access to these markets incentivised the optimisation of agricultural production for profit. By providing a means by which other commodities could be purchased, the Roman market system enabled producers to focus on the animals and crops most suited to their local environments, thus facilitating optimised production (Valenzuela-Lamas and Albarella 2017, 409). The movement of people around the Empire, such as with the military or to take up posts in the provincial administration, led to the spread of culturally-influenced dietary customs and preferences to new regions, impacting the demand and supply systems of the provinces (Peters 1998, 204; King 1999a, 143, 145; Alcock 2001, 14, 149).

Thus in many regions the Roman period saw an increase in agricultural specialisation in the provinces (King 1999b; Valenzuela-Lamas and Albarella 2017, 403), with less generalised mixed-species husbandry and more emphasis on the species most suited to local conditions, evidenced zooarchaeologically by the increased prominence of single livestock species in the faunal assemblages of the period. New or increased demand for certain animal products, such as the military demand for leather and preference for beef and pork products (King 1999a, 139-143; Alcock 2001, 149), can similarly be detected via the increased prominence of certain species in the zooarchaeological record. The Roman period also saw the widespread appearance of larger, more productive livestock in the provinces, a development likely

stimulated by the profit potential of optimised production, and which may have been achieved by an increased input of resources into livestock feeding, or as a result of greater genetic flow between livestock populations, facilitated by the Roman transport network (Valenzuela-Lamas and Albarella 2017, 406-408). Changes in dog size are also evident in the Roman period, with particularly large and small dogs attested in the archaeological record in many parts of Europe (Harcourt 1974, 151, 168, 171; De Grossi Mazzorin and Tagliacozzo 2000, 157; Horard-Herbin *et al*. 2014, 26). Analysis of archaeological animal bone metrical data provides an insight into morphology, and enables changes in size and shape to be tracked over time.

The importance of the Roman occupation as a stimulus for these changes in animal exploitation is indicated by the relative lack of evidence for similar patterns beyond the borders of the Empire. Some specialisation in cattle and pig husbandry has been identified north of the imperial border in Europe, as in the Roman provinces (Valenzuela-Lamas and Albarella 2017, 403; Grau-Sologestoa *et al*. 2022, 2), though here this may largely reflect long-standing adaptation of husbandry practice to local environmental conditions (Luff 1982, 248-249). On many cattle-dominated sites in the northwest of this region, sheep and goat are the second most common livestock taxa — a pattern typical of Iron Age husbandry in the region — in contrast to the secondary emphasis on pig seen on many Roman sites (Luff 1982, 248-249), suggesting continuity in local practice rather than outside influence. Additionally, relatively little evidence for increased livestock size has been found north of the border in the period concurrent with the Roman occupation to the south (Luff 1982, 260; Teichert 1984; Valenzuela-Lamas and Albarella 2017, 406; Rizzetto 2019, 249-258; Grau-Sologestoa *et al*. 2022, 10).

Zooarchaeological studies of the transitional period at the end of the Roman occupation have identified several notable changes in animal exploitation in the provinces, as the characteristics prevalent during the Roman period begin to disappear. As the Empire became increasingly politically fragmented, the Empire-wide trade and transport network in operation at the height of Roman power could no longer be maintained, and the economic system was thus no longer able to support specialised, market-oriented agriculture (Ward-Perkins 2005, 117-121, 132-133, 145; Valenzuela-Lamas and Albarella 2017, 409). Decreased specialisation is evident in many parts of western Europe following the fall of the western Empire, and the increase in livestock size of the Roman period is followed by the reverse

trend as Roman influence declines (Ward-Perkins 2005, 145; Rizzetto *et al*. 2017, 15-16; Valenzuela-Lamas and Albarella 2017, 409; Salvadori 2019, 39; Grau-Sologestoa *et al*. 2021, 6-16). There is evidence for hippophagy — the consumption of horsemeat — in this period, a practice argued to be rare in Roman society except in times of crisis, which may result from the emergence of new cultural practices in the provinces, or could indicate resource shortages and the exploitation of more marginal resources as a result of a disrupted supply system (Kroll 2012, 98).

The analysis of zooarchaeological evidence thus provides a valuable means by which to explore cultural and economic change in the Roman provinces and neighbouring regions, and is the approach taken in this thesis. In using zooarchaeological data for this purpose, however, it is important to be aware of factors beyond the human cultural and economic context that might impact patterns of animal exploitation. Climatic and environmental factors likely played an important role in animal husbandry practice both prior to and during the Roman occupation, influencing, if not necessarily determining, the range of livestock species raised and their relative abundance in different regions (King 1999b, 171; Valenzuela-Lamas and Albarella 2017, 403, 405; Grau-Sologestoa *et al*. 2022, 13). The varied pre-Roman political, social and cultural characteristics of the territories later incorporated into the Empire were also key influences in the development of the agricultural systems in place at the time of the Roman conquest, resulting in some pre-Roman specialisation in certain regions, and varied trajectories of change across the Empire under Roman rule (Valenzuela-Lamas and Albarella 2017, 403, 405-406; Grau-Sologestoa *et al*. 2022, 2, 13).

This research follows the approach taken in Luff (1982), Teichert (1984), Rizzetto (2019), Grau-Sologestoa *et al*. (2022) and Groot and Albarella (2022), among others, and utilises zooarchaeological data in the study of a region spanning the imperial border. Synthesising published and unpublished data from 172 archaeological sites located across modern Serbia, Bulgaria and Romania, it aims to evaluate the timing, pace and extent of cultural and economic change in southeast Europe via zooarchaeological meta-analysis. The studied sites are distributed between three regions subject to varying levels of Roman political control (Figure 1.1). The Balkan provinces, to the south of the river Danube, were under Roman occupation from the last centuries BCE until the late first millennium CE. The Roman province Dacia, to the north of the Danube, was under occupation only in the second and

third centuries CE, while the regions to the north and east of the Danube, and beyond Roman Dacia, were never subject to long-term Roman occupation.

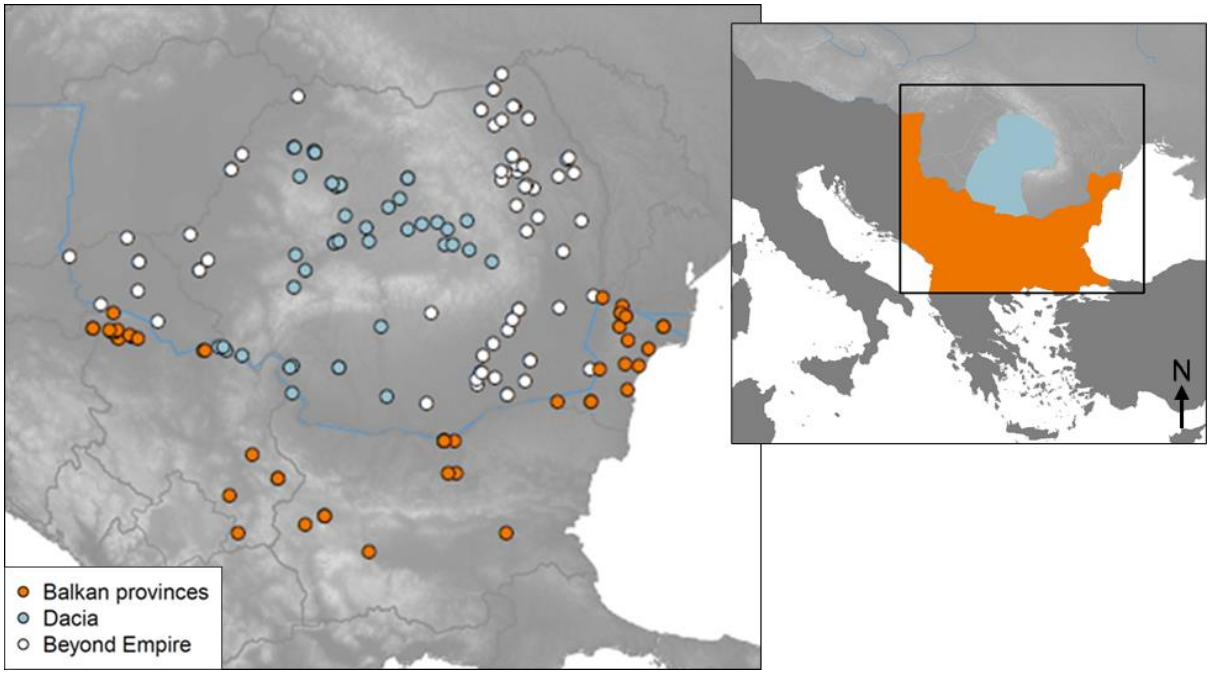


Figure 1.1: Distribution of studied sites by region.

Building on previous zooarchaeological studies of various parts of this study region with various temporal foci (e.g. El Susi 1996; King 1999b; Blažić 1999-2000; Gudea and Gudea 2000; Haimovici 2000; 2006; Gudea *et al*. 2008; Stanc 2009; Stanc and Bejenaru 2013; Vuković 2020), this research aims to explore cultural and economic change across the region as a whole from the late Iron Age to the early Byzantine period, c. 400 BCE – c. 700 CE. To facilitate data analysis, this temporal range has been divided into five periods, with period divisions following major political transitions within the study region. The five periods and their date ranges are as follows:

1) The late Iron Age c. 400 BCE – 168 BCE
2) The early Roman period 168 BCE – 106 CE
3) The mid-Roman period 106–271/275 CE
4) The late Roman period 271/275–476 CE
5) The early Byzantine period 476 CE – c. 700 CE

The transition from the late Iron Age to the early Roman period is marked by the first Roman occupation in southeast Europe in 168 BCE; the mid-Roman period spans the Roman

occupation of Dacia, with its beginning and end thus marked by the Roman conquest of and withdrawal from Dacia, respectively; and the transition from the late Roman to the early Byzantine period is marked by the fall of the last western Roman Emperor, after which only the eastern, Byzantine, territories of the Empire remained under Roman control. This research focuses on the early and mid-Roman periods, when the Empire was still expanding to its greatest territorial extent, and on late Antiquity, defined here as 271/275 CE – c. 700 CE, a period that saw increasing political fragmentation across the Empire.

1.2 Research aims and questions

This research aims to explore the nature and extent of change in animal exploitation, and by inference to evaluate the timing, pace and extent of wider cultural and economic change, in Roman and late antique southeast Europe.

The thesis aims to address the following research questions:

1) To what extent and in what ways did animal exploitation vary spatially and temporally in southeast Europe from the late Iron Age to the early Byzantine period, as revealed by the meta-analysis of zooarchaeological data?
2) How did animal husbandry and the productive economy change during this period?
3) How did reliance on hunted resources and hippophagy change during this period?
4) What evidence is there for a change in the morphology of dogs, and, by inference, in their roles within and relationships with human societies?
5) Using changes in animal exploitation as a proxy for wider cultural and economic change, what was the timing, pace and extent of cultural and economic change in Roman and late antique southeast Europe and how did this vary spatially and temporally?

1.3 Thesis structure

Chapter 2 introduces the historical and (non-zoo)archaeological sources of evidence for cultural and economic change in southeast Europe, and analyses the contribution of these sources chronologically, providing both the background to the study and the context within which the zooarchaeological data presented in the thesis will be interpreted.

Chapter 3 provides the zooarchaeological background to the study, reviewing the conclusions drawn in previous zooarchaeological studies of the Roman provinces and neighbouring regions, and demonstrating the varied patterns of animal exploitation in evidence across Europe. It begins by highlighting the key changes in animal husbandry under the Roman occupation, and then discusses hunting, hippophagy, and the morphology of dogs and their roles in Roman society. Finally, the chapter details previous zooarchaeological research into animal exploitation within the study region in southeast Europe.

Chapter 4 begins by discussing the data sources used for this research, and then describes the structure of the database compiled for the study. It then introduces zooarchaeological methods, with particular reference to the impact on zooarchaeological meta-analysis of the methodological choices made by zooarchaeologists during the primary analysis of the faunal assemblage. Integrated into the discussion of each zooarchaeological method is a discussion of the research methods employed in this study for the collection and analysis of each type of zooarchaeological data.

Chapter 5 summarises the dataset compiled for the study, introducing the climatic and environmental characteristics of the study region, explaining choices made in periodisation, discussing the structure of the sample with regard to the spatial and temporal distribution of studied sites, and detailing the range of site types included within the study.

Chapter 6 presents the analysis of the livestock data — a term defined for the purposes of this study as cattle, sheep, goats and pigs. The chapter begins by discussing livestock relative abundance with reference to site type and period for the study region as a whole, and then by region. The chapter then explores intraregional patterns in livestock relative abundance. It then considers the relative abundance of each livestock taxon individually and discusses the results of statistical testing, before discussing patterns in livestock age and morphology.

Chapter 7 presents the analysis of hunted taxa and horses. The chapter begins by discussing large game relative abundance, and then considers hunting and husbandry patterns, with a focus on sites that exhibit particularly high proportions of game. Large game relative abundance is then analysed by taxon, with spatial, temporal and site-type-based patterns considered. The chapter then discusses red deer morphology, followed by horse relative abundance and morphology, and the extent of evidence for hippophagy.

Chapter 8 presents the analysis of dog relative abundance and morphology.

Chapter 9 presents the discussion of the results of the study. It is organised chronologically, and focuses first on the early and mid-Roman periods, and then on late Antiquity, discussing changes in animal exploitation and their implications for wider cultural and economic change in southeast Europe within the context of the historical and archaeological evidence introduced in chapter 2.

Finally, chapter 10 summarises the conclusions of the study. The thesis ends with a reflection on the viability and value of zooarchaeological analysis, closing with a final remark on research aims.

2 Roman and late antique southeast Europe

2.1 Introduction

In order to determine the potential contribution of zooarchaeological analysis to an understanding of cultural and economic change in southeast Europe, it is first necessary to identify and evaluate the contribution made by other forms of evidence. This chapter reviews historical and archaeological sources of evidence for cultural and economic change in southeast Europe, in order to assess their relative contribution and identify their limitations, and thus to highlight the areas of understanding to which zooarchaeological analysis might make a useful contribution. The chapter analyses these sources of evidence chronologically, from the late Iron Age to the early Byzantine period, in order to provide both the background to the study and the context within which the zooarchaeological data presented in the thesis will be interpreted.

2.2 The late Iron Age background c. 400 BCE – 168 BCE

Figure 2.1 shows the study region in the late Iron Age. Many earlier — and some more recent — approaches to the Iron Age of southeast Europe conflate the spread of material culture with the movement of ethnically homogeneous 'tribes'. Such approaches reconstruct from material culture distributions or ancient historical sources the geographical distribution of coherent groups of people — the 'Celts', 'Illyrians' or 'Thracians', for example (e.g. Mócsy 1974 [2014]; Archibald 1994; Hammond 1994; Németi 2010), following wider traditions of a culture historical framework for the interpretation of archaeological data (Džino 2012, 70; Mihajlović 2014, 97; Vranić 2014, 161-163). More recent work has increasingly called into question the validity of such approaches (Džino 2010a, 57-58; Roberts and Vander Linden 2011, 2-3; Vranić 2014, 163-164), with the spread of material culture now more often interpreted not as evidence for large-scale migration or colonisation, but as the result of politically- or economically-motivated trade or exchange, or of smaller-scale mobility of individuals (Džino 2007, 50; Hauschild 2010, 173-174). Thus in the late Iron Age, prior to the earliest Roman occupation, the archaeological evidence indicates wide economic and cultural connections between the communities of southeast Europe and those in neighbouring areas, with influences in both directions.

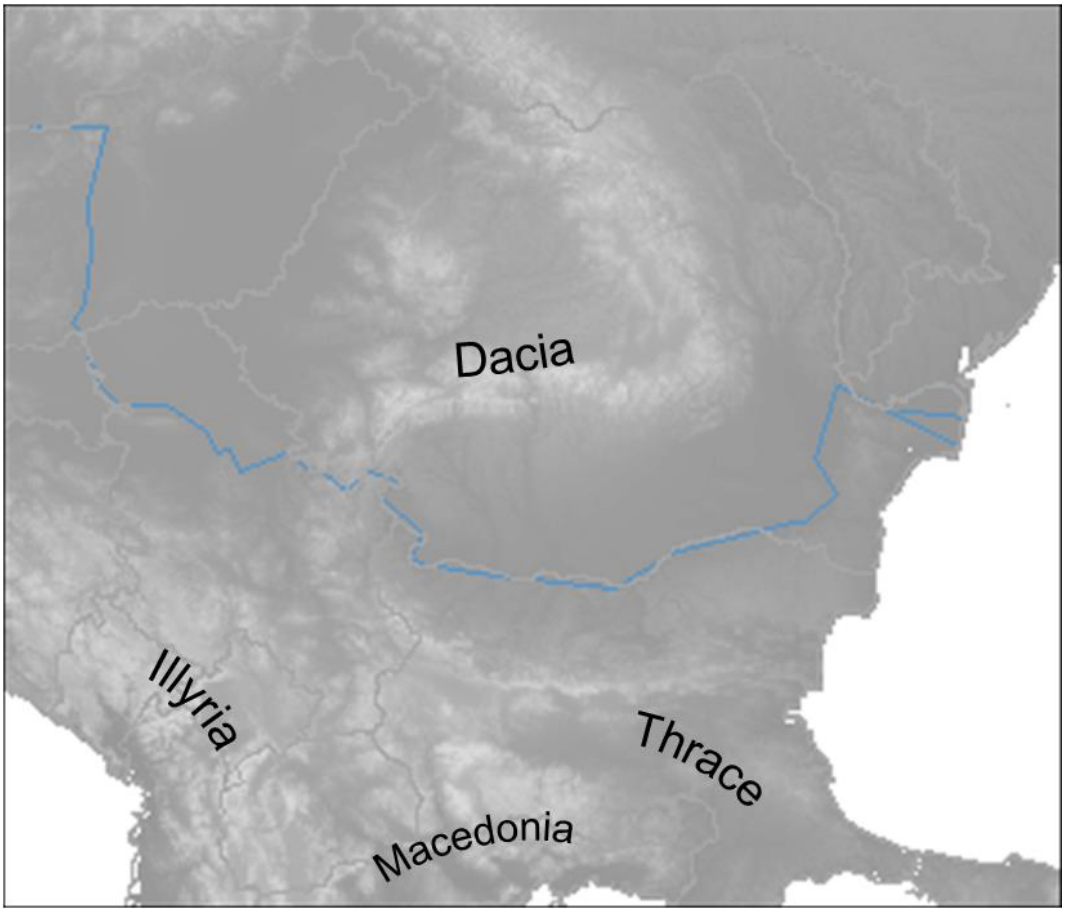


Figure 2.1: The study region in the late Iron Age.

In Thrace, in the southeast of the Balkan peninsula, Greek colonisation brought late Iron Age societies into contact with eastern Mediterranean trade networks (Tzochev 2015, 414, 419). The local development and widespread deposition of coinage showing Greek influence in its design from the fourth century BCE attests to the impact of this contact on the economy of the region (Tzochev 2015, 419-420). In the same period, the distribution across southeast Europe of imported Greek products, including food and drink attested archaeologically by finds of amphorae in Macedonia, Thrace, and northeast around the Danube delta, demonstrates the wide geographical extent of Mediterranean economic and cultural influence (Archibald 2013, 14; Tzochev 2015, 421). Occasional finds of Greek pottery and metalwork to the north of the Danube in modern Romania from the sixth to third centuries BCE (Glodariu 1976, 2, 7-9) demonstrate just how far north Greek influence reached via trade and exchange — albeit on a fairly small scale in this early period. Concurrent with the integration of southeast Europe into wider Mediterranean economic networks, local trade and exchange systems were also developing. The distribution of coinage produced in Illyria, in the western Balkans, to the north and east of the region reveals the operation of smaller-scale economies alongside those that extended further afield (Hammond 1994, 429).

Following the initial development of these Mediterranean connections, later centuries saw both the expansion and intensification of Greek influence north of the Danube, and the establishment of economic and cultural links with regions beyond southeast Europe to the north and the west. In the third century BCE, La Tène material culture appears in the archaeological record of southeast Europe (Džino 2007, 52). Concurrently, coinage and items of personal adornment originating in the region reach parts of southern and central Europe, demonstrating the establishment of economic connections and the development of cultural affinities between societies of central, southern and southeast Europe. From the second century BCE, archaeological evidence reveals an increase in trade between communities in Dacia, in modern Romania, and Hellenistic societies to the south, demonstrated by the appearance of increasing quantities of Greek coinage and products of Greek origin in the region (Glodariu 1976, 2, 56, 58). It is within this context of increasingly active communication and exchange — both internal and external, and with many different regions — that the first Roman political influence was established in southeast Europe.

2.3 The early and mid-Roman periods

2.3.1 The early Roman period 168 BCE – 106 CE

Southeast Europe was first brought under direct Roman control in the second century BCE (Figure 2.2). The earliest Roman occupation was established in the western Balkans in 168 BCE following a series of Illyrian wars, undertaken to eliminate piracy in the Adriatic, but likely also with the aim of preventing the development of strong political alliances in southeast Europe between Illyrian and Macedonian polities (Džino 2010b, 52; Kos 2013, 173-174). Concurrently, the Kingdom of Macedonia was brought within the sphere of Roman political influence. Following defeat by the Roman military, Macedonia was divided into four territories, nominally independent, but paying tribute to Rome; by 148/147 BCE, the region had been brought under direct Roman control and established as a province (Lintott 1994, 31; Adam-Veleni 2011, 552-553). The gradual subjugation of further territory in the Balkan peninsula and the reorganisation of earlier conquests over the next two and a half centuries led to the establishment by the end of the first century CE of the provinces Pannonia, Moesia, and Thracia, extending direct Roman control as far north as the Danube (Lintott 1994, 31; Gruen 1996, 172-178; Wilkes 1996, 555-556).

Figure 2.2: The study region in the early Roman period.

Across the newly-established Balkan provinces, varied patterns of economic and cultural change and settlement development can be discerned. A study of settlement patterns in these provinces undertaken by Donev (2019) reveals the impact of varied trajectories of settlement development prior to the Roman conquest on the development of settlement networks during the occupation. In the southern Balkan provinces, the occupation resulted in the maintenance and further development of multiple pre-existing urban centres, with relatively few new Roman foundations identified, suggesting that the pre-Roman urban network of the region was sufficiently well-developed and major settlements sufficiently widespread to enable the administration of the new provinces without major change (Donev 2019, 16, 18). In the western Balkans, the more varied pre-Roman settlement system resulted in more substantial change during the occupation, and the establishment of a greater proportion of new urban settlements than in the south (Donev 2019, 20). In Pannonia and Moesia, however, there is considerably less evidence for continuity in the urban settlement system before and after the Roman conquest, with the absence of sufficiently large and well-developed urban centres cited as one factor in the widespread appearance of new Roman foundations without late Iron Age antecedents (Donev 2019, 24-31).

These varied processes of urban development across the Balkan provinces during the early Roman occupation suggest that the extent of change in settlement patterns under Roman rule in a region is impacted considerably by the extent to which the pre-Roman character of that region differed from that required by the Roman state for efficient administration. Thus, while the settlement record of the southern Balkan provinces reveals relatively little change in settlement patterns under Roman occupation, the region was nevertheless more 'Romanised' in its settlement pattern than provinces that saw greater change after the Roman conquest.

Additionally, the varied nature of the reuse of existing settlements means that the extent to which their integration into the Roman settlement system represented genuine continuity was variable. While certain Roman urban settlements reused earlier infrastructure, others represent continuity with pre-Roman patterns only in their reuse of the location of an earlier settlement (Donev 2019, 41). Conversely, where administrative and population continuity before and after the conquest is observed, a lack of Roman influence cannot simply be inferred, as the development of these settlements along Roman lines often occurred in later centuries of the occupation (Donev 2019, 41). The proximity of existing settlements to sources of raw materials or to strategically-useful communication routes also likely played a role in their fate after the Roman conquest (Lozanov 2015, 84; Ilić 2017, 17; Donev 2019, 47-48). The importance of the latter suggests that later settlement distribution may have been influenced at least in part by military concerns early in the occupation. Many factors thus informed the changing settlement patterns of the early Roman period, making the evaluation of the nature and extent of the impact of Roman rule on the communities inhabiting these settlements a complex process.

The economic and cultural impact of the early Roman occupation extended to many aspects of life in the Balkan provinces. The reorganisation of land ownership and the allocation of agricultural land to new villa estates that became the economic focus of each region would have altered the organisation of rural production after the conquest (Panaite 2016, 152; Ilić 2017, 20). The earliest Roman political influence in southeast Europe had brought about the construction of major roads across the region; this process continued during the early occupation of the Balkan provinces with the formalisation of the Iron Age road system (Lozanov 2015, 83; Panaite 2015, 593-596; Panaite 2016, 152-154; Ilić 2017, 54). This facilitated movement, communications, military control and, along with the river network,

the transport of resources around the new provinces. The Roman occupation saw the establishment of mints in the southern Balkan provinces, which produced local coinage, used alongside that obtained from Rome (Katsari 2011, 1-2). This practice did not occur in the northern Balkan provinces, however, which used only the centralised coinage from Rome. Across the Roman Balkan provinces a new economic system developed, with intensified agricultural production supplying urban centres with products including wine and grain, and an increase in crafts and trade (Lozanov 2015, 84-86; Ilić 2017, 57-58).

There is clear evidence for Roman interaction with Dacia concurrent with the early period of occupation to the south of the Danube, though the stimulus for this interaction, and its impact on the communities of the region, has been debated. In the first century BCE, large amounts of Roman Republican denarii reached Dacia, replacing local coinage, and stimulating the production of large quantities of locally-made copies (Haynes and Hanson 2004, 14; Lockyear 2004, 65). The concurrence of the major inflow of denarii in the second quarter of the first century BCE with the Third Servile War in Italy, and with the suppression of piracy in the Mediterranean by the Roman general Pompey, has led to the suggestion that it may represent payment for Dacian slaves, used as a temporary replacement source for those previously obtained via other means (Lockyear 2004, 65-67, 70).

While the primary stimulus for the appearance of Roman coinage in Dacia may thus have been economic, it has been argued that its key impact was its political and social influence. Lockyear (2004, 70) suggests that the ability to obtain Roman coinage provided Dacian elites with a means of displaying status via connection with, and apparent political support from, the Roman state; the possession of such coinage may have been used as a demonstration of authority, and its distribution among a limited social group used as a means of control of power (Egri and Berecki 2014, 130-131). Once short-term demand for Dacian slaves and the associated supply of denarii subsided, the large-scale creation of copies of the coinage would have provided elites with an alternative means of continued association with Rome (Lockyear 2004, 70). Lockyear further argues that the widespread deposition of original and copied Roman coinage in hoards across the region of modern Romania may represent a later stage in the development of this elite display, with the destruction of wealth providing the latest in a series of conspicuous means by which to demonstrate status.

More recent work has reiterated the primary economic importance of Roman coinage, however. For example, Stan (2014, 65-66) argues that the principal role of Roman coinage in Dacia was an economic one, as earlier trade links with Hellenistic societies were replaced by trade with Rome, and Greek coinage and its locally-made copies were supplanted in Dacia by Roman denarii and their locally-made copies. In this interpretation, early Roman interaction with Dacia developed via the continued operation of an earlier system of economic links with the Mediterranean. While these various interpretations present contrasting narratives regarding the appearance and role of Roman coinage in Dacia, none are mutually exclusive. While from the Roman perspective connections with Dacia may have been economic, from the Dacian perspective links with Rome could have provided an economic basis for political and social advancement. Early Roman influence on Dacia could thus be considered primarily economic, with a political and social significance that was secondary in terms of the mechanisms by which it was achieved, but not necessarily secondary in its importance.

Whatever the impact of these early connections with Rome, the transfer of money into Dacia appears ultimately to have led to the lessening of any political control had by the Empire in the region. While arguments for Roman economic influence as a factor in the political unification of Dacia under Burebista in the first century BCE have been refuted (Lockyear 2004, 69; Davis 2006, 325, 338), it is clear that by the first century CE Roman interest in the region had developed a political aspect. Following raids into the Balkan provinces by Dacians led by their king Decebalus, and a series of Roman campaigns into Dacia under the emperor Domitian, the situation was temporarily resolved via treaty in 89 CE (Haynes and Hanson 2004, 15; Oltean 2007, 54). This resulted in the provision of Roman financial aid to Dacia. The importance of these Roman diplomatic payments for the development of technological capabilities and the military in Dacia has been noted, as has the potential threat posed by a centralised Dacian power at the northern border of the Empire (Haynes and Hanson 2004, 15; Oltean 2007, 54). As elsewhere in southeast Europe, increasingly close political and economic links between the Roman state and an emerging rival led ultimately to conquest, and the establishment of direct Roman control.

2.3.2 The mid-Roman period 106–271/275 CE

Following a diplomatic resolution to hostilities under Domitian, a new campaign against the Dacians was undertaken during the reign of Trajan in 101-102 CE (Haynes and Hanson 2004,

15; Oltean 2007, 54). This ostensibly had the aim of improving the terms of the earlier peace treaty, but in reality was likely a consequence of the desire of the new emperor to eliminate a perceived threat to the northern border, and perhaps to secure access to mineral resources in Dacian territory. While the first military action in Dacia under Trajan ended in a diplomatic agreement, a second campaign in 105-106 CE saw Dacia subdued and brought under Roman control (Oltean 2007, 54-55; Rustiou 2018, 26). From 106 CE, the Roman occupation extended north of the Danube following the establishment of a province encompassing a large part of the earlier Kingdom of Dacia (Figure 2.3) (Wilkes 2000, 581; 2005b, 229).

Figure 2.3: The study region in the mid-Roman period.

The impact of the Roman conquest on the social, cultural and economic life of Dacia was considerable. While it is unlikely that the 'annihilation' of the Dacian population by Roman forces suggested by some historical sources, such as the work of the emperor Julian, ever occurred, there is evidence for extensive depopulation of the region (Ruscu 2004, 73-78). The majority of this likely occurred during the conflicts with Rome. Epigraphic and archaeological evidence indicates the disappearance of Dacian elites and religious leaders at

this time, and their replacement with already 'Romanised' settlers from elsewhere in the Empire (Ruscu 2004, 78-82). Fortified Dacian power centres — both within and beyond the borders of the Roman province — were abandoned following the conquest, and the population resettled in low-lying regions, more easily controlled than the old Dacian hillforts (Ruscu 2004, 80; Oltean 2007, 1-3; Rustiou 2018, 26). Settlement patterns after the conquest indicate the establishment of an almost entirely new settlement system in Roman Dacia (Haynes and Hanson 2004, 18; Donev 2019, 38). While in the Balkan provinces multiple pre-Roman settlements saw continued occupation in the Roman period, in Dacia the majority of the large settlements present in the Roman period were established after the conquest, despite the existence of a complex settlement system in the pre-Roman Dacian kingdom.

The Roman period also saw changes in infrastructure and resource exploitation in Dacia. New roads had been constructed in the southwest of the region during the first campaign of Trajan, facilitating the movement of the military through the landscape (Fodorean 2019, 18). After the conquest, the transport network was extended throughout the province, with a major road constructed through the centre of Dacia running from south to north, on which several important urban settlements were located, interspersed with auxiliary forts at intermediate points (Haynes and Hanson 2004, 15-18; Fodorean 2019, 19). The exploitation of mineral resources was expanded under the Roman occupation, with limestone and marble quarried, and gold, silver, copper and iron all mined in the region (Haynes and Hanson 2004, 13; Oltean 2007, 181-183).

Production of copies of Roman coinage in Dacia ceased following the conquest, though gold extracted from the region was exported for use in the central mints (Corbier 2005a, 355; 2005b, 406). Manufacture and craftworking, including of pottery, brooches, and other bronze items, is attested at urban settlements and newly-established villa estates (Oltean 2007, 185-186). This indicates the intensification of economic activity in Dacia after the Roman conquest in the manner observed elsewhere in the Empire. Finds of such items, along with others including amphorae, at settlements beyond the borders of the province, and finds at Roman forts within Dacia of items produced beyond the Empire, provide evidence for an 'interaction zone' in the border regions (Opreanu 2011; Popa 2016, 215-218). The spatial extent of cultural and economic interaction between Rome and Dacian communities thus extended beyond the region under direct imperial control. Evidence for an increase over time

in cross-border trade activity indicates that cultural and economic connections between Rome and its neighbours increased through the course of the occupation.

Overall, it is clear that the Roman occupation of Dacia resulted in considerable change to the demographic character of the region, its economic activity, and the organisation of its settlement system. It has been noted that by the early second century CE, the Roman state was able to employ well-developed mechanisms for territorial expansion, enabling the efficient establishment of control in new provinces (Oltean 2007, 1). Thus when a province was established in Dacia, the region rapidly came to resemble those that had been subject to Roman rule for a considerably longer period. The extent to which the establishment of typically Roman ways of life in Dacia can be considered to constitute 'Romanisation' has been questioned, however. Since a considerable component of the population at some of the larger urban centres had been resettled from parts of the Empire where Roman ways of life were already well-established, the appearance of Roman practices in Dacia did not necessarily result from the adoption of these practices by Dacian communities (Haynes and Hanson 2004, 21). The establishment of Roman influence in Dacia could thus be argued to represent the Romanisation of the province, but not necessarily of the people.

To the south of the Danube, there is evidence for further economic and settlement development in the second and third centuries CE. Following the completion of the conquest of Dacia, multiple new urban settlements were established in the Balkan provinces under Trajan and Hadrian in the early second century (Wilkes 2000, 589). Civilian settlements that had developed close to legionary forts but were outside of the Roman administrative and settlement system were formally brought within this system under Hadrian, and established as *municipia*, with new administrative and economic responsibilities (Wilkes 2000, 590). This process of urbanisation continued in the region into the late second century (Lozanov 2015, 86). In Thrace, an increase in economic activity from the late second century is attested by the appearance of dedicated commercial settlements, smaller than the main urban centres, and with specialised trade and craftworking functions (Lozanov 2015, 84). As in Dacia, zones of economic and cultural contact are found along the borders of the Balkan provinces in this period (Donev 2019, 120). Interactions in these zones between communities within and beyond the Empire may have included the transfer of knowledge and technological capabilities, in addition to more tangible traded items.

Despite clear Roman political, cultural and economic influence across southeast Europe, from the third century CE Roman control of the region began to fluctuate as the provinces and their borders came under increasing pressure. Early in the century, incursions by the Carpi — a group of Dacians from outside the Empire — were put down by the emperor Caracalla (Wilkes 2005b, 224). Over the next few decades, further incursions by Goths, Carpi and other groups were variously dealt with by recruitment to the Roman military, settlement in Roman territory, diplomatic payments, and Roman military action (Bowman 2005, 80; Wilkes 2005b, 225). Ultimately, continued pressure led to Roman withdrawal from Dacia under the emperor Aurelian in the 270s CE, likely with the aim of focusing resources on the defence of the territory to the south of the Danube (Haynes and Hanson 2004, 24). Roman withdrawal made available large amounts of land to the north of the river, which may have played a role in temporarily ending the hostilities (Wilkes 2005b, 229). The loss of Dacia brought to an end nearly two centuries of Roman occupation north of the Danube, following several decades of declining influence (Haynes and Hanson 2004, 24).

2.4 Late Antiquity

2.4.1 The late Roman period 271/275–476 CE

Following the loss of Dacia as a Roman province in the 270s CE, the northern border of the Empire withdrew to the Danube (Figure 2.4), along which extensive refortification took place in the following decades (Wilkes 2005b, 259-260). The late Roman period also saw the fortification of urban settlements in the Balkan provinces. There were also considerable administrative changes to the south of the river, as the region was restructured into a greater number of smaller provinces within the larger administrative dioceses of Pannonia and Moesia, following a reorganisation and division of imperial power between east and west under the Tetrarchy (Wilkes 2005a, 706-709). Although much of the region to the south of the Danube remained under nominal Roman control into the seventh century (Louth 2005, 291-292), renewed incursions of groups including Goths, Huns, Avars and Slavs from the late fourth century led to declining political control over the territories of the Balkan provinces (Whitby 2001, 701-702, 712-716, 720-721).

The rise of Christianity from the fourth century led to increasing religious influence over urban communities, as bishoprics were established within cities (Mulvin 2002, 63-64). While the Balkan provinces were under the political control of the new imperial capital at

Constantinople (modern Istanbul), bishops were subordinate to the Pope at Rome, resulting in the establishment of religious influence from the western Empire in southeast Europe. These religious changes led to the input of resources into the development of urban infrastructure in the fourth and fifth centuries, as public and private funds were allocated to religious building projects. The most prosperous settlements were to be found in the southern Balkan provinces in this period, where raiding groups from beyond the Danube had had less impact (Whitby 2001, 701-702). Those further to the north saw more extensive depopulation, with some rural settlements abandoned as populations moved into the better-defended fortified urban settlements. Overall, the late Roman period saw extensive change in the settlement system of the Balkan provinces. While certain communities continued to flourish, others were more significantly affected by declining Roman political control in the region.

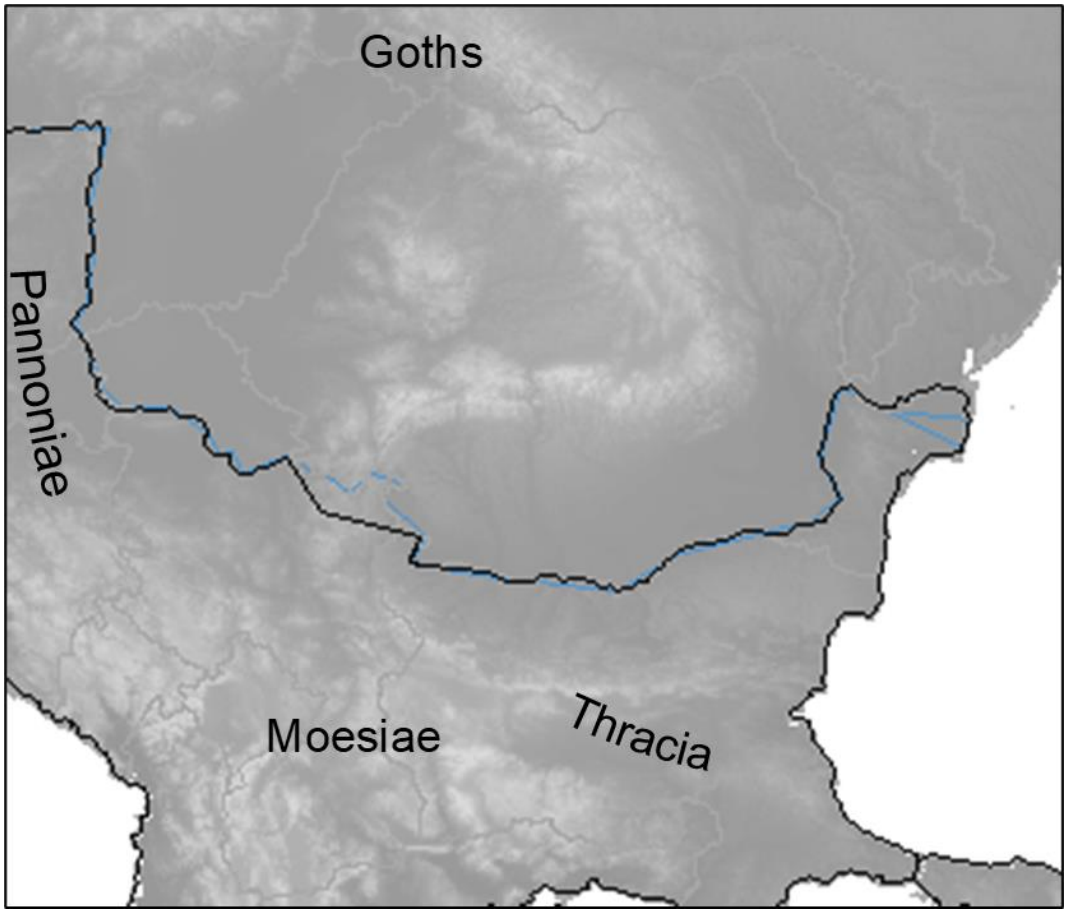


Figure 2.4: The study region in the late Roman period.

North of the Danube, changes in the organisation and structure of life in Dacia following the Roman withdrawal appear to have occurred fairly gradually. There is little evidence for a major change in settlement patterns in the short-term, though it has been noted that ways of life in the urban settlements of the region may have been considerably different in character

from those during the Roman occupation (Haynes and Hanson 2004, 24). A change in economic links between the Empire and Dacia occurred from the late fourth century, when imperial policy towards the communities north of the Danube altered under the emperor Valens. In the earlier part of the century, hostilities between Goths and Roman forces were resolved via diplomatic payments from the Empire (Heather and Matthews 1991, 17). Following conflicts during the reign of Valens, trade across the Danube frontier was reduced and limited to two crossing points, Goths serving in the Roman military were excluded from campaigns, and diplomatic payments were stopped. While the exact nature of the peace agreement and the extent of Roman control have been debated (Heather and Matthews 1991, 18-23), it is clear that the late Roman period saw a change in the nature of Roman involvement and economic influence beyond the Danube.

2.4.2 The early Byzantine period 476 CE – c. 700 CE

Following a decline in Roman political control over the provinces and the imperial frontier in the western part of the Empire, leading to the fall of the last western emperor in 476 CE, the imperial capital at Constantinople became the sole political centre of the remaining Roman territories, forming the eastern, Byzantine, Empire (Figure 2.5). Internal and external developments over the next few centuries resulted in considerable variation in the extent of Roman control over the social and economic life of the provinces. It has been argued that in the late fifth and early sixth centuries, coinage and taxation reforms under the emperor Anastasius brought greater economic stability to the eastern Empire (Lee 2001, 54-55). On the other hand, evidence for a gap in the supply of low-value coinage to several major settlements in the eastern Balkan provinces in this period indicates variation in the extent of integration of different regions into the wider economic system; it has been suggested that populations in the eastern Balkans may have had to rely on the continued use of older coinage during gaps in supply (Guest 2007). The early part of the reign of Anastasius saw further incursions into Roman territory, prompting the restoration of fortifications, resulting in the temporary cessation of attacks (Lee 2001, 57-58).

In the middle decades of the sixth century, the reign of Justinian brought greater stability, legal reforms, and the construction of new churches and fortifications, and saw the expansion of imperial control into territories that had been lost following the fall of the western Empire (Cameron 2001, 65-70; Whitby 2001, 718). On the other hand, the reign saw the imposition

of a range of restrictions on the activity of groups such as pagans and Jews, who were forced to convert or face severe consequences (Cameron 2001, 69). An outbreak of plague in the 540s may have resulted in considerable population decline in the east, though a decrease in the volume of material culture used and in the use of building materials likely to survive in the archaeological record may account for the apparent decline (Ward-Perkins 2001, 322-324). Economic changes, including the imposition of taxes owed by deserting rural occupiers on their neighbours, contributed to an on-going process of increasing economic pressure on rural communities in the early Byzantine period (Curta 2006, 44-45). Overall, while the reign of Justinian saw the establishment of renewed political and economic control in the Balkan provinces, the cultural and economic changes instituted in this period had a considerable negative impact on at least part of the population.

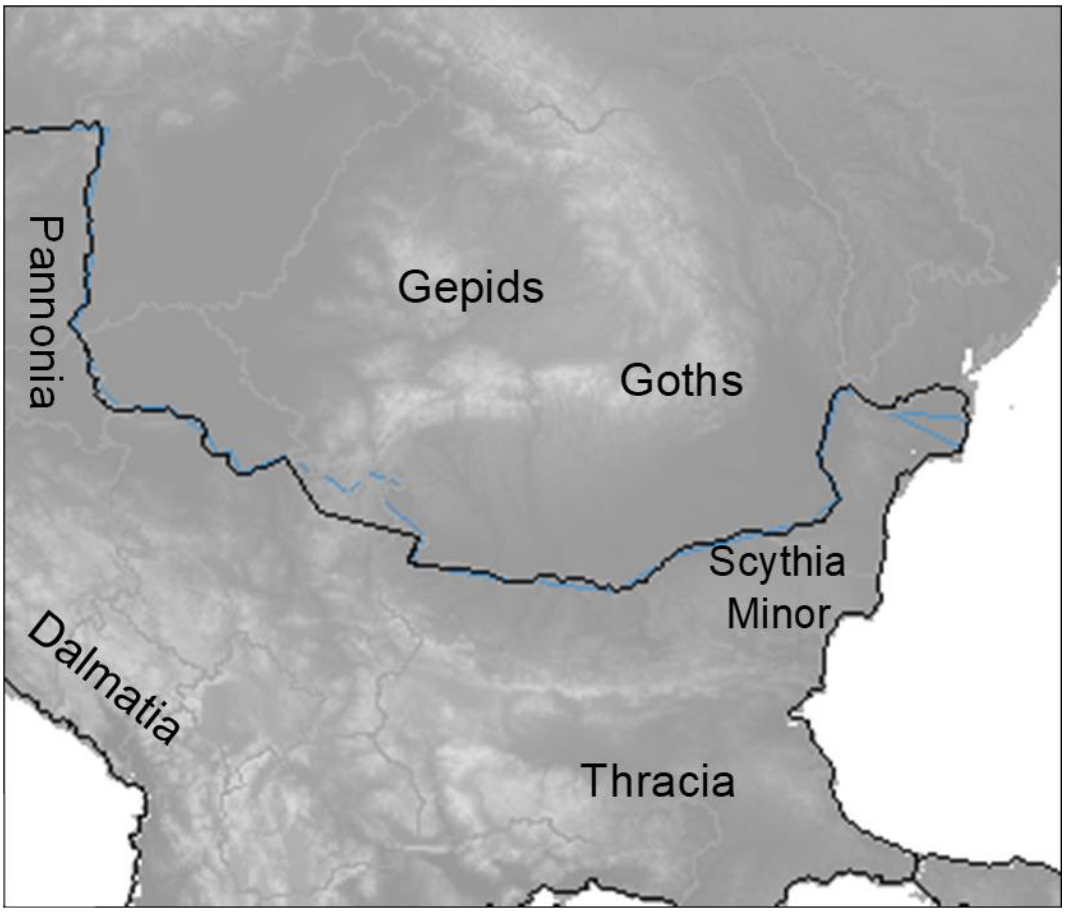


Figure 2.5: The study region in the early Byzantine period.

To the north of the Danube, the early Byzantine period saw continued social and cultural change, though continued imperial connections with the region are apparent. Increased migration into Dacia occurred in this period, as groups including Goths, Avars, Slavs and Gepids settled in and around the former Roman province (Haynes and Hanson 2004, 25). The

establishment of the Gepids in Transylvania saw the reoccupation of several of the old Roman fortified settlements in the region. Evidence for the transfer of imperial coinage and the trade of Roman products across the Danube attests to continued economic and cultural cross-border connections and imperial influence beyond the Empire in the early Byzantine period (Gandila 2018, 4-6), though this influence was clearly of a different character to that seen during the Roman occupation of Dacia. The suggestion that Roman coinage may have had a greater social than economic role north of the Danube in this period, providing individuals with an opportunity to show status by association with Rome (Gandila 2018, 3, 6), draws parallels with the situation observed in the region prior to the Roman occupation. This evidence suggests that, while occupation north of the Danube lasted less than two centuries, imperial influence in the region was of considerably longer duration, and was not confined only to the period of direct political control.

2.5 Summary

While considerable variation is evident in the nature and extent of cultural and economic change across southeast Europe from the late Iron Age to the early Byzantine period, several key themes emerge. Firstly, regarding temporal change, it is clear that although proximity to the Roman state often resulted in the development of cultural and economic connections, it is during the periods of direct Roman political control that the greatest changes in infrastructure, organisation, administration, culture and the economy can be seen. In all regions subject to direct Roman control, the occupation resulted in widespread and long-lasting changes in the structure of society and the built environment. Decreasing Roman political influence was often accompanied by cultural and economic change with its beginnings predating the ultimate loss of control of a region by the Roman state. This was the case in Dacia, where infrastructure established under the Roman occupation continued to structure ways of life even after the withdrawal of Roman power. Thus although in early periods the establishment of Roman cultural and economic influence often precipitated the institution of political control, the decline of cultural, economic and political influence in later periods often occurred concurrently. In contrast, the impact of the Roman occupation on the physical and settlement structure of the landscape generally outlasted the period of direct control.

Secondly, regarding spatial variation, it is clear that Roman influence in various forms often extended beyond the territories under direct Roman control. In the early periods of Roman

activity in southeast Europe, there is evidence for a wide sphere of influence beyond the region under direct Roman control, demonstrated by the economic and social impacts of the spread of Roman material culture. At the height of the Roman occupation, a zone of interaction, trade and exchange developed between communities within and beyond the Empire, resulting in cross-border influences in both directions. As Roman political control began to decline, the influence of the Empire reached beyond the borders via military campaigns following incursions from groups living outside the Empire, and via schemes of resettlement of these people within Roman territory, impacting the political and social structure of the societies both to the north and the south of the border. Although Roman political power over the region continued to fluctuate through the early Byzantine period, there is evidence for continued trade, and transfer of imperial coinage, across the Danube, demonstrating the continued action of a system of contact and interaction that had been in operation since the earliest period of Roman influence in southeast Europe.

This chapter aimed to highlight the areas of understanding to which zooarchaeological analysis might make a useful contribution. The value of zooarchaeological data lies in its capacity to elucidate patterns of production, distribution and consumption — of primary products such as meat and leather, and of secondary products such as milk and wool — and to provide an insight into the nature and extent of change in these fundamental processes. It provides a means of ascertaining the scale of change in animal exploitation under Roman rule — whether enacted across the imperial territories as a whole, or on a smaller, more local, scale.

When settlement patterns changed and craft production and trade intensified in the Balkan provinces in the early Roman period, zooarchaeological data can reveal whether animal husbandry and the productive economy were transformed to a similar extent during the early centuries of the occupation. When the Roman occupation expanded into Dacia and the new province saw rapid cultural and economic change, the zooarchaeological record provides a means of understanding the impact of the occupation on food production. Later, when the power and coherence of the Empire began to decline in late Antiquity, zooarchaeological data can reveal the extent to which animal exploitation practices diverged between post-Roman Dacia and the northern and southern Balkan provinces, with their increasingly divergent settlement patterns and economic systems. The zooarchaeological record can provide an insight into the impact of these processes of change at the local scale and across southeast

Europe as a whole, elucidating patterns of production and consumption in a period that saw major political and social change. Evidence for the extent of reliance on hunted resources and hippophagy can reveal both the cultural impact of major political and social change throughout the period of Roman occupation, and also the degree of dependence on more marginal resources at times of economic instability.

Changing patterns of animal exploitation stimulated by wider changes in society, culture and the economy can provide both a proxy for broader cultural and economic change, and a means of assessing the impact of that change on one particular aspect of life under Roman rule. In turn, changes in animal exploitation have ongoing consequences for the ways in which production, distribution and consumption are approached and experienced. Zooarchaeological data not only provide a means of exploring the nature and extent of change in animal exploitation, their analysis facilitates a consideration of the impact and implications of that change.

3 Animals in Roman and late antique societies

3.1 Introduction

This chapter provides an overview of previous zooarchaeological studies of the territories of the Roman Empire and neighbouring regions in Europe, giving an insight into the principal changes in animal exploitation that occurred during the Roman occupation. It begins by presenting and evaluating the evidence for changes in animal husbandry and the productive economy, with a focus on livestock relative abundance and morphology. The chapter then considers evidence for changes in the extent of reliance on hunted resources and hippophagy during the period of Roman occupation, before considering studies of dogs, their morphology and their roles in human society. Finally, the chapter evaluates previous zooarchaeological studies of the study region in southeast Europe. This section constitutes a review of comparative studies for which the purpose of the study is the comparative analysis of data from sites across a region. Not included, therefore, are faunal reports that present the first analysis of an assemblage from a single site in which faunal data from nearby sites are discussed with the purpose of contextualising the findings of the study.

3.2 Husbandry of cattle, sheep/goat and pigs

3.2.1 Introduction

While the Roman period saw widespread changes in animal husbandry practice, production, and consumption, with evidence for greater specialisation and changes in livestock morphology in many occupied regions, the timing and pace of these changes vary considerably across Europe. While in some regions developments in husbandry practice during the Roman occupation represent the continuation of trends and processes of change that had their origins in the Iron Age, in other regions the practices that emerge in the Roman period represent clear divergence from previous modes of production and consumption. In still other regions, there is relatively little evidence for any meaningful change in approach to husbandry practice and consumption during the Roman period.

The following sections evaluate data from previous zooarchaeological studies, with the analysis divided into broad regional groupings. The discussion is ordered broadly on the basis of the temporal progression of Roman occupation across Europe, though with some

divergence to allow the consecutive consideration of evidence from neighbouring, and closely linked, regions. Thus several regions of western Europe are discussed before earlier-occupied regions further to the south and the east. The discussion begins with a consideration of animal husbandry in Italy — the first region to be brought under Roman control. The aim of this evaluation is to identify the key changes in and characteristics of animal husbandry in each region during the Roman occupation. Throughout the chapter, and the remainder of the thesis, the term 'livestock' is used to refer specifically to cattle, sheep/goat (grouped together as a single taxon due to the difficulty of distinguishing between the skeletal remains of the two species) and pigs.

Several of the zooarchaeological studies discussed here consider animal husbandry across multiple regions. King (1999b) analyses data from across Europe, southwest Asia and north Africa, and features in the discussion of several European regions here. Rizzetto and Albarella (2022) consider husbandry patterns in Britain and the lower Rhine region, while Groot and Deschler-Erb (2015) present data from the Netherlands and Switzerland. Grau-Sologestoa *et al*. (2022) analyse data from across the modern Netherlands, Germany, France and Switzerland, and feature in the discussion of two of the regions considered below. Frémondeau *et al*. (2017) and Pigière (2017) examine animal exploitation in Gaul and neighbouring regions, but are discussed here only with regard to the region of modern France and Belgium. Groot and Deschler-Erb (2017) analyse data from the Netherlands and Switzerland, but are only considered here with regard to the latter region. The remaining zooarchaeological studies present data from a single region.

3.2.2 Italy

In an Empire-wide study, King (1999b, 169-171) identifies a clear shift in livestock relative abundance in Italy from the pre-Roman to the Roman period, though considerable regional variation in animal husbandry is evident in the latter period. At Greek, Etruscan, and other pre-Roman sites in Italy, husbandry practice is fairly generalised, with a slight focus on sheep/goat over cattle and pigs. In the Roman period, there is a clear change in the west central region, where pigs become considerably more abundant than either sheep/goat or cattle, comprising 65% of the livestock remains on average — this change may have occurred as early as the third century BCE in parts of the region. Both a dietary preference for pork and an increase in arable production, limiting availability of pasture for cattle and sheep/goat,

are cited as likely stimuli for this change. In the north, husbandry practice remains somewhat more generalised into the Roman period, with a slight focus on pigs, and higher proportions of cattle than are seen in other regions. In the south of Italy, sheep/goat remain the most abundant livestock taxon into the Roman period, interpreted as evidence for the continued impact of Greek influence on animal husbandry, and the perpetuation of local pre-Roman practices.

There is little clear differentiation in practice by site type overall in Roman Italy, though increasing variation is evident by the later part of the period (King 1999b, 171-173). At urban sites, there is a focus on pigs until the fifth century CE, with sheep/goat becoming more abundant in the following century. At rural sites, however, a decrease in reliance on pigs is evident from as early as the fourth century CE. King cites a possible move away from local food sources and an increase in provisioning from elsewhere in the Empire as a possible factor in the early changes observed at rural sites, a move that enabled rural communities to focus more on the husbandry of sheep/goat, perhaps for their secondary products. Disruption to provisioning via the Mediterranean in the fifth century is presented as a possible stimulus for increased reliance on sheep/goat at urban sites in later centuries, as these communities once again came to rely on more locally-available resources. Despite the various spatial and temporal differences, a focus on pig husbandry is the dominant pattern across Roman Italy; the relative lack of evidence for import of this practice by the Roman military to other regions of the Empire (King 1999a) suggests that it was to a certain extent regionally-specific, rather than Roman-specific.

A more recent study, incorporating additional sites, confirms and qualifies the patterns observed by King. Trentacoste *et al*. (2021) identify spatial and temporal variation across the northern part of Italy, and note a heavy pre-Roman reliance on pigs in Etruria, though this is often considered a typically 'Roman' practice when observed in other regions. In northeast Italy, there is a slight late Iron Age focus on cattle, which increases in the Roman period (Trentacoste *et al*. 2021, 7). In the northern subregion, a late Iron Age cattle focus is followed by fairly generalised husbandry in the Roman period. In the southern subregion, a mid-Iron Age pig focus intensifies in the late Iron Age, concurrent with the emergence of urban Etruscan societies, but is replaced by fairly specialised cattle husbandry in the early Roman period; limited data for subsequent periods indicate greater reliance on sheep/goat. Overall, the study reveals a late Iron Age pig focus, early and late Roman peaks in cattle abundance,

and relatively generalised husbandry in the mid-Roman period. Cattle appear more abundant in northern Italy than was indicated by the dataset available to King. A recent study by Salvadori (2019) indicates that fairly generalised husbandry practice emerged across Italy in the centuries after the study period considered by Trentacoste *et al*.

Alongside changes in livestock ratios, multiple studies indicate a change in livestock morphology through the period from the Iron Age to late Antiquity. A study of sites in Rome reveals an increase in sheep/goat size in the Republican period, from the fourth to later first century BCE, and a further increase in late Antiquity (De Grossi Mazzorin and Minniti 2017). Pig data reveal a somewhat later size increase, in the Imperial period, from the first century BCE to third century CE. In a study of cattle morphology, MacKinnon (2010) identifies sufficient morphological variation to infer the appearance of distinct 'breeds' of cattle. MacKinnon notes a clear increase in cattle size between the Republican and Imperial periods, and an increase of somewhat lesser magnitude between the latter period and late Antiquity. The study reveals regional variation in the extent of size increase, and demonstrates a greater degree of variation in cattle bone widths than lengths, indicating varied robustness; a greater increase in widths than lengths across certain periods is attributed to possible deliberate breeding for more robust cattle. Pressures on production — including taxation by the state, market demand, and competition between producers — are cited to account for these changes.

In a more recent study, Trentacoste *et al*. (2018) present metrical data from northern Italy across a greater time-depth than that considered by MacKinnon, revealing a pre-Roman increase in cattle and sheep/goat size. The study identifies a statistically significant increase in both width and length data for the two taxa between the Bronze Age and the Iron Age. A decrease in pig size is observed across the same period transition, however. Trentacoste *et al*. argue that this interspecies variation indicates an anthropogenic, rather than an environmental, stimulus for size change, and suggest that a change in approach to the husbandry of cattle and sheep/goat in the region occurred several centuries before the Roman period. Data from later periods indicate another statistically significant increase in cattle and sheep/goat size in the Roman period, at which time a significant increase in size in pig bone width measurements is also seen (Trentacoste *et al*. 2021). In the context of data from earlier periods, this size increase represents not an originally 'Roman' phenomenon — despite its later association with Roman influence elsewhere in the Empire — but rather the

continuation of an earlier trend that emerged during a pre-Roman period of developing networks and increasing social and economic complexity (Trentacoste *et al*. 2021, 17).

Following the emergence of increasingly large livestock in Italy through the Roman period, a subsequent decrease in size is observed in some taxa. Data for later periods indicate a decrease in average cattle size from the Imperial period to late Antiquity, and from late Antiquity to the early medieval period, with increasingly few large individuals present in the cattle population of each period (Salvadori 2019, 39). Less change is evident in pig size, however. While a slight decrease in average pig withers height is observed between the Imperial period and late Antiquity, this is followed by a very slight increase in the early medieval period (Salvadori 2019, 40). Overall, data from sites in Italy indicate a pre-Roman increase both in the extent of specialisation in husbandry practice in certain regions, and in the size of livestock. These trends continue into the Roman period, and become associated with the spread of Roman influence beyond the Italian peninsula. By the early medieval period, however, decreased specialisation and a decline in the average size of certain taxa are evident in the zooarchaeological record.

3.2.3 Iberia

A 2013 study of Iberia, covering the late Iron Age to the Roman period, aims to fill a gap in understanding of the impact of Roman occupation on animal exploitation in this previously understudied region (Colominas Barberà 2013, 3). The study spans the period of increasing Roman political influence and the earliest occupation of Iberia in the last centuries BCE to the period of declining Roman control from the fifth century CE. Interpreting the results of primary study of faunal assemblages from northeast Iberia within the context of previous work across the peninsula, Colominas Barberà identifies regional variation in the extent of animal husbandry change under Roman occupation.

A range of husbandry practices are evident during the late Iron Age, ranging from fairly generalised in the south to more specialised in sheep/goat to the east, the northeast and centrally, and with slightly higher numbers of cattle to the north and west than elsewhere (Colominas Barberà 2013, 108-123). These patterns are interpreted as the result of a climate better suited to cattle in the north of the peninsula, though the possible influence of varied

political, social and economic backgrounds on husbandry practice is also noted (Colominas Barberà 2013, 136). In the Roman period, little change is observed to the south, the east and centrally, while the north sees a move towards greater specialisation in cattle husbandry — a pattern echoed in the west, where sheep/goat also increase in abundance during the Roman occupation (Colominas Barberà 2013, 108-118). In the northeast, an increase in cattle and pigs relative to sheep/goat results in a fairly generalised pattern of livestock exploitation during the Roman period (Colominas Barberà 2013, 123). The pattern observed in the northeast highlights the importance of considering pre-Roman husbandry practice when evaluating the impact of the Roman occupation, since increased cattle and pig abundance may indeed have been precipitated by the occupation, though the resultant relative abundance of livestock represents unspecialised husbandry practice overall.

Metrical data reveal an overall increase in cattle and sheep size from the late Iron Age to the Roman period, a trend more pronounced in the central region than to the north and the south, but not seen to the west (Colominas Barberà 2013, 109-118). In the northeast, where late Iron Age cattle were the smallest, the Roman period sees a clear increase in average size, along with that of sheep, until the third century CE, from which time there is a slight decrease in the size of both taxa (Colominas Barberà 2013, 124-125). The desire to increase production is posited as a stimulus for this change in northeast Iberia (Colominas Barberà 2013, 138), though more recent work indicates that this process may have begun much earlier than the Roman occupation. Data from late Bronze Age to late antique sites in northeast Iberia reveal an increase in size beginning as early as the early Iron Age for sheep/goat, and the middle Iron Age for cattle and pigs (Nieto Espinet *et al*. 2021, 30). The Roman occupation thus sustained the trend for increasing livestock size in northeast Iberia, but did not originate it.

Finally, Colominas Barberà (2013, 136-138) identifies variation by site type in the Roman period, both in the relative abundance of livestock taxa and in their size. While cattle and sheep/goat, and larger livestock in general, are more common on villa sites and at military camps, pigs predominate on urban sites; overall, this variation is interpreted as the result of emerging specialised production and consumption sites in Iberia during the Roman occupation. This evidence for change in economic organisation in Iberia, despite notable variation in the specific taxa exploited in the various parts of the region, suggests a transformation precipitated not by regional factors such as environment or political or social

background, but rather the result of the influence to which the region as whole was subject — the Roman occupation of the peninsula.

Two studies identify an association between larger cattle and settlements newly founded in the Roman period in Iberia. Metrical analysis undertaken by Colominas *et al*. (2013) demonstrates that larger cattle were present at sites established during the Romanisation period, from the second to first centuries BCE, than are seen in the same period at sites with an earlier date of establishment. The study additionally identifies an association between larger cattle and villas and trade centres, with smaller cattle recovered from urban sites. This association is interpreted as possible evidence for a primary focus on the production of larger cattle for use in traction, rather than for meat. It is suggested that this change was facilitated via the import of larger cattle into the region.

A study of cattle in Roman-period western Spain and Portugal also reveals the presence of larger cattle at newly-founded Roman sites, though in this region, these larger animals are also found at urban sites in addition to other site types (Detry *et al*. 2022). Detry *et al*. identify a greater focus on the exploitation of cattle at Roman-founded urban settlements than is seen at older urban sites and Roman villas, where sheep/goat and pigs are more common. The study also reveals the appearance of progressively larger cattle in the region from the later Iron Age to the late Roman period, with larger individuals present on Roman-founded sites — both cities and villas — than elsewhere. A possible role for villas as production sites used in the provisioning of Roman cities is suggested.

The work of Detry *et al*. indicates a continued increase in cattle size in western Spain and Portugal into the late Roman period, as Roman political control across the Empire began to decline. By the Islamic period, however, the data indicate a clear decrease in cattle size (Detry *et al* 2022, 99-100). Changes in sheep size in this region do not appear to have followed this pattern, however. Metrical data analysed by Davis (2017) reveal an increase in sheep size in Portugal from the Iron Age to the Roman period, and again from the Roman period to the Islamic period. A desire to increase meat yields, concurrent with a range of other improvements in farming practice in the Islamic period, is cited as a likely stimulus for the observed continued increase in sheep size. Data from elsewhere in Iberia indicate that this post-Roman sheep size increase was limited to the southwest of the peninsula — in the

northeast and centrally, average size of both sheep/goat and pigs is shown to decline from the sixth century CE, and that of cattle from the eighth century (Grau-Sologestoa 2015).

3.2.4 France and Belgium

In Gaul, in the region of modern France and Belgium, zooarchaeological analysis reveals variation both by site type and by region in the extent of reliance on each livestock taxon. King (1999b, 174, 177) notes very high proportions of sheep/goat in the Roman period in the southeast, in Gallia Narbonensis, where this taxon is considerably more abundant than cattle or pigs at the majority of urban settlements, villas, and other rural sites. The long-term impact of Greek influence in the region — of continued importance into the Roman period — is cited as a likely stimulus for this pattern. Some limited intraregional variation is however apparent, with higher than average proportions of pigs at urban settlements that were Roman colonies, indicating a greater Roman influence at these sites, while a change over time is also evident, with some later Roman sites exhibiting particularly high proportions of cattle.

Across the remainder of Gaul, data analysed by King (1999b, 176, 178) reveal regional variation, with progressively more cattle and fewer sheep/goat and pigs further to the north. In the southwest, in Gallia Aquitania, husbandry is fairly generalised overall, with a slight focus on pigs. Further to the north, in Gallia Lugdunensis, cattle and pigs are more-or-less equally abundant, while sheep/goat are present in much smaller proportions. In the northeast of France, in Gallia Belgica, cattle reaches 46% of the livestock remains on average, followed by pigs and then sheep/goat. For the three provinces as a whole, cattle are particularly abundant at villas and vici, while pigs are more common at urban and military sites. King argues that the capacity of Gaul to produce its own food enabled the development of a clear regional pattern of livestock exploitation, little affected by the Roman occupation. The spread of Gallic dietary practices to communities in more northerly provinces in the Roman period (King 1999b, 178) demonstrates that 'Roman' influence on occupied regions could constitute the export of practices from other provinces of the Empire, and not only from the Italian peninsula.

A more recent study reveals temporal, intraregional and site-type-based variation in livestock exploitation in the Roman period. In the western region of Gallia Belgica, Pigière (2017, 476-

477) notes a progressive increase in the exploitation of cattle and a decrease in sheep/goat abundance from the first century CE into the late Roman period. In the Civitas Tungrorum, in the far north of Gallia Belgica, urban sites exhibit consistently high proportions of cattle — between 40% and 80% of the livestock remains — until the third century CE, but from the fourth century, the abundance of this taxon decreases (Pigière 2017, 484). Rural sites feature similar proportions of cattle in the first to second century CE, but by the third century, cattle do not exceed 40% of the remains at any rural site, and both sheep/goat and pigs become more abundant. Overall, the study demonstrates considerable variation in practice even within relatively small subregions. Within the broader north-south gradient in livestock exploitation, multiple subregion-level specificities in both the nature and timing of change in husbandry practice are thus evident.

Multiple studies reveal a change in livestock size in Gaul, beginning some centuries prior to the start of the Roman occupation. In a study of the north of Gaul, Lepetz (1996, 319-320) identifies a very slight increase in cattle withers height during the Iron Age, followed by a much clearer increase in the first century CE, in the early Roman period. Maximum cattle size is reached in the second to third centuries CE, whereafter a small decline occurs. Lepetz (1996, 317) argues that Roman-period size increase is of sufficient magnitude to infer the import of larger cattle into northern Gaul, though a few smaller individuals continue to form part of the population into the fifth century. Analysis of sheep/goat and pig metrical data indicates a larger pre-Roman increase in withers height than that observed for cattle (Lepetz 1996, 319-320). Sheep/goat size continues to increase during the early Roman occupation, reaching a maximum in the first century CE. Pig size also continues to increase into the Roman period, reaching a maximum in the second to third centuries, and changing little thereafter.

More recent work on cattle and pig size demonstrates that the changes observed by Lepetz in the north took place across Gaul, though there is regional variation in the timing and extent of change. Frémondeau *et al*. (2017) identify a progressive increase in average cattle and pig size from the third century BCE to the third century CE. When the data are separated by region, the earliest increase is seen in the southeast, in Gallia Narbonensis, where both cattle and pigs begin to increase in size from as early as the fourth century BCE. For pigs, there is then a clear divergence in regional trajectories in the first century BCE. After this time, size increase occurs at a greater rate in the north, in Gallia Lugdunensis and Gallia Belgica, than

in the south, eventually resulting in a larger northern maximum. For cattle, however, there is little regional difference in maximum size in the third century CE. In much of Gaul, there is a decline in average cattle and pig size from the fourth century CE; in Gallia Belgica, however, where some of the largest Roman pigs were seen, it is not until the following century that average pig size begins to decline.

In addition to temporal variation in size, change over time in the slenderness of livestock can be seen across Gaul. Forest and Rodet-Belarbi (2002) identify a slight change in cattle slenderness around the time of or just before the earliest Roman occupation, but a much greater change from the second century CE. In the period from c. 50 BCE to 100 CE, several quite tall but averagely robust individuals, and several other quite robust individuals of average height, appear in the cattle population. The conformation of these individuals is considered too similar to late Iron Age cattle to indicate an overall change in the morphology of the population (Forest and Rodet-Belarbi 2002, 294). In the period from c. 100–400 CE, however, there is a much clearer change in cattle morphology, as multiple individuals both taller and more robust than the late Iron Age cattle appear in the population. The extent of change, and the virtual disappearance of any very small or very slender individuals in this period, suggests that within a century or so of the occupation, a considerable change in both height and slenderness had occurred.

The early date of livestock size increase identified in Gaul by Lepetz (1996) and Frémondeau *et al*. (2017) clearly demonstrates that these processes of change were in motion prior to the advent of Roman political control of the region. Changes in livestock morphology are argued to result from a combination of internally-driven changes of approach to animal husbandry, within the context of and in response to wider economic developments and greater connectivity between markets in the late Iron Age (Frémondeau *et al*. 2017, 503-504). It was within this late Iron Age context that the early expansion of Roman political control began. The development of increasingly large livestock during the Roman period thus represents the continuation of a late Iron Age process in Gaul in response to increased demand and potential, as economic changes that began in the late Iron Age accelerated, and the expansion of Roman control resulted in greater economic connectivity across an expanded market network.

3.2.5 Britain

In the late Iron Age, animal husbandry in Britain is characterised by a focus on cattle and particularly sheep, with fewer pigs present at the majority of sites (Hambleton 1999, 43). Some regional variation in practice is apparent across the sites studied by Hambleton (1999, 45). In the southeast of Britain and in the north, sites exhibit a focus on either cattle or sheep, with very few pigs at any site. In the southwest, the midlands and in the east, the pattern is similar, but a few sites exhibit relatively high proportions of pig. At western sites, pigs are somewhat more abundant on a larger proportion of sites, resulting in more equal reliance on each livestock taxon, and thus fairly generalised husbandry practice overall.

In the Roman period, livestock ratios at sites studied by King (1999b, 178-180) reveal a change in the extent of reliance on each taxon, with fewer sites exhibiting high proportions of sheep/goat, but a clear increase in both cattle and pig abundance. Overall, cattle become the most abundant taxon, followed by sheep/goat, and then pigs, though some variation in this pattern is evident at different site types. Cattle abundance is highest at military sites, where this taxon comprises over 60% of the livestock remains on average. At auxiliary sites, there is a secondary focus on the exploitation of sheep/goat, while at legionary sites, pigs are the second most abundant taxon — the only site type at which this is the case. At urban sites, vici and villas, there is also evidence for fairly specialised exploitation of cattle — the taxon comprises over 50% of the livestock at these site types — followed by sheep/goat at around 30%, and then pigs. At other rural settlements, however, cattle and sheep/goat are present in somewhat more equal proportions, while pigs only form a very small percentage of the livestock remains. It is suggested that the relatively high proportion of sheep/goat at these sites results from the continued influence of pre-Roman practices on rural communities (King 1999b, 180).

The varied patterns of livestock exploitation across the various site types analysed by King (1999b, 178-180) are argued to represent the result of varying levels of Roman influence at different types of site. Higher proportions of cattle at the more 'Romanised' site types are interpreted as evidence for a greater degree of Roman influence on livestock exploitation and dietary preferences at military and urban sites than at other site types. It is suggested that the relatively cattle-focused economy of Gaul is the source of this exploitation pattern, imported and established in Britain via military and urban communities. King notes evidence for

temporal change in Britain, as the focus on cattle gradually spreads to all site types by the late Roman period, arguing that a process of emulation of 'Romanised' practices may have provided the mechanism by which this change was achieved.

Some regional variation in livestock exploitation is evident, as revealed by a study of the rural settlements of Roman Britain. The most generalised husbandry is seen in the southwest, the south, the west and the northeast, where similar proportions of cattle and sheep/goat are present, with pigs comprising a relatively small component of the assemblages studied (Allen 2018, 79). Across these four regions, sheep/goat only outnumber cattle in the southwest. In the central west and the east, there is a clearer focus on cattle, though not to the extent necessary to indicate specialised husbandry. The study identifies a particularly high proportion of cattle in the north, though this is principally due to the classification of vici as rural sites — high proportions of cattle in this region thus predominantly result from military influence (Allen 2018, 79-80). Overall, Allen identifies regional variation in livestock exploitation that neither shows any clear spatial patterning — such as a north-south gradient, as might be expected to result from the impact of Roman influence on husbandry practice — nor any clear correlation with the regional patterns of the Iron Age identified by Hambleton (1999). Thus while the Roman period sees an overall increase in reliance on cattle in Britain, regional variation remains a feature of the animal husbandry of the province.

King (1999b, 180) notes an increase in sheep/goat abundance following the end of the Roman occupation of Britain, suggesting that the changes in animal husbandry that occurred under Roman rule were relatively short-lived. This pattern is confirmed by a more recent study, which reveals a decline in the importance of cattle in the early medieval period. Across sites in the southeast of Britain, Rizzetto and Albarella (2022, 10) identify a clear focus on cattle husbandry in the late Roman period, this taxon comprising 50% or more of the livestock remains on the majority of sites. In the fifth to seventh centuries CE, however, cattle comprise 50% or more of the assemblage on less than half of all sites. The period sees an increase in the abundance of both sheep/goat and pigs, resulting in more generalised husbandry practice overall in the early medieval period. While some regional variation in husbandry practice is apparent, the study identifies no clear general spatial trends in the extent of reliance on each livestock taxon across Britain — either during or after the Roman occupation.

In addition to changes in relative abundance, changes in livestock size are also evident in the Roman period. Data from southeast Britain analysed by Rizzetto *et al*. (2017, 540-544) indicate a clear cattle size increase in the early Roman period. The late Roman period then sees little change, though larger cattle are present at certain sites. There is a decrease in average cattle size in the early medieval period, evident in both width and length measurements. Earlier work by Albarella *et al*. (2008, 1836-1838) reveals little change in sheep/goat and pig size in the early Roman period, though both taxa increase in size in the mid-Roman period. While there is then little change in sheep/goat size after the end of the Roman occupation, pig size decreases in the early medieval period (Rizzetto *et al*. 2017, 544-549). It is argued that these changes in livestock size were achieved via the import of larger livestock with the intention of increasing yields, and were stimulated by the development of a new economic system in Roman Britain; post-Roman size decrease thus indicates the decline of this system, as husbandry became smaller-scale and regionalised (Albarella *et al*. 2008, 1836; Rizzetto *et al*. 2017, 551).

A more recent study of the late Roman to post-Roman transition in southeast Britain, incorporating data from a larger number of sites, largely confirms these patterns. Rizzetto and Albarella (2022, 11) identify a lower mean and median cattle size at the majority of early medieval sites than at the majority of late Roman sites. While there is considerable overlap in the interquartile range of sizes present in each period, the difference between average values indicates a clear size decrease after the end of the Roman occupation — this is confirmed by statistical testing (Rizzetto and Albarella 2022, 10-12). Also confirming the results of previous studies, Rizzetto and Albarella (2022, 12-14) note a decrease in pig size in the early medieval period, but little evidence for a decrease in sheep/goat size, with considerable overlap in the distribution of late Roman and early medieval average values for this taxon.

While these studies demonstrate a clear increase in livestock size during the Roman occupation, recent work on cattle provides evidence for a more prolonged period of increase, with an earlier, Iron Age, origin. At sites across England and Wales, Duval and Albarella (2022, 116) demonstrate a gradual increase in cattle size beginning as early as the fifth or fourth century BCE, and continuing through the late Iron Age. The Roman period sees a continued increase in size, though smaller individuals remain a part of the population until a century or so after the conquest; in the fifth century CE, average size begins to decline. The influence of broad continental economic change in the late Iron Age is suggested as an

impetus for the pre-Roman change in cattle size revealed by the study (Duval and Albarella 2022, 122-123). Further size increase early in the occupation reveals the initial impact of Roman influence, while the disappearance of smaller cattle after the second century CE demonstrates the further establishment of this influence in the mid-Roman period.

Duval and Albarella (2022, 116-119) also note considerable regional variation in cattle size. In the late Iron Age, cattle are smallest in the south and southeast and largest in the north and west. In the early Roman period, the largest cattle are seen in southern and eastern Britain, where the clear change in size is interpreted as evidence for the appearance of a different form of cattle. Northern cattle remain large in this period. In the mid-Roman period, there is continued size increase, though this is greatest in magnitude in regions where little size increase had previously occurred; in this period, the smallest cattle are seen in western and northern regions. In the late Roman period, cattle size generally decreases along a southeast-northwest gradient, though large cattle are also found in the northeast. It is noted that varied pre-Roman social and cultural context likely had a considerable influence on the trajectory of change in each region, demonstrating the importance of local responses to broader influences in determining the ways in which those influences manifested themselves (Duval and Albarella 2022, 119).

3.2.6 The Netherlands and Germany

Two studies of the Roman Netherlands provide evidence for a clear focus on cattle husbandry, though temporal and site-type-based variation are apparent. Groot and Deschler-Erb (2015, 451) identify very high proportions of cattle, comprising over 70% of the livestock, at rural sites in the western Netherlands through the first to third centuries CE. In the east, there is evidence for temporal change at rural sites, however. Husbandry is least specialised in the first century CE, when cattle comprise a little over 50% of the livestock, followed by sheep/goat at around 40%. At first-to-second-century sites, cattle become considerably more abundant, at almost 70% of the livestock remains, with a corresponding decrease in reliance on sheep/goat. In the second to third centuries, cattle abundance increases once again, now exceeding 70% of the livestock, but in the third to fourth centuries the percentage falls to below 70% once again. There is an increase in the abundance of pigs in the latter period, this taxon becoming more abundant than sheep/goat for the first time. Age profiles for rural sites indicate mixed exploitation of cattle, with a greater focus on

exploitation for traction in arable production in the east than the west (Groot and Deschler-Erb 2015, 455).

A second study of the Roman Netherlands reveals variation by site type (Groot 2017, 456). In the western part of the province Germania Inferior, cattle average around 70% of the livestock remains at military sites. Both sheep/goat and pigs comprise less than 20% of military assemblage on average, though pig abundance exceeds 50% at a few sites. At rural sites, cattle abundance is very similar to that observed at military sites, while sheep/goat are somewhat more abundant. At urban sites, cattle abundance is highest, at over 80%, while both sheep/goat and pigs average less than 10%. In eastern Germania Inferior, average cattle abundance at military sites is much lower, at around 40%, while both sheep/goat and pigs are somewhat more abundant than in the western region. At rural sites, average values similarly indicate more generalised husbandry than was seen in the west. At urban sites, however, there is little difference between west and east, with cattle exceeding 80% of the livestock in the latter region. In general, the study indicates greater reliance on cattle at urban sites than at military or rural sites, though the specialised exploitation of this taxon is evident at a proportion of sites of each type in both regions.

Two more recent studies provide insight into cattle husbandry across a broader spatial and temporal range. Groot and Albarella (2022, 7) analyse husbandry across four regions in the Netherlands, the most northerly lying beyond the Empire. Across the Netherlands as a whole, average cattle abundance is high throughout the Iron Age, indicating fairly specialised husbandry. Cattle abundance decreases in the early Roman period, returns to Iron Age levels in the mid-Roman period, and declines again in the late Roman period. While relatively generalised early Roman husbandry is attributed to a requirement for communities to produce their own food, greater mid-Roman specialisation is argued to result from access to a more organised market economy (Groot and Albarella 2022, 29). Data by region reveal that Iron Age cattle abundance is highest in the north (Groot and Albarella 2022, 8). Early Roman decline is evident both within and outside the Empire, while mid-Roman increase occurs predominantly in occupied regions. In the late Roman period, average cattle abundance falls in all occupied regions, but increases outside the Empire. While widespread low early Roman cattle abundance indicates disruption to Iron Age production systems both within and outside the Empire, the earlier recovery of specialised production in occupied regions suggests that Roman control resulted in the earlier establishment of greater economic stability.

A second study of cattle husbandry on both sides of the Roman border reveals a somewhat different trajectory of change in the region of modern Germany. Grau-Sologestoa *et al*. (2022, 4-5) identify a decrease over time in cattle abundance in Roman-occupied Germany. In the early Roman period, average cattle abundance is around 70%, considerably higher than that observed in the Netherlands in this period. In the mid-Roman period, there is no change in the average; increased cattle abundance in the Netherlands in this period results in a similar degree of reliance on this taxon in both regions. In the late Roman period, there is a clear decrease in reliance on cattle in Germany, followed by a further small decrease in the early medieval period. Outside the Empire, in Germania Magna, a smaller decline in cattle abundance is observed. From the Iron Age to the earlier part of the Roman period, cattle abundance exceeds 70%. In the late Roman period, there is a decrease to just below 65%, followed by a further decrease to just under 50% at sites spanning the Roman to early medieval periods. Clear differences in exploitation are thus evident between the Roman-occupied Netherlands and Germany, and regions to the north of the border. In all three regions, however, cattle exploitation was clearly of considerable importance.

Analysis of livestock size across the Netherlands and Germany reveals spatial and temporal variation. In the Netherlands, Groot and Albarella (2022, 15-21) identify contrasting patterns within and outside the Empire. Outside the Empire, there is a slight increase in cattle bone widths in the late Iron Age, followed by a decrease in the early Roman period, and little change thereafter. No very large individuals are present in the region in any period. Within the Empire, cattle size increases from the Iron Age to the mid-Roman period in the western region, and continues to increase until the late Roman period in the central region. The largest individuals are seen at rural and consumer sites in the mid-Roman period. In the south, cattle size also increases between the Iron Age and the Roman period. Overall, cattle are thus larger in the Roman period than in the Iron Age in occupied regions. While late Iron Age cattle outside the Empire are slightly larger on average than those within the Empire, the clear Roman size increase in occupied regions means that Roman-period cattle outside the Empire are on average the smallest. There is thus little evidence for Roman influence on cattle breeding north of the border (Groot and Albarella 2022, 29-30).

In Germany, Grau-Sologestoa *et al*. (2022, 5-6) identify varied trajectories of change within and outside the Empire. In the Iron Age, there is very slight regional variation in cattle bone widths — the average is largest in Germania Superior, in the east, and smallest in Germania

Inferior, in the west, while average cattle size in Germania Magna falls between that of the two other regions. In the early Roman period, following the Roman occupation of Germania Superior and Inferior, there is a slight increase in average size in these two regions. In the mid-Roman period, average size increases in all three regions, though the increase is the largest in Germania Superior, where particularly large individuals appear in the sample. In the late Roman period, average size increases in Germania Inferior and decreases elsewhere, though the cattle in Germania Superior remain the largest on average. Overall then, while data analysed by Grau-Sologestoa *et al*. reveal greater cattle size increase outside the Empire in Germany than was observed north of the border in the Netherlands, these German cattle were still smaller than those raised within Roman-occupied Germany.

Overall, there is little indication of a pre-Roman increase in cattle size in the Netherlands and Germany on the scale seen elsewhere in Europe. A study of sites in the Netherlands undertaken by Rizzetto and Albarella (2022) reveals somewhat different trajectories of change in sheep/goat and pig size to those seen in cattle from the late Roman period. Average cattle size decreases slightly between the late Roman and early medieval periods both within and outside the Empire; overall, cattle within the Empire are slightly larger than those outside the Empire in both periods. Average sheep/goat size increases very slightly from the late Roman to the early medieval period outside the Empire. In the latter period, there is little to no difference in average sheep/goat size within and outside the Empire. There is a slight decrease in mean pig size from the late Roman to the early medieval period both within and outside the Empire; individuals outside the Empire are larger than those within the Empire in both periods.

3.2.7 Switzerland, Austria and Hungary

In two studies of northern Switzerland, Roman husbandry practice is revealed to be fairly generalised overall, though some temporal and site-type-based variation is evident. For the Roman period as a whole, cattle and pigs are present in very similar proportions at rural sites, with sheep/goat considerably less abundant (Groot and Deschler-Erb 2015, 450). In the first century CE, there is a slight focus on cattle, the taxon comprising around 46% of the livestock remains (Groot and Deschler-Erb 2015, 451). In the first to second centuries, cattle abundance decreases slightly, and pigs become most abundant, while in the second to third centuries, both taxa comprise around 41% of the livestock. Sheep/goat abundance increases

slightly over time, but never exceeds 18%. In a second study, Groot and Deschler-Erb (2017, 99) identify slightly different patterns of exploitation at urban and military sites. At urban sites, cattle comprise 44% of the livestock on average, pigs 36% and sheep/goat 20%. At military sites, however, pigs are considerably more abundant than either cattle or sheep/goat, comprising 44% of the livestock remains on average. Sheep/goat follow at 30%, with cattle least abundant at 26%. Overall, husbandry in the north focuses fairly equally on cattle and pigs, though military communities consumed much lower proportions of cattle and higher proportions of pigs than civilian communities.

A more recent study encompassing northern Switzerland and eastern France, and covering a broader time period, reveals fluctuation in cattle abundance from the Iron Age to the late Roman period. There is a clear decrease in cattle abundance from the Iron Age to the early Roman period, attributed to the inclusion in the dataset of two military sites and a temple assemblage with particularly low proportions of cattle (Grau-Sologestoa *et al*. 2022, 4-5). Cattle abundance reaches its highest point in the mid-Roman period, exceeding 50% on average, but declines again in the late Roman period to a little over the Iron Age average. The study thus indicates that reliance on cattle was highest during the Roman occupation, but towards the end of the Roman period had begun to decline.

Two studies of cattle metrical data provide evidence for the appearance of progressively larger individuals through the late Iron Age and the Roman period, the first study also revealing a post-Roman decline in average cattle size. At four sites in northern Switzerland, Breuer *et al*. (1999, 218) identify an increase in cattle size between the La Tène D1 (c. 150–70 BCE) and La Tène D2 (c. 70–20 BCE) periods, with multiple larger individuals appearing in the latter period. There is a progressive increase in average cattle size through the first and second halves of the first century CE, the second century, and the first and second halves of the third century. From the second half of the first century onwards, a few very large individuals appear in the sample for each period. In the sixth to seventh centuries, however, cattle size decreases to the average observed for La Tène D2, and the largest individuals disappear from the population, thus reversing the increase that occurred through the Roman period. A similar pattern is identified in a more recent study encompassing a larger number of sites. Grau-Sologestoa *et al*. (2022, 9) identify a progressive increase in cattle size from the Iron Age to the late Roman period, confirming the patterns identified by Breuer *et al*.

A 2021 study of sites in Switzerland and eastern France reveals similar trajectories of change in sheep/goat and pig size. Sheep/goat width measurements reveal a small increase in the average size of this taxon between the first to mid-third century CE and the late Roman period, followed by a small decrease in the early medieval period (Grau-Sologestoa *et al*. 2021, 11). In the length data, there is a very slight decrease in the late Roman period, followed by a larger early medieval decrease. A late Roman increase in widths, but not lengths, indicates that sheep/goat may have become somewhat more robust in this period. Pig widths reveal little change from the first to the seventh century CE (Grau-Sologestoa *et al*. 2021, 13). In the length measurements, there is a slight increase in the late Roman period, followed by a slight decrease in the early medieval period (Grau-Sologestoa *et al*. 2021, 14). Overall, the pig data provide relatively little evidence for a decline in average size in early medieval Switzerland.

Further to the east, in the Roman province Raetia — encompassing modern central and eastern Switzerland, western Austria, southern Germany and northern Italy — somewhat different patterns of livestock exploitation are evident. In the La Tène period, husbandry is relatively generalised overall, with little evidence for a clear focus on any taxon (Trixl *et al*. 2017, 437-438). Pigs are considerably more abundant at sites in the northern and southern Alpine forelands than at inner Alpine sites, where sheep/goat are more abundant. These patterns are attributed in part to the contrasting environmental conditions and requirements of these taxa, though the likely influence of varying cultural context on husbandry is also noted. In the early Roman period, there is little change at inner Alpine sites, where sheep/goat remain most abundant, likely due to their suitability for the Alpine environment (Trixl *et al*. 2017, 440-444). In the northern Alpine foreland, contrasting practices are observed in the eastern and western parts of the region. In the east, the early Roman period sees a small increase in reliance on cattle, with relatively few pigs, and fewer sheep/goat, present. In the west, pigs are most abundant, with a secondary reliance on cattle — changes in livestock exploitation here are argued to result from greater Roman influence in this region.

Cattle metrical data reveal a contrasting picture with regard to the extent of external influence on local practice, however. In the northern Alpine foreland, the early Roman period sees a clear increase in average cattle size in the east, where the magnitude of size variation remains similar to that observed in the La Tène period (Trixl *et al*. 2017, 441-443). The relative lack of intrapopulation variation is argued to result from the rapid or gradual replacement of local

cattle with imported breeding stock, resulting in a fairly homogeneous population of larger individuals. In the west, there is a much smaller increase in cattle size from the La Tène to early Roman period, and a much larger range of sizes in the early Roman period than was observed in the eastern region. Trixl *et al*. (2017, 441) suggest that the breeding of local cattle with imported larger males, without replacing the local population, could have led to the distribution of sizes observed.

Further still to the east, in modern Hungary, data analysed by King (1999b, 195) indicate little change in husbandry practice in the Roman period, with a slight focus on cattle exploitation evident both before and after the Roman conquest. In the region of modern western Hungary, a study of Celtic and Celto-Roman sites — the latter featuring evidence for the adoption of 'Romanised' ways of life — reveals little clear evidence for variation in husbandry practice correlated with extent of Roman influence (Lyublyanovics 2010). At a single site dated to the period prior to the Roman occupation, cattle comprise around 50% of the livestock (Lyublyanovics 2010, 185). After the conquest, considerable variation in livestock exploitation is evident at Celtic sites. Several exhibit a clear focus on cattle, with sheep/goat and pigs variously second or third most important, while three sites in the region of Lake Balaton reveal a focus on pig husbandry. Lyublyanovics notes the probable influence of environment on the forms of husbandry practised at Celtic sites across the region. At two Celto-Roman sites, livestock ratios vary widely, with a slight focus on cattle evident at one site, and a clear focus on sheep/goat at the second.

There is little evidence for any difference in livestock size between Celtic and Celto-Roman sites. Like the cattle present in the Iron Age, those at the majority of Celtic and Celto-Roman sites are fairly small; only at a single Celtic site are any particularly large individuals found, interpreted as imports of Roman cattle (Lyublyanovics 2010, 188-189). Sheep/goat at both Celtic and Celto-Roman sites are also fairly small, showing no evidence of size increase relative to the Iron Age population. Similarly, the majority of pigs appear to have been of fairly small stature in both the Iron Age and the Roman period, though Lyublyanovics notes the presence of slightly larger individuals at Roman urban settlements, attributing their larger size to better feeding. Overall, there appear to be few clear patterns differentiating husbandry practice at the Celtic and Romanised Celto-Roman sites studied by Lyublyanovics, suggesting that the economic basis of these communities was little affected by the Roman occupation.

3.2.8 Greece and the western Balkans

In southern Pannonia, in modern eastern Croatia, detailed analysis of livestock exploitation via zooarchaeological evidence is precluded by limited available data. A study of food production in the Roman period undertaken by Reed and Roguljić (2020, 49) reveals a focus on cattle husbandry at a single site dated to the third to fifth centuries CE. Cattle comprise 52% of the animal remains, followed by sheep/goat at 35%, and pigs at 3%. The late Roman animal husbandry at the site is thus focused on the exploitation of herbivore taxa. More data would be necessary to understand the impact of the Roman occupation on husbandry in this region.

In Greece, King (1999b, 183-184) identifies an overall focus on the exploitation of sheep/goat. In the Hellenistic period, husbandry practice is fairly generalised at Messene, in the south, while sheep/goat are considerably more abundant than either cattle or pigs at several other sites. The two assemblages exhibiting the highest proportions of sheep/goat only comprise just over 100 bone fragments, however, so may be unrepresentative. From the first century CE onwards, there is little change overall in livestock exploitation. A focus on sheep/goat can once again be seen at several sites, though at Messene exploitation remains fairly generalised into the fifth century CE. King identifies some variation in practice by site type. While at rural sites, sheep/goat abundance is uniformly high, at urban sites a greater degree of variation can be seen. While half of all urban sites exhibit a clear focus on sheep/goat exploitation, the other half reveal more equal proportions of each livestock taxon, indicating fairly generalised exploitation. Overall, the region is thus characterised by greater site-type-based variation than temporal variation, with little evidence for a clear change in practice following the establishment of Roman control; more recent work suggests that this continuity in practice persisted into the Byzantine period (Kroll 2012, 96).

Two more recent studies of livestock exploitation in Greece reveal similar patterns. In a study of the Athenian Agora, MacKinnon (2014, 208) identifies temporal change in livestock ratios, with sheep/goat most abundant in the Hellenistic period, a clear focus on cattle in the Roman period, and fairly equal proportions of each taxon in the early Byzantine period. MacKinnon notes, however, the inflating influence of articulated sheep/goat skeletons on the Hellenistic sample, and of worked cattle bone on the Roman sample — once these potential biases are removed, the data reveal little change in livestock ratios from the Roman to the

early Byzantine period (MacKinnon 2014, 209). Metrical data, meanwhile, indicate a decrease in cattle size from the Roman to the early Byzantine period (MacKinnon 2014, 233). In a study of animal husbandry at a number of sites in Greece, data analysed by Filioglou and Çakırlar (2023, 12) reveal little change in cattle or pig size across two phases — a Hellenistic phase, and a Hellenistic-Roman transitional phase — at Messene. Overall, Filioglou and Çakırlar note little evidence for any change in livestock ratios or morphology as a result of Roman influence in Greece.

3.2.9 Summary

Overall, it is evident that across much of the territory of the Roman Empire, clear changes in livestock exploitation and livestock morphology occurred after the Roman conquest. It is also clear, however, that in many regions, the occupation did not initiate these changes, but rather sustained — or in some cases accelerated — trends that emerged several centuries earlier, in a period of increasing social and economic complexity in the later part of the Iron Age.

In Italy, Iron Age livestock exploitation is fairly generalised, with slight focuses on different taxa in different regions. A late Iron Age focus on pig husbandry in Etruria provides evidence for pre-Roman specialisation, associated with the emergence of greater social and economic complexity. While the Roman period sees an increased focus on pig husbandry, sheep/goat remain more abundant in the south, revealing continuing Greek influence. Across northern Italy, progressively larger cattle and sheep/goat appear through the Iron Age, though pigs decrease in size. Cattle and sheep/goat increase again in size in the Republican period, followed by pigs in the Imperial period. The transition from late Antiquity to the early medieval period sees the appearance of more generalised husbandry, and a decrease in the size of both cattle and pigs.

In Iberia, Iron Age husbandry is characterised by regional variation, with a greater focus on cattle in the north and west, and sheep/goat in the south. Specialisation in cattle husbandry increases in the north and west in the Roman period, while increased cattle and pig frequencies in the northeast result in fairly generalised husbandry in this region. The emergence of specialised production and consumption sites in this period indicates Roman influence on the economy of the region. There is an increase in cattle size from the middle

Iron Age in Iberia, beginning somewhat earlier in sheep/goat. Cattle and sheep/goat size continues to increase through the Roman period, with larger livestock present at newly-founded Roman sites than at sites with earlier origins. The southwest sees continued increase in sheep/goat size into the Islamic period, though cattle size declines in this period. Elsewhere in Iberia, sheep/goat and pigs decline in size from the sixth century CE, and cattle from the eighth.

In Gaul, in modern France and Belgium, there is a focus on sheep/goat in the southeast in the Roman period, more generalised husbandry with a slight focus on pigs in the southwest, and increasingly higher proportions of cattle moving further north. The north sees an increasing focus on cattle through the Roman period. Cattle, sheep/goat and pigs all begin to increase in size prior to the Roman occupation, with a further increase in the Roman period. Cattle and pig size begins to increase across Gaul from the third century BCE, beginning slightly earlier in the south, though the largest Roman pigs are ultimately seen in the north. From the third century CE, average cattle and pig size declines.

In Britain, Iron Age husbandry focuses on cattle and sheep/goat. Pigs are more abundant in the west than elsewhere, resulting in more generalised husbandry in this region. In the Roman period, there is an increase in both cattle and pigs, with the highest proportions of cattle seen at military and urban sites. Continued reliance on sheep/goat at rural sites early in the occupation indicates a lesser degree of Roman influence on these communities, while increasing reliance on cattle at all sites through the Roman period indicates more widespread influence in later centuries. The early medieval period sees the re-emergence of more generalised husbandry, with a resurgence of sheep/goat. Cattle size increases from the fifth or fourth century BCE, continuing through the Roman period, though small individuals do not disappear until a century or so after the conquest. Sheep/goat and pigs increase in size in the mid-Roman period. A size decrease is seen in all three taxa in the early medieval period.

In the Netherlands, Iron Age husbandry focuses on cattle. The early Roman period sees a decline in cattle abundance within and outside the Empire, interpreted as evidence for enforced self-sufficiency, while increased mid-Roman specialisation in cattle is argued to result from greater access to an organised market economy. Cattle abundance declines in the late Roman period. While cattle size increases within the Empire in the Roman period, there is less evidence for change outside the Empire. In Germany, cattle abundance is high from

the early Roman period, both within and outside the Empire. Occupied regions see a decline in cattle abundance from the late Roman period; a somewhat smaller decline is seen beyond the Roman border. Cattle increase in size within the Empire in the early Roman period, and within and outside the Empire in the mid-Roman period, though the largest individuals remain those in occupied regions. While average cattle size declines in the early medieval period, the period sees little change in sheep/goat and pig size. Neither the Netherlands nor Germany see a pre-Roman increase in livestock size on the scale observed elsewhere.

In Switzerland, Roman husbandry focuses on cattle and pigs — the latter at military sites in particular. Cattle abundance increases from the Iron Age to the mid-Roman period, and declines in the late Roman period. There is an increase in cattle size in the Iron Age, which continues through the Roman period, while sheep/goat increase in size between the earlier and later Roman period; both taxa decrease in size in the early medieval period. In Austria and surrounding regions, Iron Age husbandry is fairly generalised overall, with increasing proportions of sheep/goat with increasing altitude. The Roman period sees an increase in pig abundance in the west but not the east, while cattle increase further in size in the east than the west — spatial variation in the impact of the Roman occupation on different aspects of husbandry is indicated. In Hungary, there is little evidence for a change in husbandry practice after the Roman conquest, with a slight focus on cattle evident both before and after. There is also little evidence for any change in livestock size, though larger animals may have been present at Roman urban settlements than at other sites.

In Greece, there is little change in the extent of specialisation between the Hellenistic and Roman periods. Both before and after the Roman conquest, husbandry ranges from generalised at some sites to focused on sheep/goat at others. Husbandry is somewhat more generalised at urban sites than at rural sites, where a greater focus on sheep/goat is evident. Overall, there is little evidence for a change in livestock size following the establishment of Roman control in the region.

The Roman period thus sees an overall increase in reliance on cattle and pigs in Italy, Iberia, Gaul, Britain, and Switzerland, in most areas resulting in the emergence of more specialised husbandry practice. Cattle are generally most abundant at military and urban sites, associating the exploitation of this taxon with communities more directly subject to Roman influence. Fluctuating Roman political control in the later centuries of the occupation coincides with a

decline in specialisation in certain regions, while in other regions there is little evidence for a return to more generalised husbandry practice in the late Roman period. Despite evident intraregional and interregional variation in practice, there is thus a clear association between the Roman occupation, increased cattle and pig exploitation, and increased specialisation in husbandry practice. In all five regions, there is clear evidence for an increase in livestock size pre-dating the Roman conquest — in some cases by several centuries. While this trend was not therefore initiated during the Roman period, the period nevertheless saw considerable change in livestock size, with larger animals emerging in all five regions during the occupation. A general decline in livestock size in the early medieval period demonstrates the importance of direct Roman control of a region and access to the integrated market economy of the Empire in the maintenance of larger livestock.

In the remaining regions, somewhat different patterns emerge. While husbandry in the Roman Netherlands and Germany is heavily focused on cattle, the specialised exploitation of this taxon was already apparent prior to the Roman occupation. While cattle increase in size in the Roman period, this change occurs both within and outside the Empire. However, since cattle abundance does increase following the Roman conquest, and since size increase is greatest within occupied regions, the Roman occupation is nevertheless associated with greater specialisation and the emergence of larger livestock, as in the first five regions.

In Austria, while specialisation in pig husbandry and increase in cattle size are apparent in the Roman period, these changes occur separately in different parts of the region. Additionally, there is little change in husbandry practice in the parts of the region where environment limits the exploitation of certain taxa. The evidence from Austria thus demonstrates both that the impact of Roman influence was not always uniform across different aspects of husbandry practice within a single region, and that environment continued to play an important role in the Roman period in determining the capacity of communities to undertake certain forms of husbandry.

In Hungary and Greece, the relative lack of evidence for any change in husbandry practice after the Roman conquest could indicate that Roman influence on the productive economy in the east of the Empire was of lesser magnitude than in the west. In Greece, this lack of change could be attributed to the continued impact of a strong Hellenistic influence on production and consumption — though environment likely plays at least some part in the

long-term focus on sheep/goat in this region. Alternatively, a lack of change in husbandry practice may simply result from the continued utilisation of existing production systems during the Roman occupation, in regions where pre-Roman production was already sufficient to meet the demands — such as for taxes — of the Roman administration. Continuity in husbandry practice can thus occur despite considerable change in other aspects of the economy of a region.

Overall, across the European territories of the Empire as a whole, the evidence for a change in animal husbandry practice and the productive economy during the Roman occupation is clear. Despite the somewhat varied response to the occupation in terms of husbandry practice in different regions, the association between the establishment of control by the Roman state, the emergence of greater specialisation — in particular in cattle and pig husbandry — and the appearance of larger livestock, is sufficiently widespread to enable the identification of Roman rule as a key factor stimulating the observed changes in animal husbandry and the productive economy across the Empire. The utility of these changes as a proxy for wider cultural and economic change lies in their close association with the changing fortunes of the societies within which they took place.

3.3 Hunting of large game

While the extent of evidence for the hunting of large game varies across the Empire, the incidence of large game taxa is uniformly low in comparison to domestic taxa. In northern, central and eastern Iberia, there is an increase in the abundance of wild animals relative to domestic taxa between the Middle Iron Age and the Roman period, though hunting only provides a small contribution to the meat diet in both periods (Colominas *et al*. 2017, 527-528). The relatively low abundance of game in this region is argued to result from the practice of hunting for leisure rather than for subsistence. In Britain, there is little change in the extent of reliance on game between the late Iron Age and the Roman period, with hunting likely undertaken primarily as a leisure pursuit in the latter period (Cool 2006, 111-114). The somewhat higher frequencies of deer on certain higher status sites in Britain may suggest that hunting was undertaken predominantly by elites (Maltby 2014, 799).

In both the Netherlands and Switzerland, wild mammals constitute a very small proportion of the identified taxa, and may once again have been primarily consumed by elites (Groot and Deschler-Erb 2017, 105). In the Netherlands, wild taxa are significantly more abundant at military than at urban sites, while in Switzerland there is no significant difference by site type. In Roman Germany, wild species once again constitute a very small proportion of the identified taxa (Grau-Sologestoa *et al*. 2023, 5-6). Their abundance increases in the early medieval period in Germany, suggesting a greater reliance on wild resources than was the case during the Roman occupation, and antler becomes more important as a raw material (Grau-Sologestoa *et al*. 2023, 16). In Greece, alongside exploitation for meat, the remains of wild animals are also interpreted as possible evidence for craftworking (Filioglou and Çakırlar 2023, 8). At Pherae, during the early period of Roman influence in Greece, Filioglou and Çakırlar argue that hunted taxa provided a supplement to a meat diet comprising predominantly domestic animals, while relatively high proportions of red deer head and foot bones at the site suggest leatherworking or butchery of this taxon.

Overall, the widespread low incidence of large game exploitation in the Roman Empire is most commonly interpreted as the result of greater reliance on domestic taxa for food, with hunted taxa providing at most a supplement to the diet. The possible association of hunted taxa with elites — a relatively small component of society — may also provide an explanation for the low prevalence of these taxa. Large game are thus not often explicitly interpreted as a marginal resource, exploited in times of crisis, in zooarchaeological studies of the Empire, though there is some evidence for a broadening of resources to include a larger wild component after the end of the Roman period, which could be interpreted as an indication of declining availability of meat from domestic sources. This thesis aims to explore the extent to which large game exploitation may have provided a buffer during periods of economic stress, via analysis of the degree of correlation between changing large game abundance and broader political and economic change in southeast Europe.

3.4 Hippophagy

Like the exploitation of large game, the consumption of horsemeat may have provided a means of supplementing the diet when periods of instability disrupted the functioning of economic systems. It has been suggested that hippophagy was taboo, and rare in Roman society except in times of crisis; the consumption of horse is not indicated in Roman

agricultural texts (Lauwerier 1999, 101, 110-111; Kroll 2012, 98; Akeret *et al*. 2019, 83-84). Evidence for an increase in the incidence of hippophagy within the Empire could therefore indicate a change in dietary practices as a result of social and cultural change, or the exploitation of more marginal resources as a result of declining access to more usual — domestic — food sources.

In Iberia, horses comprise a very small proportion of the identified taxa in the Middle Iron Age, but increase in relative abundance somewhat during the Roman period — it is stated, however, that horsemeat was not consumed in the region (Colominas *et al*. 2017, 518, 527). In Britain, hippophagy was rare during the Roman period — there is little evidence for the butchery of horses in advance of consumption, with cut marks on horse bones instead interpreted as the result of skinning (Cool 2006, 91-92; Maltby 2014, 798-799; Rizzetto and Albarella 2022, 3). The prestige associated with horses in the Iron Age in Britain is suggested as one possible cultural reason for an aversion to horsemeat consumption after the Roman conquest (Cool 2006, 92).

While hippophagy is evidenced to the north of the Roman border in the Netherlands, there is a lack of evidence for the practice in occupied regions, which may be due to Roman influence, or to the continuation of pre-Roman practice (Lauwerier 1999, 110-111). In Roman Germania Inferior, in the modern Netherlands and Germany, horse abundance is generally low relative to cattle, sheep/goat and pigs, and it is argued that horses were of lower importance as a meat source than these taxa; on sites where horse abundance is higher, this is attributed to horse breeding by Roman veterans (Groot 2017, 454-455, 457, 460). In Switzerland, an increase in horse relative abundance after 300 CE is interpreted as the result of a culturally-induced shift in diet as Germanic groups, for whom hippophagy was more common, moved into the Empire (Akeret *et al*. 2019, 83-84). At Pherae in Greece, horses are the least abundant domestic mammal during the early period of Roman influence; a lack of evidence for butchery or burning on horse bones at Pherae suggests that horsemeat was not consumed (Filioglou and Çakırlar 2023, 8-9, 23). An association between horsemeat consumption and poorer communities is cited as a possible reason for the lack of evidence for hippophagy among the middle status households represented at Pherae.

Overall, zooarchaeological evidence suggests that the consumption of horsemeat was not a common practice among communities living within the Empire — at least during the earlier

centuries of the occupation. There is some evidence to suggest that social and cultural changes may have resulted in an increase in the incidence of hippophagy in some regions, while the possible association between horsemeat consumption and lower status households provides support for the assertion that horsemeat was a lower status food within Roman society, only consumed when meat from other livestock was not available.

3.5 Dogs

Although distinct breeds of dog did not emerge until the later nineteenth century, human-induced change in dog morphology as a result of selection for particular traits has a much longer history (Worboys *et al*. 2018, 8, 23; Welker *et al*. 2022, 1-2). European Neolithic dog populations are characterised by individuals of a wide range of sizes, though for several millennia after only medium to large individuals are present in the archaeological record (Horard-Herbin *et al*. 2014, 24-25; Miklósi 2015, 133-134). While small dogs reappear in Europe from the later Iron Age, it is not until the Roman period that the greatest size variation is seen, when individuals ranging from below 25 cm to above 70 cm at the withers are present in the archaeological record, and varieties of dog including lap dogs and hunting dogs emerge (Harcourt 1974, 151, 168, 171; De Grossi Mazzorin and Tagliacozzo 2000, 157; Horard-Herbin *et al*. 2014, 26).

In Italy, small dogs interpreted as lap dogs first appear in the archaeological record in the Roman period (De Grossi Mazzorin and Tagliacozzo 2000, 157). In Britain, while small dogs are present in the later Iron Age — whether imported from the continent or produced by selective breeding — they only become common during the Roman occupation (Harcourt 1974, 164; Clark 2000, 168; Baxter 2006, 18; Bellis 2020, 36). Such dogs may have been employed to control rodent populations, but were also likely kept as pets (Bennett and Timm 2018, 78). In Hispania Tarraconensis, in modern Spain, dogs ranging in size from under 25 cm at the withers to over 60 cm have been identified, with both small slender individuals and small robust individuals present (Colominas 2016, 899-900), perhaps suggesting several different functions. Further to the east, at the Roman urban settlement at Tác-Gorsium in Hungary, small dogs with a withers height of below 30 cm have been identified (Bartosiewicz 2002, 83). Overall, the zooarchaeological record of Europe indicates that the widespread appearance of small dogs was closely associated with the period of Roman imperialism. Their small size suggests the emergence of individuals kept primarily or

exclusively for their roles as companions, signalling a change in human-dog relationships in the Roman period.

3.6 Previous zooarchaeological studies of southeast Europe

This section will review and evaluate previous zooarchaeological studies of the study region in southeast Europe, providing a background to and context for the interpretation of the zooarchaeological evidence analysed and presented in this thesis.

In a study of late La Tène sites in Serbia, spanning the last few centuries BCE to the first century CE, Radišić (2020, 123-124) identifies a clear focus on the exploitation of domestic mammals, and very little reliance on hunted taxa at the majority of sites. The study reveals an overall focus on cattle husbandry, though variation between sites is apparent. At the majority of fortified sites, husbandry practice is relatively generalised, with cattle somewhat more abundant than either sheep/goat or pigs. At unfortified sites, husbandry practice ranges from fairly generalised to heavily focused on cattle, with a secondary reliance on sheep/goat at certain sites. Radišić (2020, 124) additionally identifies variation in the age distribution of each livestock taxon, noting the utilisation of cattle primarily for dairy production and as traction animals, the exploitation of pigs and sheep/goat for meat, and the latter additionally for their secondary products. The abundance of horse is highly variable across the sites in the study, suggesting considerable variation in the importance of this taxon for different communities; evidence of horse butchery indicates that one use of this taxon may have been as a source of meat.

A study of animal exploitation in Roman Serbia offers the opportunity to directly compare husbandry practice in this region before and after the Roman conquest, with reference to the patterns identified by Radišić. Vuković (2020, 131, 133-134) identifies a focus on cattle husbandry at all but two sites, though spatial, temporal and site-type-based variation is apparent. Cattle are relatively more abundant in the north and the northeast than in the southeast of Serbia, with fairly low proportions of both sheep/goat and pigs in the two northerly regions. In the southeast, the study reveals much more equal proportions of the three taxa, indicating generalised husbandry practice. Variation is also evident between urban and rural sites — while at the former the data indicate fairly specialised exploitation of cattle,

at the latter, average cattle abundance is somewhat lower. Vuković additionally identifies change over time in husbandry practice. In the first to third centuries CE, average cattle abundance exceeds 50%, while both sheep/goat and pigs comprise less than 20% of the livestock remains on average. In the fourth century, cattle abundance falls to around 40% on average, coinciding with an increase in reliance on both sheep/goat and pigs. The late Roman period thus sees the emergence of more generalised husbandry practice in Serbia.

In a study of sites in Romanian Banat spanning the Neolithic to the medieval period, including three late Iron Age and two Roman sites, El Susi (1996, 107, 194) identifies a long-term focus on cattle husbandry in the region. The contribution of cattle to the economy is only exceeded by another livestock taxon in the late Iron Age, at which time pigs become most abundant. From the late Iron Age to the Roman period, the study reveals an increase in reliance on cattle in Banat, and a decrease in the exploitation of wild taxa, indicating greater reliance on resources obtained from domestic mammals. El Susi identifies a return to a more generalised subsistence economy after the Roman period. While the number of sites analysed is relatively small, due to much work in Banat being in progress at the time the study was undertaken (El Susi 1996, 194), the available data nevertheless reveal a clear focus on cattle husbandry in the region. While the Roman period thus sees an increase in reliance on cattle, this change represents a return to a pre-Iron Age practice, rather than the emergence of a new pattern of exploitation in the region.

Two studies of Roman-occupied territories in the region of modern Romania and Bulgaria reveal a similar level of focus on cattle in the Roman period. In a study of a small sample of Romanian and Bulgarian sites, King (1999b, 181-182, 195) identifies a clear focus on cattle husbandry, though with some evidence for variation in exploitation between military sites and other site types. While at military sites cattle abundance only slightly exceeds that of sheep/goat, at urban sites, vici and other settlements, the data indicate the highly specialised exploitation of cattle, with sheep/goat and pigs present in much lower, and more equal, proportions than at military sites. A second study, which solely considers sites in Roman-occupied Dacia, generally confirms the patterns observed by King, and additionally identifies variation by site type in the relative reliance on domestic and wild taxa. Gudea *et al*. (2008, 44) note a greater reliance on cattle at urban than at military sites, though, contrary to King, identify a secondary reliance on pigs across Dacia, which are present in higher proportions at

military than at civilian sites. Though the abundance of hunted animals is low overall, these taxa are present in higher proportions at rural and military sites than at other site types.

Beyond the Empire in northern and central Moldavia, a somewhat similar pattern emerges, but with a still greater level of reliance on cattle evident. Across eight sites dated to the second and third centuries CE, Haimovici (2004/2005, 188-191) identifies a primary focus on cattle exploitation in Moldavia. At the majority of sites, the data indicate highly specialised cattle husbandry, with very low proportions of sheep/goat and pigs present. At several sites, however, slightly lower cattle abundance and higher pig abundance results in slightly more generalised husbandry practice. Alongside the four studies discussed above, the work of Haimovici demonstrates that a focus on the husbandry of cattle is a practice that extended from Serbia to northeast Romania in the Roman period, with the highest proportions of this taxon seen in the latter region.

The work of Vuković (2020) demonstrates that by the fourth century CE, reliance on cattle had begun to decline in Serbia. Several studies of the transition from the Roman period to the early Byzantine period demonstrate that the trend for decreasing cattle abundance over time extended beyond Serbia to other parts of the study region. A study of four Roman and nine early Byzantine sites in Dobrogea reveals a slight increase in reliance on wild taxa over time, and a change in the degree of specialisation in husbandry practice (Stanc and Bejenaru 2013, 370). In the Roman period, specialised cattle husbandry is evident in Dobrogea, with both sheep/goat and pigs comprising only a relatively small proportion of the animal remains. In the early Byzantine period, however, husbandry practice ranges from fairly generalised to highly focused on cattle. Overall, the region exhibits lower proportions of cattle in the early Byzantine period than in the Roman period. While the total contribution of wild taxa is very low in both periods, their relative abundance increases by almost a half in the early Byzantine period, revealing a slight broadening of the subsistence base over time.

In Bulgaria, Kroll (2012, 96) identifies a clear increase in pig abundance from the Roman to the early Byzantine period, alongside a decline in reliance on both cattle and sheep/goat. While cattle remain the most abundant taxon in the latter period, pigs replace sheep/goat as the second most abundant taxon, and husbandry practice becomes slightly more generalised than in the Roman period. The impact of increasing political instability in the early Byzantine period is cited as a possible stimulus for the increased reliance on pigs, which could be raised

within the intramural area, and would thus have provided a stable source of meat at times when access to pasture for cattle and sheep/goat was disrupted (Kroll 2012, 98).

As in many other regions of Europe, the Roman period sees an overall increase in livestock size in southeast Europe, but unlike elsewhere there is no evidence for any size increase prior to the Roman occupation. Data analysed by Radišić (2020, 125-126, 128) reveal a decline in both cattle and horse size between the Hallstatt and La Tène periods — the earlier and later Iron Age — in Serbia, followed by an increase in size of a much greater magnitude following the Roman conquest. Radišić notes a decrease of 3 cm in cattle withers height between the Hallstatt and La Tène periods, followed by an increase in the Roman period of between 10 and 30 cm. The Hallstatt to La Tène transition sees a slightly greater decrease in average horse withers height, at around 10 cm, while the Roman period sees an increase of around 20 cm. For both taxa, the data thus demonstrate that Roman animals were considerably larger than those present at any point in the Iron Age.

Across multiple additional Roman sites in Serbia, Vuković (2020, 135-136) identifies a clear increase in average cattle size, but notes the continued presence of both small and large individuals, indicating that the late Iron Age cattle were not entirely replaced. The study demonstrates clear spatial, temporal and site-type-based variation in cattle size during the Roman occupation. In the north, there is a clear increase in average cattle size at rural sites in the late Roman period, with much larger individuals appearing in the population. Average size also increases at urban sites, though this is due to the disappearance of smaller individuals from the population, rather than to the emergence of any particularly large cattle. In the northeast, where rural cattle are larger than those exploited at urban sites in the earlier Roman period, the late Roman period sees a slight increase in average size at urban sites. In southeast Serbia, cattle at late Roman rural sites are somewhat smaller than those further to the north in the same period. The appearance of larger individuals in the late Roman period in certain regions is attributed to the development either of more productive cattle with increased meat yields, or of more powerful animals for use in traction, associated with an increase in arable production (Vuković 2020, 136).

There is also an overall increase in sheep size in Serbia following the Roman conquest. Sheep size, like that of cattle, varies spatially, temporally and by site type, but exhibits a somewhat different trajectory of change to that identified in the cattle data (Vuković 2020, 136-138). In

the north, average sheep size is very similar at rural and urban sites in the earlier Roman period. In the northeast, however, average size is slightly lower at urban than at rural sites in the earlier Roman period. In the late Roman period, the region sees a slight decrease in average sheep size, and the largest individuals disappear from the population. In the southeast, average sheep size at rural sites lies between the average figures observed for rural sites in the two more northerly regions.

The Roman period also sees an increase in pig size in Serbia, though regional variation in size is once again evident (Vuković 2020, 136-137). In the north, there is little difference in average pig size at rural and urban sites in the earlier Roman period, and little change evident in the late Roman period. In the northeast, average pig size in the earlier Roman period is very similar to that observed in the north. The northeast sees a slight increase in average size in the late Roman period, however. In the southeast, average pig size in the late Roman period is considerably lower than that observed elsewhere, with the largest individuals in the southeast falling at the lower end of the size range observed in the other two regions.

In Romanian Banat, El Susi (1996) identifies similar patterns, though there is little evidence for any change in pig size in this region. Bronze Age cattle are relatively small in Banat, and while the early Iron Age sees little change in average size, greater size variation emerges (El Susi 1996, 112-113). On the basis of very limited late Iron Age material, El Susi identifies a decline in cattle size from the early to late Iron Age, noting little evidence for any large cattle in the latter period. In the Roman period, there is an increase in average cattle size and robustness, attributed to the import of larger breed stock, though a wide range of sizes are present in the population, demonstrating the continued presence of local pre-Roman forms (El Susi 1996, 114). El Susi notes variation in the extent of reliance on larger individuals and smaller local types at different settlements. Material from medieval sites indicates a slight decline in cattle size, though the lack of data from any sites dated to the immediate post-Roman period limits the analysis of temporal change.

There is a decrease in sheep/goat size in Banat from the Bronze Age to the Iron Age, with little change in size then observed through the latter period (El Susi 1996, 122). The Roman period sees the appearance of larger sheep/goat than were present in either of the preceding two periods, and while the population comprises individuals of a range of sizes, the majority are larger individuals. El Susi notes that sheep/goat in Roman Banat are larger than those

beyond the Empire to the northeast, and suggests that size increase was achieved via the import of larger individuals from other Roman provinces, resulting in the development of a population comprising individuals of intermediate size between 'Italian' forms and the local pre-Roman sheep/goat. Limited post-Roman material indicates a subsequent decrease in sheep/goat size (El Susi 1996, 123).

The early Iron Age pig population shows little size change relative to that of the Bronze Age, though a relatively wide range of sizes is identified, interpreted as the possible consequence of interbreeding between wild and domestic populations (El Susi 1996, 126-127). In the late Iron Age, there is once again little change in average size, the population continuing to comprise predominantly relatively small individuals. The Roman period similarly sees little change in average pig size, though an increase in the range of sizes is evident. The lack of change in pig size in the Roman period, when an increase in both cattle and sheep/goat size is observed, is interpreted by El Susi as evidence for a greater interest in the development of more productive cattle and sheep/goat than pigs. The post-Roman period sees a slight decline in average pig size, however, as is also observed in cattle and sheep/goat.

In a study of cattle size at seven sites in Roman Dobrogea, Haimovici (2006) identifies larger 'improved' cattle in the Roman period. Haimovici notes a decrease in cattle size from the Neolithic to the late Iron Age in Dobrogea, with periods of particular decline in the Bronze Age and the early Iron Age. The study identifies a clear increase in cattle size after the Roman conquest, with some particularly large individuals present in the population, alongside smaller individuals. The import of larger breeding stock is cited as a likely stimulus for this change (Haimovici 2006, 352). Haimovici notes a decrease over time in the proportion of larger cattle present in the population, with these 'improved' individuals gradually disappearing from the region through the later part of the first millennium CE. Though the quantity of bone material analysed by Haimovici is relatively small, it reveals a similar pattern to that observed elsewhere in southeast Europe — the development of larger cattle during the Roman occupation, with a decline in average size in later centuries.

3.7 Summary

Overall, it is clear that in southeast Europe, as in many other regions, the Roman occupation coincided with — and likely played a key role in — the development of more specialised husbandry practice and the appearance of larger livestock than had previously been present. While cattle abundance appears already to have been relatively high in southeast Europe in the late Iron Age, there is nevertheless an increase in reliance on cattle after the Roman conquest, with more specialised husbandry apparent in several parts of the region. A focus on cattle husbandry is also evident beyond the Empire, with high proportions of this taxon seen in Moldavia, beyond the Roman border to the northeast. In this respect, previous studies of animal husbandry in southeast Europe reveal several parallels with the situation seen in the Netherlands and Germany, where pre-Roman husbandry also focused on cattle — both in territories that later lay within the Empire, and in those that later lay outside it. In both the Netherlands and Germany, and in the parts of southeast Europe encompassed by the studies discussed here, the Roman occupation thus resulted in the further development of a focus already in place in the late Iron Age.

The Roman period also saw an increase in livestock size in southeast Europe, though the extent and longevity of this change varied between different taxa. A clear size increase is observed in both cattle and sheep/goat, generally interpreted as having been achieved via the import of larger individuals from elsewhere in the Roman Empire. Overall, a more limited increase in pig size is observed during the Roman occupation. In parts of Serbia, the late Roman period sees a further increase in cattle size, while sheep/goat size declines somewhat. In southwest Romania, cattle and sheep/goat size declines in the post-Roman period. In Dobrogea, there is a gradual decrease in cattle size through the later part of the first millennium CE. There is little evidence in the regions encompassed by these studies for any increase in livestock size prior to the Roman occupation.

By the analysis of data from the sites included in these previous studies of southeast Europe, alongside data obtained from faunal reports for a large number of additional sites across the region, this study aims to systematically evaluate the nature and extent of change in animal exploitation across southeast Europe from the late Iron Age to the early Byzantine period. It aims to elucidate patterns of animal husbandry, production and consumption, and of change in livestock morphology, on the broad scale demonstrated by studies of many other parts of

the Roman Empire in Europe. It will also explore the extent of change in reliance on hunting and hippophagy, and will investigate changing human-dog relationships via the analysis of changes in dog morphology. This broad-scale approach will enable the assessment of the extent of spatial, temporal and site-type-based variation in animal exploitation across three regions subject to varying levels of direct Roman control — the Balkan provinces, Dacia, and the region beyond the Empire. The study will thus enable the evaluation of cultural and economic change across three regions that saw very different trajectories of political change through the time period encompassed by the study.

4 Materials and methods

4.1 Introduction

This research was undertaken during the COVID-19 pandemic. Due to travel restrictions and uncertainty regarding access to faunal collections, a planned project centred on primary analysis of faunal material from late antique sites in Serbia, Montenegro, North Macedonia, and Bulgaria, supported by data collection from published literature, could not take place. Instead, this research is entirely literature-based, and uses data sourced predominantly from published faunal reports, with the addition of a small amount of unpublished data, for the use of which permission has kindly been provided. As such, methodological standardisation was not possible in the primary analysis of the faunal assemblages included in the study. Provided methods are stated, this lack of standardisation does not preclude the use of data in zooarchaeological meta-analysis — the synthesis and analysis of faunal data from multiple archaeological sites and previous studies — but a consideration of any variation in approach is important in any interpretation. This chapter will first discuss data sources and the database used for the study, before detailing methods of data collection and analysis.

4.2 Data sources

Data used in the study were primarily sourced from published faunal reports. The majority of faunal reports used are published in archaeological, historical or biological journals, with a smaller proportion published in conference proceedings and museum bulletins, or as chapters in archaeological site monographs, regional studies, or edited books. For the site Dichin (Veliko Tarnovo Province, Bulgaria), additional unpublished data were also used with permission from Andy Hammon, one of two zooarchaeologists who analysed the assemblage. An initial set of relevant faunal reports was identified via a bibliographic search, focusing on archaeological, historical and biological journal contents lists available online, and including recent issues for many journals. This initial list of sources was augmented extensively via a review of the bibliography of each faunal report consulted, to identify any further sources that met the criteria for inclusion in the study. By this means, fairly comprehensive coverage of the study region is likely to have been achieved — in theory, once no new sources are identified via the review of faunal report bibliographies, all relevant previously published faunal reports should already be on the source list.

Once an initial source list had been compiled, faunal reports were obtained via online sources, including the Romanian Biblioteca Digitală a Publicațiilor Culturale (Institutul Național al Patrimoniului 2022); via the University of York Interlending and Document Supply Service; and, in a small number of cases, via direct request to zooarchaeologists working in or on the relevant region. Faunal reports published in the journal *Argesis* were sourced via direct request to the Muzeul Județean Argeș, and those published in the journal *Drobeta* via direct request to the Muzeul Regiunii Porților de Fier. In the small number of cases for which it was not possible to obtain a copy of a faunal report, but where some or all of the data were available via an alternative source, data were collected via this source. Alternative sources include faunal reports for nearby sites, in which comparative data for the surrounding region are compiled, and regional studies of relevant regions, in which data for multiple sites are compiled.

4.3 Database

All data collected for the study were recorded in a Microsoft Excel workbook, henceforth referred to as 'the database'. The database has twelve sheets: the first sheet provides a summary of the dataset; the second and third sheets record site and phase level data respectively; the following seven sheets record seven categories of zooarchaeological data; and, finally, two key sheets are provided. The twelve sheets in the database are named as follows: Summary, Site, Phase, Taxon, Skeletal element, Age, Sex, Hippophagy, Metrics raw data, Metrics summary data, Metric codes key, and Key.

The Metrics code key contains a list of elements of the skeleton, measurement codes for the measurements that can be performed on each element following the system of standard measurements defined by von den Driesch (1976), and a description of the bone dimension indicated by each measurement code. The Key contains lists of input options for columns within the database with a restricted range of inputs; a reference list of site type codes and a description of the site type indicated by each code; and a reference list of common and Latin names for all taxa recorded in the database, each with a corresponding taxon code, assigned according to the broad taxonomic group within which each taxon is classified.

The data recorded in each sheet are as follows:

1) Summary:

Total number of identified specimens (NISP), number of sites, number of phases, taxon data number of phases, skeletal element data number of phases, age data number of phases, sex data number of phases, hippophagy data number of phases, metrics raw data number of phases, and metrics summary data number of phases.

2) Site:

Site ID, country, region ID, region, settlement, site and excavation date, latitude, longitude, latitude and longitude source, and site total NISP.

3) Phase:

Site ID, site, phase ID, phase in source, phase description in source, start date, end date, period ID, site phase, site type 1 in source, site type 2, site type 3, site type code, comments, long reference, short reference, phase total NISP, taxon data recorded (Y/N), skeletal element (Y/N), age (Y/N), sex (Y/N), hippophagy (Y/N), metrics raw data (Y/N), and metrics summary data (Y/N).

4) Taxon:

Site ID, site, phase ID, phase in source, recovery, taxon code, taxon Latin name, taxon common name, NISP, minimum number of individuals (MNI), comments, long reference, and short reference.

5) Skeletal element:

Site ID, site, phase ID, phase in source, recovery, taxon Latin name, taxon common name, element number or percentage, element sample size if percentage, multiple skeletal element columns, total high meat-value, total medium meat-value, total low meat-value, total NISP, comments, long reference, and short reference.

6) Age:

Site ID, site, phase ID, phase in source, recovery, taxon Latin name, taxon common name, age number or percentage, age sample size if percentage, multiple age category columns, total very young, total young, total adult, total NISP, comments, long reference, and short reference.

7) Sex:

Site ID, site, phase ID, phase in source, recovery, taxon Latin name, taxon common name, sex number or percentage, sex sample size if percentage, multiple sex category columns, total NISP, comments, long reference, and short reference.

8) Hippophagy:

Site ID, site, phase ID, phase in source, taxon Latin name, taxon common name, hippophagy frequency, hippophagy code, comments, long reference, and short reference.

9) Metrics raw data:

Site ID, site, phase ID, phase in source, specimen ID, taxon Latin name, taxon common name, element, withers height (WH) given in source, WH calculation source, WH calculation, WH in cm, multiple measurement code columns, comments, long reference, and short reference.

10) Metrics summary data:

Site ID, site, phase ID, phase in source, taxon Latin name, taxon common name, element, measurement code, number of specimens, minimum, maximum, mean, comments, long reference, and short reference.

11) Metric codes key:

Element, measurement code, and measurement description.

12) Key:

Site type 2, site type 3, site type code, site type code description, taxon, skeletal element, age, sex, hippophagy, metrics raw data, metrics summary data, recovery, taxon common name, taxon Latin name, taxon code, hippophagy frequency, hippophagy code, and WH given in source.

Sheets within the database are linked via the inclusion of a 'SITE_ID' column in every sheet from 'Site' to ‘Metrics summary data’, and a 'PHASE_ID' column in every sheet from 'Phase' to ‘Metrics summary data’. This format enables sheets to be linked together, such as for analysis in R. The database is provided in Appendix 1: Southeast Europe faunal database — see file 'Southeast Europe faunal database.xlsx' — made available alongside this thesis.

4.4 Data collection and analysis

4.4.1 Introduction

This section will explain choices made during the process of data collection, define terms used in the classification of the data collected, and describe the analytical approaches selected. Sections on zooarchaeological data collection and analysis introduce the methods employed by zooarchaeologists in the analysis of faunal assemblages, discuss any difficulties in intersite comparison introduced by methodological variation at different sites, and detail the methods of data collection and analysis employed in this study. Data analysis and visualisation were undertaken in R (R Core Team 2022). Table 4.1 shows the R packages used in data analysis and visualisation. Roman Empire shapefiles used in maps were sourced from the Ancient World Mapping Center (2012).

Table 4.1: R packages used in data analysis and visualisation.

Use	R package and reference
Box plot	ggplot2 (Wickham 2016); zoolog (Pozo *et al*. 2022)
Map	dplyr (Wickham *et al*. 2022); mapdata (Brownrigg 2018); mapplots (Gerritsen 2018); raster (Hijmans 2022); shades (Clayden 2019)
Radiator plot	dplyr
Scatter plot	dplyr; ggplot2
Significance testing	dplyr
Ternary plot	dplyr; Ternary (Smith 2017); tidyr (Wickham and Girlich 2022)

The dataset comprises site, phase, taxonomic, skeletal element, age, sex, hippophagy, and metrical data. A threshold of 200 identified bone specimens was applied at the phase level for the inclusion of taxonomic data in the dataset, since the valid analysis of spatial and temporal variation in these data depends upon the accurate representation of ratios between taxonomic categories, and thus adequate sample size per phase is essential. Skeletal element, age and sex data were only recorded in the database for phases that meet the taxonomic data threshold; a further threshold in the use of age data was applied at the analysis stage (see below). Skeletal element and sex data are available in the database, but are not analysed further in this thesis. Hippophagy and metrical data were collected for all phases for which the data were available, since the former records the presence or the absence of a single phenomenon in a phase, while the latter records a single data point per specimen, so sample size per phase is less important.

4.4.2 Site and phase data

Site and phase data provide the spatial and temporal framework within which the zooarchaeological data collected for the study are analysed and interpreted. Where possible, site name, site location and site type, and phase name and phase date range, were obtained directly from the faunal report from which the zooarchaeological data for the site were sourced. Where site and/or phase data were not available in the faunal report, an alternative source — the excavation report for the site, for example — was used.

Where geographical coordinates were provided in a faunal report, the location of a site was recorded in the database using these coordinates. In cases where coordinates were not provided, but where a faunal report provided a sufficiently detailed description of the geographical setting of an archaeological site that its location could be precisely determined, the latitude and longitude coordinates of the site were obtained by reference to Google Maps, and recorded in the database. Where it was not possible to determine the exact location of a site using the information provided in a faunal report, the latitude and longitude coordinates of the nearest modern settlement, as named in the faunal report, were obtained using Google Maps and recorded in the database. At the level of precision required for this study, this method provides a sufficient degree of accuracy in the recording of site location.

Faunal assemblages originating from a single settlement but analysed and published separately were assigned separate site IDs for this study, so each site ID effectively represents a single faunal assemblage, though these are referred to throughout this thesis as 'sites'. Where multiple identically-named sites lie within a single settlement, the sites are represented by a single point on period site maps (see section 5.4); where multiple sites within a single settlement are referred to by different names in their respective faunal reports, each is marked separately on period site maps.

Three forms of site type data were recorded in the database. These were recorded at the phase level, due to changes over time in site character at some multiphase sites. Site type was first recorded following the terminology in the faunal report, in column 'SITE_TYPE_1_IN_SOURCE'. Each site type was then assigned a second descriptor, according to its position on a scale from urban to rural (Table 4.2). Cities and towns are classed as urban, while *oppida*, *davae* and *vici* are considered semi-urban, on the basis that their size and density are intermediate between urban and rural. This second descriptor was recorded as 'SITE_TYPE_2'. Finally, a third form of site type data was added based on the terminology used in the faunal report but restricted to a limited list of site type categories (Table 4.2), recorded as 'SITE_TYPE_3'. Both site types 2 and 3 were then used to assign a composite site type to each phase, recorded in the database using a site type code (Table 4.3, codes also provided in database — see sheet 'Key'). Site type codes 3 to 6 are sometimes referred to in the text in abbreviated form as 'semi-urban', 'fortified semi-urban', 'rural nucleated' and 'fortified rural nucleated' respectively.

Table 4.2: Site types within site type categories 2 and 3.

Site type category	Site types within category
Site type 2	Urban, semi-urban, rural nucleated, rural non-nucleated
Site type 3	City, fortified city, town, fortified town, oppidum, dava, vicus, village, settlement, fortified settlement, mansio, villa, military, natural feature

Only in the case of one site type — 'military' — used for castra, military camps, auxiliary forts and fortresses, is there variation in urban-rural status within the same site type. Around half of the studied military sites are classed as semi-urban, while the other half are considered rural nucleated — this distinction was made on the basis of the size and density of the occupation as indicated by the faunal report or the site excavation report. All were recorded

using a single site type code as military sites, as it was considered that their military status likely provided a greater influence on animal exploitation practice than the characteristics that designate them semi-urban or rural nucleated. Where it was not possible to obtain information regarding site type and urban-rural status for any site, or where these characteristics were not determined during excavation, site type was recorded as 'settlement', and urban-rural status as 'unspecified'. Although it was not possible to ascertain the character of such sites, it is most likely that they represent relatively small, likely rural, settlements, since larger or urban settlements are much more likely to have been positively identified during excavation, or to have been known to be such prior to excavation.

Table 4.3: Site type codes and descriptions for composite site types.

Site type code	Site type description
1	Urban
2	Fortified urban
3	Oppidum/dava/vicus/semi-urban
4	Fortified oppidum/dava/vicus/semi-urban
5	Village/rural nucleated
6	Fortified village/rural nucleated
7	Settlement
8	Fortified settlement
9	Mansio
10	Villa
11	Military
12	Natural feature

4.4.3 Taxonomic identification and quantification data

Spatial and temporal variation in relative taxonomic abundance are identified via the analysis of taxonomic quantification data, generated by the identification and quantification of the taxa present on an archaeological site by a zooarchaeologist. The first stage in this process is the identification to skeletal element and taxon of each specimen in the faunal assemblage. This is achieved by reference to comparative reference resources such as zooarchaeological reference collections and identification guides, and aims to identify each specimen to the lowest possible taxonomic level. The precision of the identification will depend upon the extent to which diagnostic criteria were originally present on the portion of bone or tooth in question, and the extent of their survival on the archaeological specimen. Where identification to species is not possible, specimens will be recorded at a higher taxonomic

level, such as genus or family, in some cases with reference to the size of the animal — large, medium or small mammal, for example.

Due to the morphological similarity of some closely-related species, differentiation to species may not be possible on certain elements, so identification of specimens originating from these elements will be made to a higher taxonomic level. This is the case in the recording of many sheep and goat remains as 'sheep/goat', for example (Zeder and Lapham 2010, 2887). This issue also arises when attempting to distinguish between the morphologically similar horse and donkey (Hanot *et al*. 2017, 88-89), and between wild and domestic forms such as aurochs, bison and cattle (Wright 2013, 1, 29); wild boar and pigs (Rowley-Conwy *et al*. 2010); and wolves, jackals and dogs (Janssens *et al*. 2019; Yeomans *et al*. 2019, 161). While domestic forms are generally smaller than wild forms for many of these taxa, size overlap makes identification to species level difficult for certain specimens.

For the purposes of this study, all sheep/goat, sheep and goat were recorded separately in the database where they appear so in the faunal report. However, to avoid obscuring overall sheep/goat abundance relative to other taxa by the division of sheep/goat, sheep and goat into three categories, they were combined into a single 'sheep/goat' category at the analysis stage. A pragmatic approach to the recording of horse, donkey, and the various morphologically similar wild and domestic forms, was taken in this study in order to maximise sample size. Where specimens are identified to species level in a faunal report, the identification was accepted and the specimens recorded as such in the database; where indeterminate specimens are recorded to a higher taxonomic level in a faunal report, the faunal report was followed when recording the specimens in the database. Only specimens recorded to species level were included in analyses for which the differentiation of species is important, however — designations such as ‘?horse’ and ‘horse/donkey’ were excluded in the analysis of hippophagy, for example.

In addition to the morphological characteristics of the bone specimens, the pre- and post-depositional history of a faunal assemblage will also impact identification (Lyman 1987, 94-95; Lam 2010, 86). Taphonomic processes, including human use of animals pre-deposition and the post-deposition burial environment, will influence the degree of fragmentation and the state of preservation of animal remains. A high degree of fragmentation or a poor state of preservation may result in an absence of diagnostic criteria on many specimens, reducing the

proportion of the assemblage that can be identified. Taphonomic processes such as fragmentation and attrition differentially affect different species and skeletal elements and the remains of individuals of different ages, due to differences in the character of the remains such as size and density (Grayson 1984, 21-22; Lam 2010, 87-89; Orton 2012, 323). Thus more robust elements and those originating from larger or older animals may be more likely to survive in the archaeological record, affecting the representativeness of the studied assemblage with regard to the remains originally deposited.

Additionally, the proportion of an archaeological site that is excavated and the excavation methods employed will determine the proportion of the deposited assemblage that is recovered, while the expertise and experience of the zooarchaeologist, and the availability of time and reference material, will determine the proportion that is identified (Grayson 1984, 22; Lam 2010, 86-88). It is important to consider the effect of these potential biases in any interpretation. In meta-analyses, the systematicness of this process will depend upon the extent to which the necessary information is provided in faunal reports. Relatively little information regarding recovery methods and the extent of sieving of deposits was available from the faunal reports consulted for this study — of 182 phases for which taxonomic data were available, recovery method was only stated for 33. Of these, only seven featured any sieving of deposits. It is possible, therefore, that the range and relative abundance of the taxa recorded at the majority of sites included in the study have been impacted by some degree of recovery bias.

However, since sieving is only explicitly recorded as having taken place for 6 of the 17 phases from which microfauna — such as rats, voles, and mice — were recovered, it is likely that at least some of the bones of these very small taxa were recovered by hand collection. The bones of many other small taxa such as chicken and hare are also present on many of the sites included in the study. This evidence suggests that bone recovery even at the relatively coarse scale of hand collection at these sites is likely to have been sufficiently thorough that the smaller skeletal elements of the principal taxa analysed in this study — cattle, sheep/goat, pigs, horses, dogs, and large game — will have been recovered sufficiently consistently to permit the analysis of relative taxonomic abundance. In order to avoid the reduction of sample size by the subdivision of the dataset, a pragmatic approach to recovery bias has been taken in this study, and no separation of faunal data for analysis was made on the basis of recovery method.

These various factors influence the proportion of an assemblage that can, in theory, be identified; the zooarchaeologist's choice of quantification protocol will influence the proportion that is, in practice, identified and recorded. The largest proportion of an assemblage will be recorded when the protocol used is a total fragment count. In this method, every specimen that can be identified by the analyst is recorded, and the specimens attributed to each taxon summed to produce a count of the number of identified specimens (NISP) for each taxon. As this quantification method employs a simple specimen count, the result is additive between contexts, phases and excavation seasons, and can therefore easily be used in meta-analyses requiring collation of data recorded at varying units of analysis in different faunal reports. Since every bone or tooth fragment identified to taxon increases the count for that taxon, however, the total fragment count can produce a biased view of relative taxonomic abundance if the remains of certain taxa are considerably more fragmented than others — such as might occur due to differences in the manner of butchery — inflating the count for the former relative to the latter (Grayson 1984, 21).

In order to counter this inflation, diagnostic zone protocols are used by some analysts in place of or alongside a total fragment count. Introduced in the later twentieth century, methods such as those used by Watson (1979), Dobney and Reilly (1988) and Serjeantson (1996) divide skeletal elements into a series of zones. Then, as in Serjeantson (1996), for example, a specimen is only recorded and included in the diagnostic zone count if it represents more than 50% of any zone, or if a particular diagnostic criterion found within that zone is present on the specimen. While such protocols vary in the precise system of diagnostic zones, all work on the principle that by counting only specimens that represent more than 50% of a zone, or a particular diagnostic criterion found within that zone, no one zone from a single individual will be repeated in the count. Thus the potential for highly fragmented remains to contribute to the assemblage many times over is reduced, and the abundance of each taxon can be quantified consistently and reproducibly. By recording and quantifying only a pre-selected range of skeletal elements, diagnostic zone methods allow for rapid recording of faunal assemblages. Like the total fragment count, diagnostic zone methods produce a specimen count that is additive.

Since the choice of specimen count protocol — whether a total fragment count or a diagnostic zone protocol — will determine the range of skeletal elements from which relative taxonomic abundance is calculated, comparison between sites can best be achieved when the

protocol used by each analyst is clearly defined in each faunal report, allowing the impact of methodological variation on results to be carefully considered. The absence of this information does not preclude the use of data in meta-analyses, however. Comparable results have been achieved when a total fragment count and a diagnostic zone protocol have each been used to record a single assemblage (Trentacoste 2009), indicating that relative taxonomic abundance can be directly compared between sites even in cases where different quantification protocols have been employed at different sites. In order to avoid the reduction of sample size by the subdivision of the dataset by quantification protocol, this direct comparison approach was been taken in this study — all available NISP data were recorded in the database, including in cases where the protocol used was not explicitly stated.

Specimen count protocols produce data that can be used to calculate relative taxonomic abundance on the basis of the specimens within the recovered assemblage. Another quantification method — the calculation of the minimum number of individuals (MNI) — aims to determine relative taxonomic abundance on the basis of the live animals represented by those specimens. Unlike the specimen count, in which every specimen identified for each taxon increases the count for that taxon, the calculation of the MNI determines the minimum number of individuals required to account for all of the specimens of each taxon that make up an assemblage. The calculation is achieved by separating left-sided and right-sided specimens of each skeletal element within each unit of analysis for each taxon, and identifying the most commonly-occurring sided element, which provides the MNI (Grayson 1984, 27). The accuracy of the calculation can be improved by the identification of any specimens within the assemblage that originate from an individual of an age or size not represented by the most commonly-occurring element, and their addition to the figure calculated (Grayson 1984, 28).

Unlike the specimen count, the MNI is not additive between units of analysis, presenting particular problems for the use of MNI data in meta-analyses. These data can only be analysed on a site-by-site, or phase-by-phase, or context-by-context basis — according to the unit of analysis chosen by the zooarchaeologist in the primary analysis of the faunal assemblage — since the most commonly-occurring element for each taxon within the separate assemblages recovered from different sites may not be the most commonly-occurring if the assemblages for all sites were pooled and analysed as a single unit. The value of MNI data in the evaluation of relative taxonomic abundance is therefore limited when undertaking a study on a regional or broader scale.

The analysis of relative taxonomic abundance was therefore undertaken using NISP data in this study. Raw NISP data for a single species cannot be used to evaluate intersite variation in reliance on that species, since intersite variation in faunal assemblage composition and fragmentation due to taphonomy will influence raw species counts, potentially biasing the apparent abundance of a given species at a given site. Instead, ratios between the taxa present at each site are used, enabling reliable intersite comparison. Since the abundance of each taxon is calculated relative to other taxa, however, it is important to be aware that an increase over time in the abundance of one taxon may result from a decline in the exploitation of other taxa. While this distinction is inconsequential when seeking to understand the relative importance of each taxon, it is more important when considering the overall extent of reliance on animal resources, since a large increase in cattle relative abundance, for example, may not necessarily indicate a large increase in overall meat consumption, if instead it is due to a decline in the total quantity of meat obtained from other taxa.

To facilitate the analysis of spatial and temporal variation in the relative abundance of domestic mammals, large game and small game, all taxa recorded in the database were assigned a taxon code — such as ‘DM’ for domestic mammals, or ‘LG’ for large game (taxon codes are provided in full in the database — see sheet 'Key'). Where taxa are recorded in a faunal report at a taxonomic level that combines categories, such as 'cattle/aurochs', a combined code was assigned — in this case, 'DM/LG'. Due to the importance of differentiating between domestic and wild taxa in the analysis of relative taxonomic abundance, owing to their very different cultural and economic value for past societies, taxa recorded in combined categories were excluded at the analysis stage.

In order to assess the significance of differences in relative taxonomic abundance across spatial and temporal categories, statistical testing was undertaken. Pairwise Wilcoxon rank sum tests were used to assess the statistical significance of differences in relative abundance between period- and region-based samples for cattle, sheep/goat and pigs. The Benjamini and Hochberg (1995) correction was used to control the false discovery rate in multiple comparisons. The following null hypothesis was used: there is no significant difference between two samples. $p \leq 0.05$ is significant; $p \leq 0.01$ is highly significant.

4.4.4 Age data

Further insight into animal husbandry practice is provided by the analysis of age-at-death data, used to reconstruct the culling strategies employed by past communities. Mortality profiles show the proportion of the animal population culled within each age group, and vary according to the products for which the animals were exploited. Exploitation principally for meat, or milk, or wool, or for use in traction, would each result in a different culling pattern, due to the different age range within which the relevant taxon is most productive of each of the products extracted (Payne 1973, 281-284). Since in practice many animal populations were likely exploited for a range of products, for many assemblages the mortality profile is likely to reflect a composite culling strategy; a mortality profile more obviously characteristic of either meat, or milk, or wool production is therefore an indication of more specialised production. While the extent of specialised production by past societies, and thus the value of theoretical product-specific mortality profiles, has been debated, they are widely used in the interpretation of culling strategies (Halstead 1998, 4-5). The determination of the age at death of the individuals represented by the specimens in an assemblage is achieved using two principal methods.

The timing of eruption and wear of teeth is highly correlated with age, and, as such, provides a useful means of assessing age at death (Hillson 2005, 215-216). In mandibles with teeth in-situ, the stage reached in the process of eruption of deciduous and permanent teeth can be determined. If teeth are erupted within the mandible, the extent of tooth wear will be analysed. This is achieved by reference to illustrated reference resources for each taxon, comparing the archaeological specimen with diagrammatic representations of the stage of wear on the occlusal (biting) surface, such as in Grant (1982) for cattle, sheep/goat and pigs, or schematic representations of the same, as in Payne (1973) for sheep/goat. In Payne (1973), the mandible is then assigned an alphabetic code on the basis of its overall stage of tooth eruption and wear, each of which has a corresponding suggested age. In Grant (1982), the eruption and wear stage of each tooth is assigned an alphanumeric code, each with a corresponding score. Tooth scores for molars are summed to produce a mandible wear stage (MWS). While absolute ages are not provided in Grant (1982), more recent work has proposed age ranges for mandible wear stages (Hambleton 1999, 64-67; Greenfield and Arnold 2008), enabling greater comparability between mandibles assessed using different systems.

Such methods are subject to a degree of bias, however. Bias towards the overestimation of age results from the influence of a coarser diet on the progression of tooth wear (Twiss 2008, 330; Mutze *et al*. 2021, 1), leading to individuals being assigned to a later wear stage than corresponds to their actual age at death, skewing the age-at-death distribution of that taxon. However, coarseness of diet might be expected to be sufficiently consistent across a population that any bias would not differentially affect individuals of different ages, and tooth wear is thus widely used in the assessment of age at death (Twiss 2008, 330). The post-mortem loss of teeth, as taphonomic processes degrade and break up the mandible, means that they are often recovered loose from archaeological contexts, and are thus less useful for the determination of age at death than those remaining in-situ in the mandible. In favour of their use in ageing is the relative robustness of teeth, such that they regularly survive in the archaeological record.

A second technique used in the determination of age at death is the analysis of epiphyseal fusion. Bone growth in mammals occurs at two cartilage growth plates situated between the epiphyses and the diaphysis of the bone. The fusion of the epiphysis to the diaphysis occurs after growth ceases (Popkin *et al*. 2012, 1776), and the cartilage plate is converted to bone. Fusion occurs at different ages for different elements of the skeleton, and, in many cases, also occurs at different ages for the proximal and distal ends of the same element (Silver 1969, 283-289; Zeder 2006). In the analysis of zooarchaeological material, specimens are grouped following a system such as in Zeder (2006), in which alphabetic categories for each taxon are used to group elements that fuse within the same age range. Using Zeder (2006), proximal radii of sheep are categorised as group A, for example — the category for elements that fuse prior to six months of age. Once each specimen has been assigned to a category, the number of specimens unfused, fusing and fused for each group can be quantified to reveal the abundance of specimens at each fusion stage. In the example given, if all group A specimens in the assemblage are fused, all sheep were at least six months of age when culled.

Once again, potential problems are associated with the use of the method. Sex-related variation in the age at which elements fuse has been observed, with certain studies finding that some elements fuse at a younger age in female sheep than in male (Popkin *et al*. 2012, 1776). Unless the elements on which ageing is attempted can also be assigned to sex — not possible for many elements — it will not be possible to allow for this variation in the analysis of age-at-death data. Human management strategies can also influence the timing of

epiphyseal fusion. Castration results in late fusion, and in sheep has been observed to cause a delay of a year or more in the fusion of certain elements (Popkin *et al*. 2012, 1776-1777). An additional difficulty in the use of fusion for ageing is that once all elements of the skeleton are fused — at some point after 48 months of age in sheep in the system used by Zeder (2006), for example — it is not possible to further distinguish between individuals of different age. Thus if all specimens in the final fusion category are fused for any taxon, all that can be determined in terms of age for that taxon is that the animals were skeletally mature when culled.

Despite potential methodological problems, it is nevertheless possible to estimate age at death with sufficient precision to gain insight into husbandry practice. Once ageing of specimens is complete, mortality profiles can be constructed, and the types of products for which the animals were exploited can be inferred. In the system proposed by Payne (1973, 281-282), animals raised for meat are typically culled once optimal weight is reached, with some females kept to maintain a breeding population. For a dairy herd, Payne (1973, 281, 283-284) proposes a high rate of male infant mortality, with the majority of females kept into adulthood, while for wool production a mortality profile showing a high proportion of adult, but not elderly, females and castrates, culled once the quality of the product decreases in later life, is proposed. While, as noted above, aspects of Payne's system have been questioned, it nevertheless provides a useful guide for the interpretation of age data (Halstead 1998, 4-5, 15). Thus a high proportion of young individuals would likely result from exploitation primarily for meat, while a high proportion of adults is more likely to indicate traction; a combination of both could result from dairy production.

The principal problem that arises in the use of age-at-death data in meta-analyses is the varied formats in which the data are recorded in faunal reports. Formats include lists of numbers of specimens within sequential age ranges of months or years, or within descriptive categories such as neonate, infant, juvenile, subadult, adult, and mature. Intersite comparability can be achieved by the conversion of age ranges to equivalent categories by reference to a source in which both age ranges and categories are used, such as in Greenfield and Arnold (2008, 838) for sheep/goat. When different, overlapping, age ranges are used in different faunal reports, the data cannot easily be compared. In such cases, comparability can be achieved by pooling age ranges or categories into lower-resolution groups — very young, young, and adult, for example. This will reduce the resolution at which animal husbandry strategy is understood,

but avoids the reduction of sample size by the subdivision of the dataset according to the format in which age data are recorded.

For the purposes of this study, age data were recorded in the database in the format in which they appear in the faunal report — whether in age ranges or categories — with a note in the column ‘COMMENTS’ to record the source of the data — whether tooth eruption and wear or epiphyseal fusion. Age ranges and categories were then pooled to form the following groups: very young, young, and adult. Individuals below three months of age, and those categorised as 'very young', 'foetal', 'neonatal' or 'neonate' in faunal reports, are classed here as 'very young'. Variation in age reporting in faunal reports results in some overlap of age ranges between the categories 'very young' and 'young' — individuals aged 0-2 months and 0-3 months are classed here as 'very young', while those aged 2-4 months and 0-6 months are classed as 'young'.

The cut-off points between the categories 'young' and 'adult' for each taxon follow Hambleton (1999, 65) for cattle and pigs, and Greenfield and Arnold (2008, 838) for sheep/goat, but with a slight adjustment on the basis that cut-off points between age ranges vary in the faunal reports consulted, and do not always correspond exactly to those indicated in these two sources. Thus a minimum age of three years was used for the category 'adult' for cattle and sheep/goat, while a minimum age of 2.5 years was used for pigs. Individuals recorded as 'over 2 years old' were excluded from the analysis as it is not possible to ascertain whether they fall within the 'young' or 'adult' category used here.

A threshold of 5 specimens was applied at the analysis stage for the inclusion of age data in the analysis. Where age data were provided in a faunal report as percentages with no total sample size stated, these percentages were recorded in the database. The data were only included in the analysis, however, if the percentages were anything other than 25%, 33.3%, 50%, 100%, or multiples of 25% and 33.3% — these are the only percentages that can result from total sample sizes of 4, 3, 2 and 1 specimens, so their exclusion ensures the exclusion of any sample size below the chosen threshold of 5 specimens.

4.4.5 Metrical data

The evaluation of intrapopulation and interpopulation morphological variation is achieved by the analysis of metrical (bone measurement) data, which enable the size and shape distribution of the animal population represented by an assemblage to be reconstructed. Via comparison between sites, periods and regions, metrical data provide an insight into spatial and temporal variation in population characteristics, and in approaches to the breeding of livestock or the exploitation of wild animals. The first step in this process is the collection of metrical data from the specimens in an assemblage. Measurements of a range of dimensions are taken, usually with reference to a standard set of dimensions for each skeletal element such as those defined by von den Driesch (1976) in an illustrated guide. In the system used by von den Driesch, a range of length, width (or breadth) and depth measurements are defined for each element, each assigned an alphabetic code for ease of recording. Measurements are typically taken using calipers and recorded to the nearest 0.1 mm; where specimens are too large to be measured using calipers, a measuring box is used (Orton 2014, 903). The use of a standardised system such as this ensures reproducibility and facilitates comparison between assemblages.

In order to use metrical data to evaluate the extent of livestock morphological variation resulting from variation in feeding and breeding practices, it is necessary to consider and eliminate as far as possible the impact of other influences. Thus it is important to ensure that all measured specimens derive from individuals for whom fusion of the epiphyses to the diaphysis of the measured element was complete prior to death. Morphological variation can then be determined not to have resulted from the presence in the assemblage of individuals that were not skeletally mature at time of death. Additionally, it is important to ensure that any pathological bone growth on the surface of a specimen does not extend across the point from which a measurement is taken. Since state of fusion and extent of pathology of measured specimens is only occasionally noted in faunal reports, when undertaking meta-analyses it is necessary to assume that measurements derive from skeletally-mature, non-pathological individuals unless otherwise stated.

The potential influence of sexual dimorphism on size distribution must also be considered in the analysis of metrical data. Certain elements exhibit size and shape variation between females, males, and, in some cases, castrates. In cattle, for example, skulls, horn cores and

metapodials can be notably larger in males than in females, while the metapodials of castrates are longer and somewhat more slender than those of males (Grigson 1982, 7, 9, 10). In sheep, long bones are somewhat longer in castrates than in males and females (Davis 2000, 384). In pigs, meanwhile, canine teeth and much larger, and of a different shape, in males relative to females (Ruscillo 2014, 8004). The utilisation of size variation to identify change introduced by improved feeding or genetic change is therefore complicated by the existence of size variation in the skeletal elements of individuals of different sexes. In Roman assemblages, there may be a considerable size overlap between males of a smaller local population and females of a larger imported population, for example, presenting potential issues — and factors that must be carefully considered — in the interpretation of morphological variation.

Size overlap between wild and domestic forms of certain taxa, as noted above with regard to taxonomic identification, can also present potential issues in the interpretation of metrical data. The potential for size overlap between aurochs and cattle (Wright 2013, 1); between wild boar and pigs (Rowley-Conwy *et al*. 2010); and between wolves and dogs (Janssens *et al*. 2019), is an important consideration in the analysis of metrical data. For the purposes of this study, all metrical data recorded in faunal reports under the headings ‘cattle’, ‘pig’ and ‘dog’ — or under their Latin names, or their common name equivalents in Serbian, Bulgarian or Romanian — were recorded in the database. No metrical data recorded in faunal reports under the headings ‘aurochs’, ‘wild boar’ or ‘wolf’ were recorded in the database. However, where metrical data under the headings ‘cattle’, ‘pig’ or ‘dog’ were qualified in the faunal report with a note indicating uncertainty regarding the domestication status of the individual from which the bone specimen originated, a note was added to the database in the column ‘COMMENTS’ to this effect, and the specimen was excluded from the analysis.

Any duplicated measurements identified in faunal reports were recorded in the database, noted as duplicates in the column 'COMMENTS', and excluded from the analysis. Where any measurement in a faunal report was identified as a likely error due to its being unusually large or small, and likely the result of a typographical error, the measurement was recorded in the database, noted as an error in the column 'COMMENTS', and excluded from the analysis.

Raw metrical data were available for the majority of sites included in the study. In some faunal reports, however, metrical data are presented in summary format, with only the number of specimens (n), the minimum measurement, the maximum measurement, and the

mean given for each species-element-measurement combination. Separate sheets were used in the database to record raw and summary metrical data separately. Where a publication presented metrical data in summary format, but the number of specimens measured was 1 or 2, data were recorded in the sheet 'Metrics raw data', since a single measurement (where n=1) or a minimum and maximum (where n=2) are raw data. Where n=3, the minimum and maximum were recorded as raw data, and these two values were then used along with the mean to calculate the third, intermediate, value — this was then also recorded as raw data. Where n>3, it is not possible to calculate intermediate values from the minimum, maximum and mean, so in these cases the data were recorded in the sheet 'Metrics summary data'. Preliminary analysis of a sample of summary data indicated that temporal trends observed in these data echoed those observed in the raw data. Summary data are available in the database, but are not analysed further in this thesis.

Once the collection of metrical data by a zooarchaeologist is complete, a useful technique in the analysis of morphological variation is the log standard index (LSI) method, which enables the direct comparison of measurements derived from different elements of the skeleton, and thus the pooling of data to increase sample size. The method involves dividing each measurement taken on an archaeological specimen by the same measurement obtained from a 'standard' animal, and the calculation of a logarithm to base 10 of the result (Meadow 1999, 288; Orton 2014, 904). The standard used will typically be a modern individual, a complete archaeological skeleton, or the average for each measurement calculated from those obtained from an archaeological population. Each resultant LSI value shows the size of the archaeological individual relative to the standard animal, with negative values indicating smaller archaeological individuals and positive values indicating larger individuals. Since each LSI value indicates size relative to a fixed (zero) point, values for different skeletal elements can be plotted together, enabling the evaluation of morphological variation across a larger sample than would be available for each individual element.

For cattle, sheep/goat, pigs, horses and red deer, LSI values presented in this study were calculated using the R package *zoolog* (Pozo *et al*. 2022), utilising the standards provided in the package. For cattle, the standard used was a Bronze Age female individual from Catalonia, Spain, from the reference set designated ‘Nieto’ in *zoolog* (Nieto-Espinet 2018). For sheep/goat, the standard used was the set of mean measurements obtained from adult males of a single flock of Soay sheep from Hirta, Scotland, from the reference set ‘Clutton’

(Clutton-Brock *et al*. 1990). For pigs, the standard used was the set of mean measurements obtained from late Neolithic pigs from Durrington Walls, England, from the reference set 'Albarella' (Albarella and Payne 2005). For horses, the standard used was a modern adult female from Iceland, from the reference set 'Johnstone' (Johnstone 2004). For red deer, the standard used was a modern adult male from Switzerland, from the reference set 'Basel' (Stopp and Deschler-Erb 2018).

For dogs, the standard used for the calculation of LSI values was a modern greyhound in the University of York Zooarchaeological Reference Collection. In addition to the analysis of LSI data, dog morphological variation was evaluated via the analysis of withers height data and slenderness indices. Withers heights were estimated using the formula for each skeletal element proposed by Harcourt (1974, 154). Slenderness indices were calculated following the method used by Colominas (2016, 900-901), using the formula (SD/GL)*100. A modern poodle and greyhound in the University of York collection were used as modern comparators in the analysis of slenderness.

Several factors have to be taken into consideration when using LSI values to analyse morphological variation. Since length, width and depth dimensions of skeletal elements vary in their response to influences that induce size change, resulting in shape change alongside overall size increase or decrease, these dimensions should be analysed separately (Albarella 2002, 54; Orton 2014, 905). In order to avoid the repeated representation of a single individual within any analysis, in cases where multiple length, width or depth measurements are available for a single specimen, only one measurement in each category should be used, following a preferential order such as that proposed by Trentacoste *et al*. (2018, 6-7). Length, width and depth measurements were therefore analysed separately in this study, and in cases where multiple length, width or depth measurements were available for any one specimen, the preferential order proposed by Trentacoste *et al*. (2018) was followed to select a single measurement for analysis.

While the principal focus of the morphological analysis undertaken in this study is livestock and dogs, metrical data for horses, domestic chickens, domestic geese, red deer and roe deer were also recorded in the database. Horse and red deer metrical data were analysed to provide a domestic and a wild comparator respectively for the analysis of the livestock data. If similar patterns are observed in horse and livestock data, anthropogenic influence can be

hypothesised; if similar patterns are observed in red deer and livestock data, the potential influence of climate and environment on livestock morphological change would need to be more carefully considered. Insufficient chicken, goose and roe deer metrical data were available to enable the analysis of spatial and temporal morphological variation, so data for these taxa are not analysed further in this thesis.

In order to assess the significant of morphological differences across spatial and temporal categories, statistical testing was undertaken. Pairwise Wilcoxon rank sum tests were used to assess the statistical significance of morphological differences between period- and region-based samples for cattle, sheep/goat and pigs. The Benjamini and Hochberg (1995) correction was used to control the false discovery rate in multiple comparisons. The following null hypothesis was used: there is no significant difference between two samples. $p \leq 0.05$ is significant; $p \leq 0.01$ is highly significant.

4.4.6 Evidence for hippophagy

Though Roman communities utilised the skins and bones of horses for various purposes, hippophagy — the consumption of horsemeat — is argued to have been taboo, and rare in Roman society except in times of crisis (Kroll 2012, 98; Miladinović-Radmilović 2016, 365; Akeret *et al*. 2019, 83-84). Indicators of hippophagy include evidence for the butchery, burning or boiling of horse bones, the presence of horse within assemblages otherwise consisting of the remains of consumed domestic mammals, the fragmentation of horse bones to a similar extent to that observed for other consumed taxa, and the presence or predominance of high meat-value skeletal elements in the assemblage (Lauwerier 1999, 107-108, 111). Some of these indicators can also result from the removal of skins or the processing of horse bones for use as tools or in craftworking, however, and horses that were not butchered or consumed may have been deposited within domestic refuse as a means of disposal. A careful consideration of the whole assemblage, and of the types of cut marks present on the bones, is therefore important before concluding that hippophagy is present, and a combination of indicators is necessary to confidently infer hippophagy.

The quantitative analysis of evidence for hippophagy within an assemblage is subject to the same potential biases as a result of degradation and fragmentation as are experienced in the

analysis of other aspects of the assemblage. A qualitative approach can instead be taken, in which the extent of evidence for each of the indicators of hippophagy is considered, and an assessment regarding the extent of hippophagy is made for the assemblage as a whole. A more quantitative approach can then be taken in meta-analyses when using the qualitative data obtained from faunal reports, by assigning each assemblage to one of a limited range of categories according to the extent of evidence for, or the likelihood of, the consumption of horsemeat.

In this study, hippophagy was recorded at the phase level using the categories ‘possible’, 'occasional', 'common', and ‘present but frequency unspecified’. The selection of category was made according to the assessment made in the faunal report regarding the extent of evidence for the practice. Where it was noted in a faunal report that the processing, fragmentation or depositional context of horse bones suggested that the taxon may have been consumed, but where the faunal analyst did not state explicitly that hippophagy had taken place, or noted their uncertainty regarding the presence of the practice, hippophagy was recorded in the database as ‘possible’. Where it was noted that evidence for hippophagy was present, but where it was only present in small quantities, or where the faunal analyst stated that the evidence indicated only occasional horsemeat consumption such as in times of crisis, hippophagy was recorded in the database as ‘occasional’. Where evidence for hippophagy was present in large quantities, or where a faunal report stated that the practice was regular or frequent, hippophagy was recorded in the database as ‘common’. Finally, where evidence for hippophagy was noted at a site, but no indication was given as to the frequency of the practice, hippophagy was recorded in the database as ‘present but frequency unspecified’.

5 The dataset

5.1 Introduction

The dataset comprises site, phase and zooarchaeological data from 172 sites located across modern Serbia, Bulgaria and Romania. The 172 sites included in the study are distributed across 140 settlements and one natural feature. All faunal assemblages derive from domestic — i.e. non-ritual — activity, and originate from 243 dated phases of activity from the late Iron Age to the early Byzantine period. The zooarchaeological dataset comprises taxonomic data from 182 phases, with a total NISP of 205,736, skeletal element data from 79 phases, age data from 125 phases, sex data from 100 phases, hippophagy data from 108 phases, raw metrical data from 193 phases, and summary metrical data from 36 phases. Volume of data per phase ranges from a single measured bone specimen to zooarchaeological data in all six categories deriving from an assemblage with a total NISP of many thousand. Taxonomic data, age data, hippophagy data, and raw metrical data are analysed in this thesis; skeletal element data, sex data, and summary metrical data are recorded in the database but are not analysed here.

5.2 Regions and climatic and environmental zones

The 172 sites included in the study are distributed across seven climatic and environmental zones. These seven zones are: the Pannonian Plain; Transylvania; Moldavia; Oltenia and Muntenia; Dobrogea; southeast Serbia and western Bulgaria; and central Bulgaria (Figure 5.1). These seven zones are distributed across three regions subject to varying levels of Roman occupation and administrative control. These three regions are: the Balkan provinces, occupied from the last centuries BCE until the late first millennium CE; Dacia, under Roman occupation for much of the second and third century CE; and the regions to the north and east of the Danube, and beyond Roman Dacia, never subject to long-term Roman occupation (Figure 5.1).

For consistency, the area of the study region to the south of the Danube will be referred to in this thesis as the Balkan provinces, though strictly speaking this term should only apply to the region when under Roman occupation. The terms pre-Roman, Roman and post-Roman Dacia will be used to refer specifically to the territory that corresponds to the second to third

century CE Roman province of Dacia — as distinct from the larger Kingdom of Dacia of the last century BCE, for example. The term late Iron Age Dacia will be used to refer to the wider territory within modern Romania constituting Dacia in earlier centuries BCE.

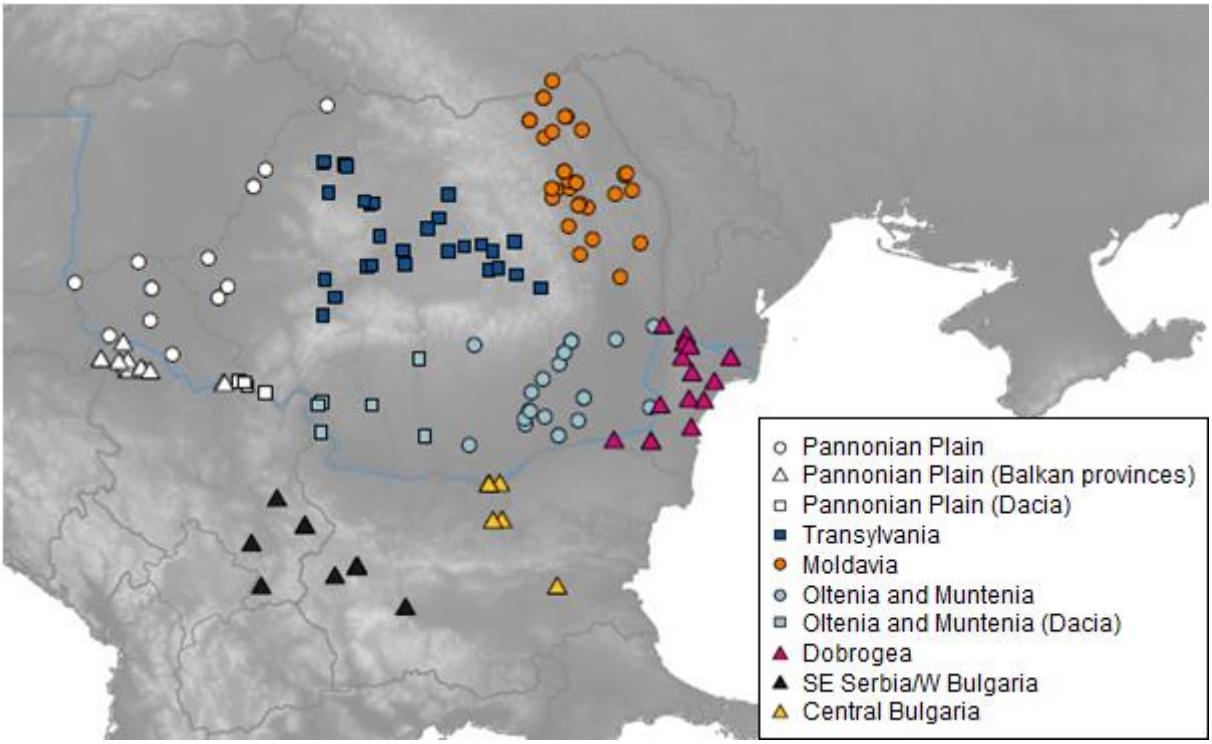


Figure 5.1: Distribution of studied sites by climatic and environmental zone and region. Triangles: Balkan provinces; squares: Roman Dacia; circles: beyond the area of long-term Roman occupation.

In general, the study region is characterised by a temperate continental climate, with summer temperatures ranging from warmer to cooler with increasing latitude (Arnold and Greenfield 2006, 19-21). Oak forests were present in the region in prehistory, and would have been well-suited to the colder, more northerly parts of the region (Ilić 2017, 5). The majority of the study period coincides with a period of relatively warm climate in Europe from c. 250 BCE to 400 CE, known as the Roman Warm Period (Haselgrove *et al*. 2019a, 9). While a lack of data means that the understanding of past climate and environment across the study region has to rely substantially on extrapolation from the modern character of each part of the region, it is likely that the climate has changed relatively little since the Roman period (Ilić 2017, 5-6), and modern data thus provide a reasonable approximation to the situation in the past. The climatic and environmental characteristics of the seven zones across which the studied sites are distributed are as follows.

The Pannonian Plain

This region comprises northern Serbia and northwest Romania, and lies within the southern and eastern part of the Pannonian Plain, a basin bounded by the Alps to the west and the Carpathians to the north and the east. The region experiences warm summers, and features a varied environment, heavily forested in parts but characterised by open agricultural land in others (Ács *et al*. 2015, 398; Reed and Roguljić 2020, 40).

Transylvania

This region is located in central Romania, and is bounded by the Carpathians. The region is forested at higher altitudes, while the lower-lying landscape within the arc of the Carpathians is composed of hills, plains and agricultural land (Oltean 2007, 26, 33). Due to its position relative to the Carpathians, much of the region experiences a milder climate with cooler summers and milder winters than more exposed neighbouring regions (Oltean 2007, 31). Humidity is generally lower and temperature higher in the western part of the region than in the east.

Moldavia

This region is located in northeast Romania and comprises the Romanian part of Moldavia, lying between the eastern Carpathians and the Romanian-Moldovan border. The region is relatively dry, and, due to its location and geographical character, is subject to influence from the less temperate climate of neighbouring regions, which results in hot summers and cold winters (Spinei 2009, 15).

Oltenia and Muntenia

This region in southern Romania comprises the Getic plateau and the Romanian Plain, and extends from the Serbian-Romanian border in the west to the western edge of Dobrogea in the east. The region is bounded to the north by the southern Carpathians, and to the south by the Danube. Topographically, the region is mountainous in the north, gradually decreasing in

altitude to plains in the south and the east (Boia 2001, 16-17). The western part of the region experiences higher rainfall than the east, which is subject to a dry summer climate and cold winters (Kormos 1973, 31, 33).

Dobrogea

This region comprises the northern (Romanian) part of Dobrogea, and lies between the lowermost section of the Danube and the Black Sea, in southeast Romania. The terrain ranges from low-lying to mountainous, and the region is characterised by a relatively dry climate (Boia 2001, 19). The environment became increasingly open from the Iron Age, as a result of anthropogenic influence (Feurdean *et al*. 2021, 1083, 1094).

Southeast Serbia and western Bulgaria

This region is located in mountainous terrain spanning the southern part of the Serbian-Bulgarian border, and encompasses the westernmost sections of the Rila-Rhodope massif and the Balkan mountains. The region features less extreme summer and winter temperature variation than regions further to the north, and experiences a cooler and wetter climate at higher altitudes than is the case in neighbouring lower-lying regions (Pavlović *et al*. 2012, 348; Pavlović *et al*. 2017, 35).

Central Bulgaria

This region comprises the central parts of the Danubian and Upper Thracian plains, lying between the Danube to the north and the southern Bulgarian border to the south, and divided latitudinally by the Balkan mountains. The north of the region is characterised by a dry continental climate, while the south is subject to influence from the warmer Mediterranean climate of more southerly neighbouring regions (Shishkov and Kolev 2014, 13; Niedźwiedź 2012, 22).

5.3 Periodisation

To facilitate the analysis of temporal variation in animal exploitation, the 243 phases included in the study have been divided between five periods:

1) The late Iron Age, c. 400–1 BCE

2) The early Roman period, c. 100 BCE – 100 CE

3) The mid-Roman period, c. 100–300 CE

4) The late Roman period, c. 200–500 CE

5) The early Byzantine period, c. 400–700 CE

Figure 5.2 shows the distribution of phases between these five periods.

Periods have been defined according to the principal political changes in the study region during the study period. The late Iron Age is the period prior to Roman occupation, providing the pre-Roman background to the study; the early Roman period spans the period of early Roman occupation to the south of the Danube; the mid-Roman period corresponds to the Roman occupation of Dacia; the late Roman period falls between the loss of Roman Dacia and the fall of the western Roman Empire; and the early Byzantine period follows the fall of the western Empire. Phases have been assigned to period on the basis that their midpoint falls within a pre-defined date range, defined according to the historical criteria described above. While a small number of phases extend beyond the principal date range of their period, no phase does so by more than half of its total time span. Overlap of periods is difficult to avoid when collating zooarchaeological data representing long-term occupation across a large region; overlap of phases, as shown in Figure 5.2, has the advantage that it enables the consideration of gradual change over time, complementing the period-by-period analysis of the dataset.

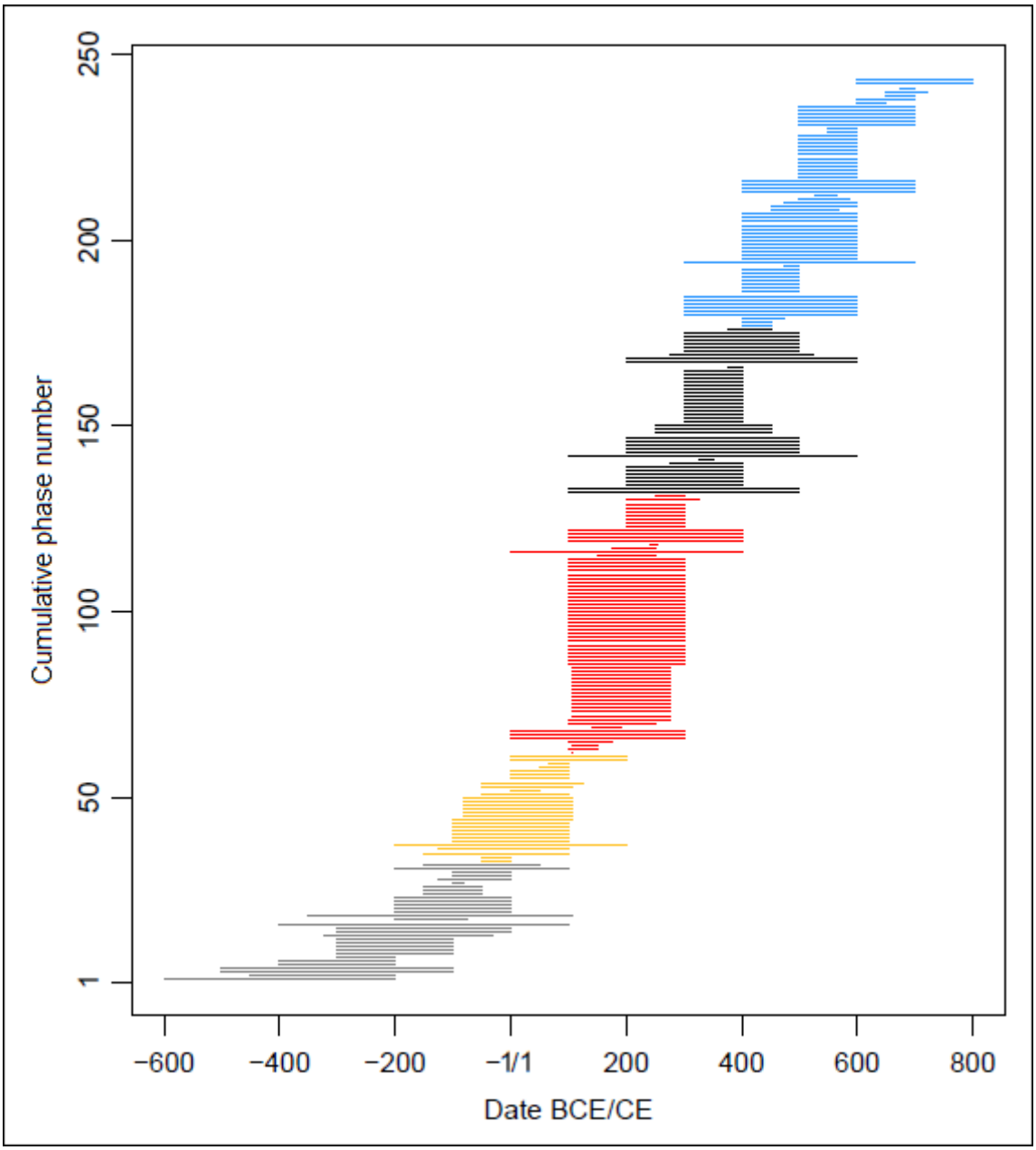


Figure 5.2: Distribution of phases by period. Each horizontal bar represents a single phase and its date range. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Due to varied regional convention and the varied distribution of past cultures across the study region, different terminology is used in different regions to refer to phases that fall within a similar date range. Additional terms used for phases in each of the five periods used in this study are shown in Table 5.1. All phases are recorded in the database following the terminology used in their respective faunal reports; the five periods used in the study are referred to throughout this thesis by the five period names given above, however.

Table 5.1: Additional terms used in faunal reports to refer to phases that correspond temporally to each of the five periods used in the study.

Period	Additional terms
Late Iron Age	Celtic, La Tène, Thraco-Getic, Geto-Dacian
Early Roman period	Late Iron Age, La Tène, Geto-Dacian, Dacian
Mid-Roman period	Antiquity, Roman, Daco-Roman, Carpi civilisation, Cernjeacov culture
Late Roman period	Late Antiquity, Roman-Byzantine, early Migration, Gothic, Sântana de Mureș culture
Early Byzantine period	Late Antiquity, Roman-Byzantine, early medieval, pre-feudal, Gepidic

The calendar dates to which each named phase corresponds are for the most part provided in the faunal reports consulted. In some cases, however, only a partial date is given, or a phase is referred to only by reference to a named period or culture. Table 5.2 lists the calendar dates assigned in each of these cases, and explains their selection; this information is also provided in the database (see sheet 'Phase', column 'COMMENTS'), in which phase data are provided in full.

Table 5.2: Calendar dates assigned to phases for which dates are not provided in the faunal report.

Site ID	Phase ID	Phase name in source	Phase description in source	Start date	End date	Comments
2	9	C and later	First half of the 5th century and later	400	475	No end date - start of next phase used
2	11	D	End of the 5th century (D1) and 530s onwards (D2)	475	600	No end date - date of abandonment of site used
3	27	Earlier than 7th		500	700	No start date - start of phase III in publication used
9	35	Roman		106	275	Start and end date of Roman occupation of Dacia
9	36	Gepidic		453	567	Gepidic period - start date move into Transylvania after death of Attila, end date defeat of Gepids by Langobards
11	38	Roman		106	275	Start and end date of Roman occupation of Dacia

Table 5.2 (continued)

Site ID	Phase ID	Phase name in source	Phase description in source	Start date	End date	Comments
12	39	Post-Roman	3rd-4th century AD	275	400	Publication says 'post-Roman' - end date of Roman occupation of Dacia used as start date
24	58	Gothic	Sântana de Mureș culture	100	500	Start and end date for Sântana de Mureș culture
32	68	Roman		106	275	Start and end date of Roman occupation of Dacia
33	69	Roman		106	275	Start and end date of Roman occupation of Dacia
34	70	Dacian		-82	106	Dacian period - start date Burebista rule begins, end date Roman conquest
46	84	Roman		200	500	Start and end date of occupation of castrum
51	89	Sântana de Mureș culture		100	500	Start and end date for Sântana de Mureș culture
60	109	Roman	Half II century AD	106	150	Publication says 'half II century AD' but does not specify first or second half - first half used here, as assemblage is from 'first terrace' of the camp, start date start of Roman occupation of Dacia
61	110	Dacian		-82	106	Dacian period - start date Burebista rule begins, end date Roman conquest
67	116	Roman		106	275	Start and end date of Roman occupation of Dacia
84	134	Roman		106	275	Start and end date of Roman occupation of Dacia
87	137	Roman		106	275	Start and end date of Roman occupation of Dacia
88	138	Roman		106	275	Start and end date of Roman occupation of Dacia
90	140	Roman		106	275	Start and end date of Roman occupation of Dacia
111	167	Late Iron Age		-500	-100	Start and end date of late Iron Age in Bulgaria
115	171	Roman		106	275	Start and end date of Roman occupation of Dacia
142	205	La Tène	Geto-Dacian	-350	106	Start date start of La Tène in Romania, end date Roman occupation of Dacia
143	206	Dacian		-82	106	Dacian period - start date Burebista rule begins, end date Roman conquest

Table 5.2 (continued)

Site ID	Phase ID	Phase name in source	Phase description in source	Start date	End date	Comments
143	207	Roman		106	275	Start and end date of Roman occupation of Dacia
152	219	Roman		106	275	Start and end date of Roman occupation of Dacia
153	222	Dacian		-82	106	Dacian period - start date Burebista rule begins, end date Roman conquest
154	223	Dacian		-82	106	Dacian period - start date Burebista rule begins, end date Roman conquest
154	224	Daco-Roman		106	275	Start and end date of Roman occupation of Dacia

The distribution of the 243 phases between the seven climatic and environmental zones that comprise the study region is shown in Figure 5.3. For the most part, the dataset provides consistent temporal coverage of each of the seven zones. In the dataset for the early part of the late Iron Age — the period up to c. 200 BCE — and in the mid-Roman, late Roman, and early Byzantine datasets — spanning the period c. 100–800 CE — phases are distributed across multiple zones, facilitating the analysis of spatial variation in animal exploitation in these periods, and ensuring that temporal trends identified in exploitation practice can reliably be interpreted as the result of temporal change in animal exploitation, rather than a consequence of smaller scale, zone-based change. In the datasets for the later part of the late Iron Age and the early Roman period — the period c. 200 BCE — 100 CE — there is, however, a bias towards the northwest and central parts of the study region — the majority of phases in this date range represent sites in the Pannonian Plain, Transylvania, and Oltenia and Muntenia. It will therefore be important to ensure that any zone-based patterns are taken into account when interpreting potential temporal trends in these two periods.

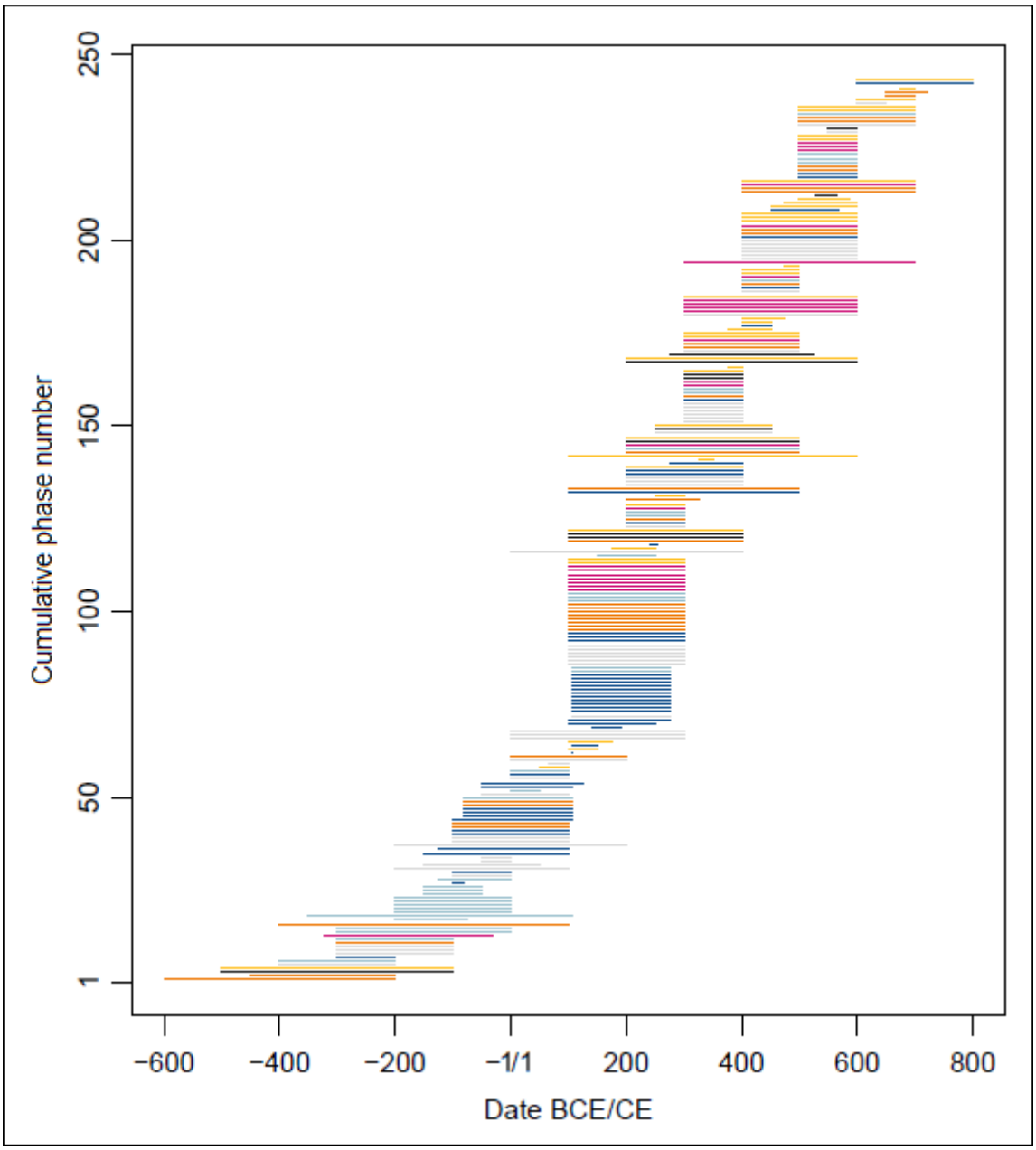


Figure 5.3: Distribution of phases by zone. Grey: Pannonian Plain; dark blue: Transylvania; orange: Moldavia; light blue: Oltenia and Muntenia; pink: Dobrogea; black: southeast Serbia and western Bulgaria; yellow: central Bulgaria.

Figure 5.4 shows the distribution of the 243 phases by region. Some temporal variation in the spatial distribution of phases is evident. The dataset for the late Iron Age is somewhat biased towards the regions outside the Empire, in particular in the later part of the period, in which the majority of phases represent sites in Moldavia. The early Roman dataset has a slight focus on Dacia, while a greater proportion of sites in the Balkan provinces than elsewhere contribute to the datasets for the late Roman and early Byzantine periods. Overall, however, the dataset provides good coverage of the three regions, with multiple phases in each region contributing to the dataset for each period.

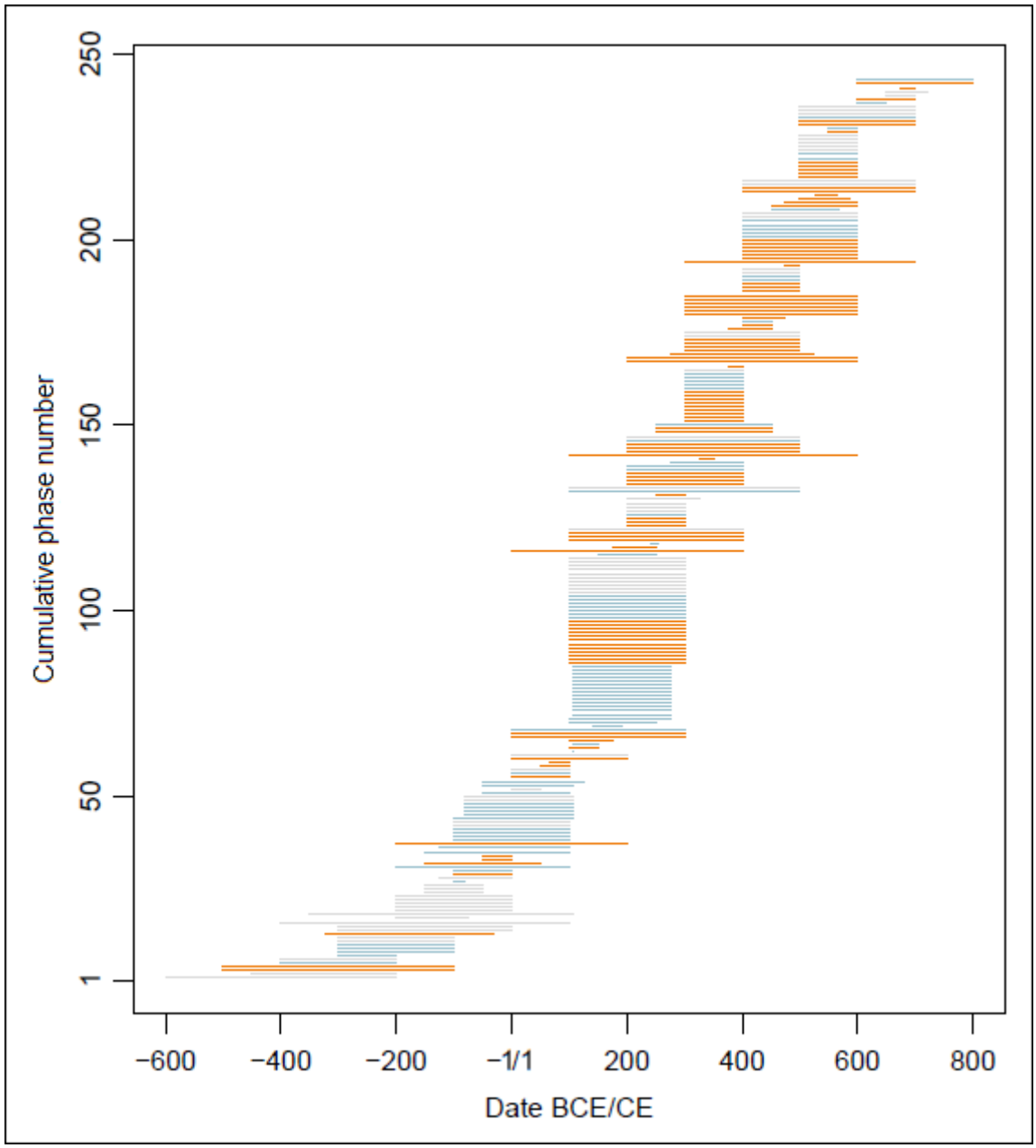


Figure 5.4: Distribution of phases by region. Orange: Balkan provinces; blue: Dacia; grey: beyond the area of long-term Roman occupation.

5.4 The sample by period

5.4.1 Overview

The distribution of sites, phases and taxonomic data between the five periods included in the study is shown in Table 5.3.

Table 5.3: Distribution of sites, phases and taxonomic data by period.

Period	Number of sites	Number of phases	Total NISP
Late Iron Age	30	32	52,555
Early Roman period	29	29	16,704
Mid-Roman period	62	70	49,816
Late Roman period	38	45	50,535
Early Byzantine period	42	67	36,126

5.4.2 The late Iron Age

The late Iron Age dataset comprises 32 phases across 30 sites (Figure 5.5). Taxonomic data included in the dataset for this period give a total NISP of 52,555, the highest for any of the five periods. Each of the seven climatic and environmental zones is represented in this period, though three of these — Dobrogea, southeast Serbia and western Bulgaria, and central Bulgaria — are represented only by a single settlement. Although Oltenia and Muntenia is well-represented overall, all late Iron Age sites included in the study for this zone lie within Muntenia. The wide distribution of late Iron Age sites across the study region provides the opportunity to understand pre-Roman animal exploitation practices in all seven zones, providing a good background to the study. Any conclusions drawn must be more tentative in the less well-represented zones, however.

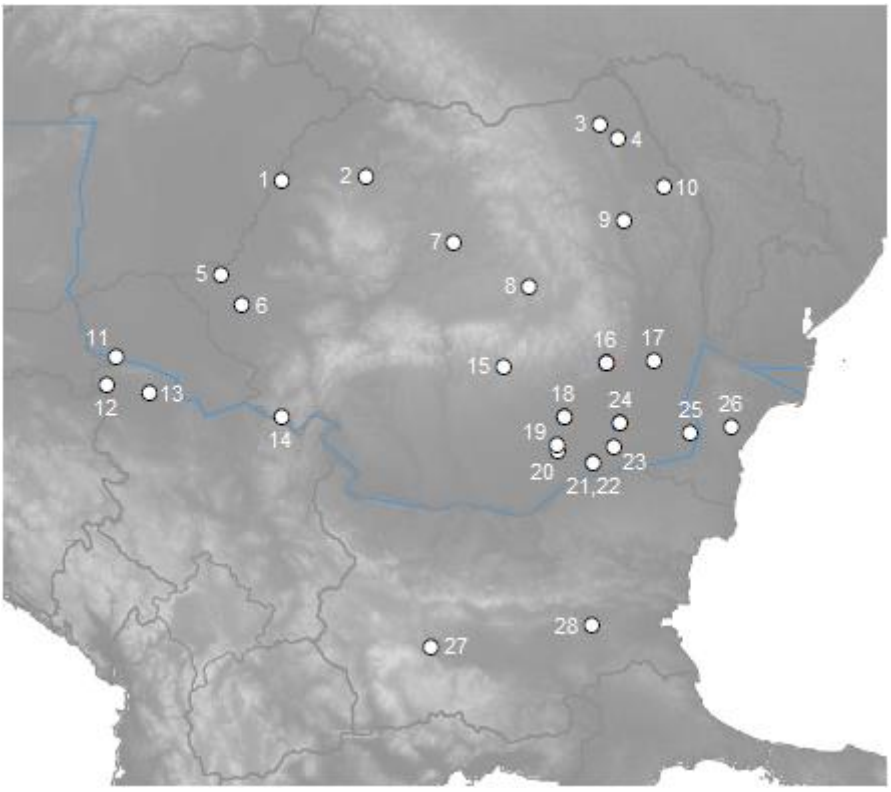


Figure 5.5: Late Iron Age sites (1: Biharea, 2: Porolissum-'Măgura' Moigradului, 3: Stânceşti, 4: Cotu-Copălău, 5: Pecica 'Şanţul Mare', 6: Giarmata-Baraj, 7: Moreşti, 8: Augustin-Tipia Ormenişului, 9: Brad, 10: Lunca-Ciurei, 11: Turski šanac-Bačka Palanka, 12: Bregovi Atovac-Kuzmin, 13: Tromeđa-Pećinci, 14: Stenca Liubcovei, 15: Cetăţeni, 16: Cârlomăneşti, 17: Grădiştea, 18: Vlădiceasca (Ilfov County), 19: Bragadiru-Bucureşti, 20: Popeşti, 21: Radovanu, 22: Radovanu-Gorgana a doua, 23: Vlădiceasca (Călăraşi County), 24: Piscul Crăsani, 25: Bordușani-Popină, 26: Cogealac, 27: Adjiyska Vodenitsa, 28: Yassa-Tepe).

5.4.3 The early Roman period

The dataset for the early Roman period comprises 29 phases across 29 sites (Figure 5.6), and taxonomic data derive from assemblages with a total NISP of 16,704. The Pannonian Plain, Transylvania, and Moldavia are the best-represented zones in this period, while Oltenia and Muntenia is represented by only two settlements, and central Bulgaria by a single settlement. No data from southeast Serbia and western Bulgaria or Dobrogea were available for the early Roman period, skewing the focus towards the west and northeast of the study region. The data are distributed fairly evenly between the Balkan provinces, pre-Roman Dacia, and the surrounding region, however, facilitating comparison between these three regions.

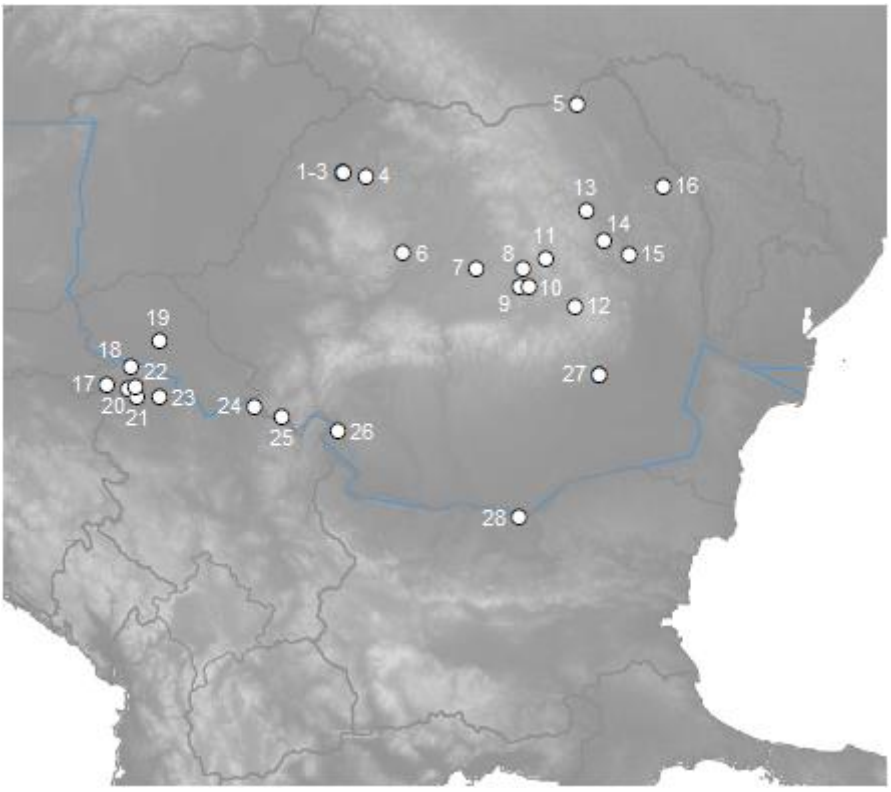


Figure 5.6: Early Roman sites (1: Șimleu Silvaniei-Cetate, 2: Șimleu Silvaniei-Observator, 3: Șimleu Silvaniei-str. A. Mureșanu, 4: Porolissum-'Măgura' Moigradului, 5: Lozna, 6: Cicău-Sălișteț, 7: Sighișoara 'Wietenberg', 8: Merești, 9: Racoș-Piatra Detunată/'Durduia', 10: Augustin-Tipia Ormenișului, 11: Jigodin 'Câmpul Morii', 12: Cetatea Zânelor (Covasna), 13: Piatra Șoimului, 14: Florești 'Via mică', 15: Răcătau, 16: Dumbrava, 17: Velike Ledine-Kuzmin, 18: Dumbovo-Beočin, 19: Čurug-Stari Vinogradi, 20: Lokalitet 85, 21: Gomolava, 22: Bare-Voganj, 23: Vrtlozi-Šimanovci, 24: Divici 'Grad', 25: Stenca Liubcovei, 26: Ostrovul Corbului, 27: Pietroasa Mică-Gruiu Dării, 28: Novae).

5.4.4 The mid-Roman period

The dataset for the mid-Roman period comprises 70 phases across 62 sites (Figure 5.7), the largest number of phases and sites for any of the five periods. The taxonomic dataset gives a total NISP of 49,816. All zones are represented in this period, with at least two settlements per zone included in the sample. Of the periods considered thus far, the mid-Roman period therefore provides the best opportunity to consider spatial variation in animal exploitation across the study region.

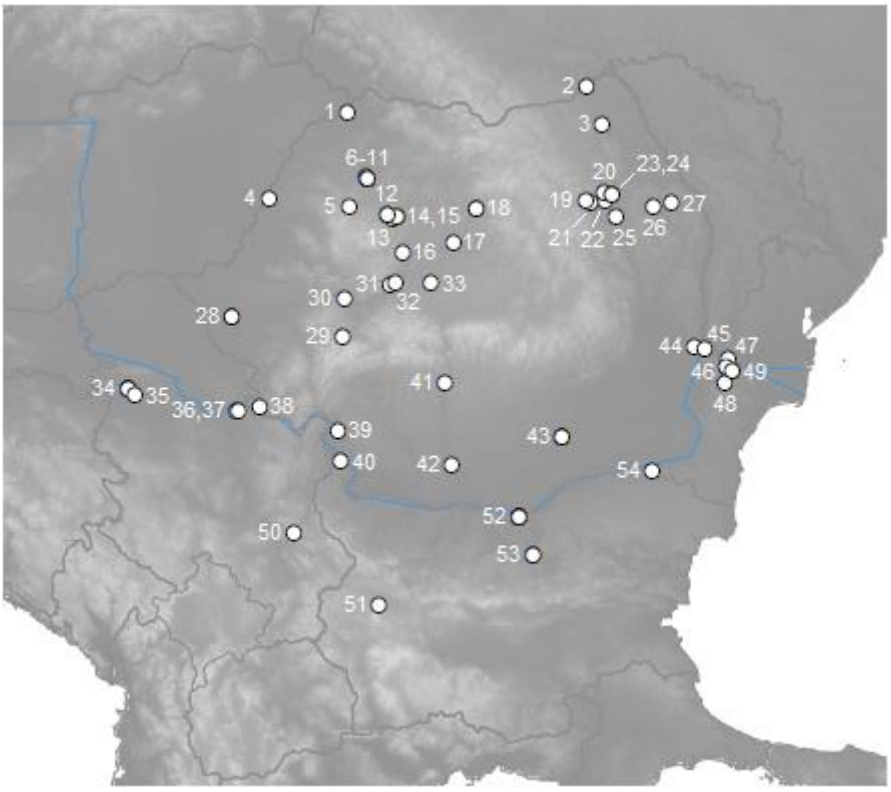


Figure 5.7: Mid-Roman sites (1: Lazuri-Lubi Tag, 2: Suharău-Ruginosu, 3: Botoșani 'Groapa lui Ichim', 4: Sânnicolau Român, 5: Bologa, 6: Porolissum-'Măgura' Moigradului, 7: Porolissum-customs building, 8: Porolissum-L7, 9: Porolissum-LM1, 10: Porolissum-OL5, 11: Porolissum-Temple Jupiter Dolichenus, 12: Suceagu, 13: Florești Polus center, 14: Cotită street, 15: Eroilor Boulevard, 16: Cicău-Sălișteș, 17: Morești, 18: Brâncovenești, 19: Piatra Neamț-Lutărie, 20: Homiceni-'Bendeasca', 21: Izvoare-Piatra Neamț, 22: Vlădiceni, 23: Poiana-Dulcești-Silișteș, 24: Poiana-Dulcești-Varnită, 25: Cârligi-Filipești, 26: Drăgești, 27: Tăcuta, 28: Timișoara 'Freidorf', 29: Ulpia Traiana Sarmisegetusa-amphitheatre, 30: Micia, 31: Apulum (Alba Iulia) 'Liber Pater temple', 32: Apulum (Alba Iulia) 'Stația de Salvare', 33: Micăsasa, 34: Lokalitet 85, 35: Vranj-Hrtkovci, 36: Viminacium-amphitheatre, 37: Viminacium-Nad Klepečkom, 38: Pojejena, 39: Ostrovul Corbului, 40: Gârla Mare, 41: Stolniceni, 42: Romula-Reșca, 43: Militari-Câmpul Boja, 44: Tirighina-Barboși, 45: Dinogetia (Garvăn), 46: Niculițel, 47: Noviodunum (Isaccea), 48: Horia, 49: Telița-Amza, 50: Niševac-Svrljig, 51: Forum Serdica, 52: Novae, 53: Nicopolis ad Istrum, 54: Ostrov-Ferma 4).

5.4.5 The late Roman period

The dataset for the late Roman period comprises 45 phases across 38 sites (Figure 5.8), and the taxonomic dataset gives a total NISP of 50,535, the second highest of the five periods.

Once again, the data are reasonably evenly distributed between the seven zones, with at least two settlements per zone. Both late Roman settlements in Oltenia and Muntenia lie within Oltenia, however, so there is a gap in data coverage in southern Romania in this period. A lack of data for late Roman northwest Romania prevents the comparison of animal exploitation practices in this region with those of the preceding and succeeding periods.

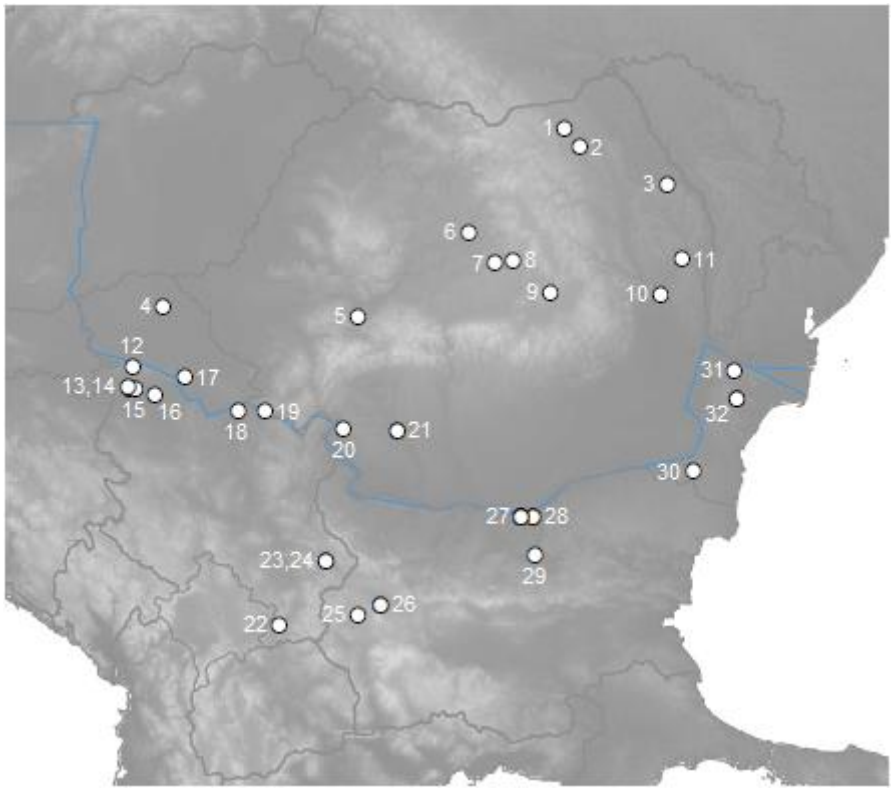


Figure 5.8: Late Roman sites (1: Todirești, 2: Podeni, 3: Nicolina, 4: Padej 'Ciglana', 5: Strei, 6: Ernei quarry, 7: Cristuru-Secuiesc-Felső-Lok, 8: Odorheiu Secuiesc-Kadicsfalvirét, 9: Olteni-Cariera de Nisip, 10: Negrilești, 11: Gara Banca 'Șapte Case', 12: Dumbovo-Beočin, 13: Lokalitet 85, 14: Mitrovačke Livade-Sremska Mitrovica, 15: Kudoš-Šašinci, 16: Prosine-Prhovo, 17: Baranda 'Ciglana', 18: Viminacium-amphitheatre, 19: Moldova Veche 'Vinograda-Vlașkicrai', 20: Hinova, 21: Răcari, 22: Davidovac-Gradište, 23: Pirot-Sarlah Bazilika, 24: Pirot-Staro Vašarište, 25: Bela Voda, 26: Exarch Joseph Street, 27: Novae, 28: Iatrus (Krivina), 29: Nicopolis ad Istrum, 30: Tropaeum (Adamclisi), 31: Telița-Amza, 32: Ibida (Slava Rusă)).

5.4.6 The early Byzantine period

The early Byzantine dataset comprises 67 phases across 42 sites (Figure 5.9). Taxonomic data derive from assemblages with a total NISP of 36,126. All zones are represented in the dataset for the early Byzantine period, though the distribution of data is skewed towards the east of the study region. The Pannonian Plain, Transylvania, Moldavia, Dobrogea, and central Bulgaria are all well-represented, facilitating comparison between these zones. Oltenia and Muntenia is similarly well-represented, though, once again, all settlements included in the dataset for this period cluster in one part of this zone. In addition to the gap in the dataset in Oltenia, few sites lie within the southwest of the study region — only one settlement in southeast Serbia and western Bulgaria is included in the early Byzantine dataset. Overall, the dataset for this period offers a good opportunity for comparison with the preceding two periods, in particular in the east and southeast of the study region.

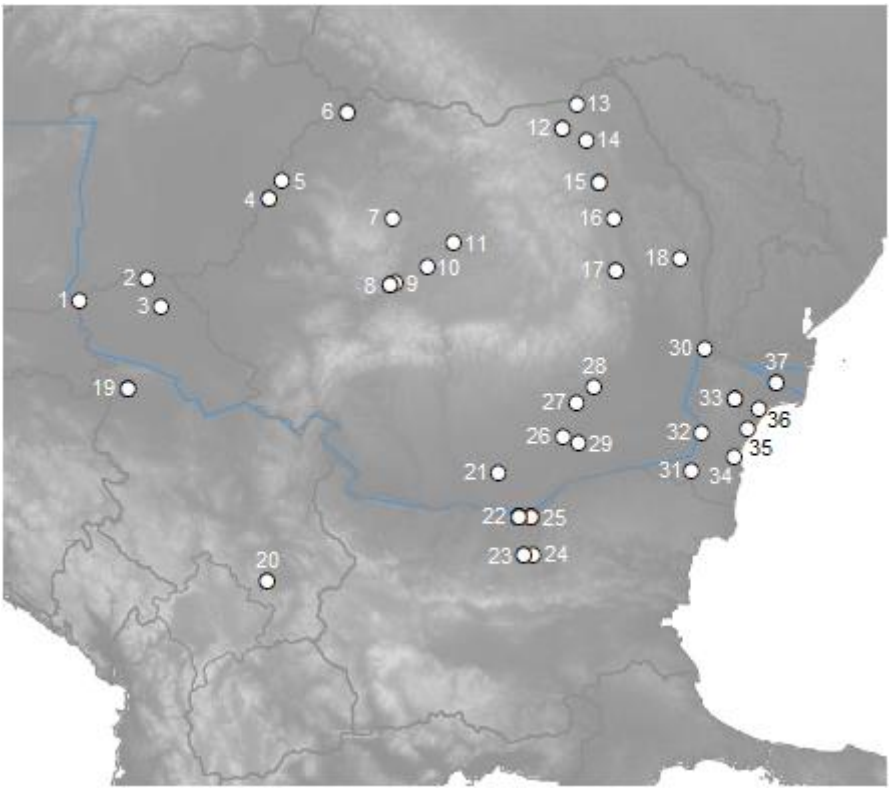


Figure 5.9: Early Byzantine sites (1: Kolut 'Baćan', 2: Horgoš 'Stub 76', 3: Padej 'Višnjevača', 4: Sânnicolau Român, 5: Biharea, 6: Lazuri-Lubi Tag, 7: Florești Polus center, 8: Alba Iulia 'Stadion', 9: Apulum (Alba Iulia), 10: Sânmiclăuș 'Răstoci', 11: Moreşti, 12: Todireşti, 13: Lozna-Străteni 'La ocoale', 14: Udești, 15: Davideni, 16: Izvoare-Bahna, 17: Ștefan cel Mare, 18: Gara Banca 'Șapte Case', 19: Lokalitet 85, 20: Caričin Grad, 21: Dulceanca II, 22: Novae, 23: Dichin, 24: Nicopolis ad Istrum, 25: Iatrus (Krivina), 26: Ciurel, 27: Belciug, 28: Cireșanu, 29: Bălăceanca 'Ecluză', 30: Dinogetia (Garvăn), 31: Tropaeum (Adamclisi), 32: Capidava, 33: Ibida (Slava Rusă), 34: Quadriburgium de la Ovidiu, 35: Histria, 36: Argamum (Jurilovca), 37: Halmyris).

5.5 Site types

5.5.1 The late Iron Age

The dataset for the late Iron Age includes sites in six categories — fortified urban, semi-urban, fortified semi-urban, rural nucleated, settlement, and fortified settlement — with 'settlement' used for sites of unknown type, and 'fortified settlement' used for fortified sites whose urban-rural status is unknown (Figure 5.10). Urban, semi-urban and rural nucleated sites of the late Iron Age are fairly well distributed across the study region. Fortified urban settlements included in the sample for this period include Adjiyska Vodenitsa (Pazardzhik

Province, Bulgaria), identified as the possible site of the Greek *emporion* (trading settlement) Pistiros (Stallibrass 2010), while fortified semi-urban settlements include the *oppidum* at Turski šanac-Bačka Palanka (South Bačka District, Serbia) (Blažić 1978), and several Geto-Dacian *davae*, located in southeast Romania. Fewer site type data were available for sites in northeast and central Romania than elsewhere in the study region in this period, making the evaluation of animal exploitation practices with regard to site type more difficult in pre-Roman Dacia than is the case elsewhere.

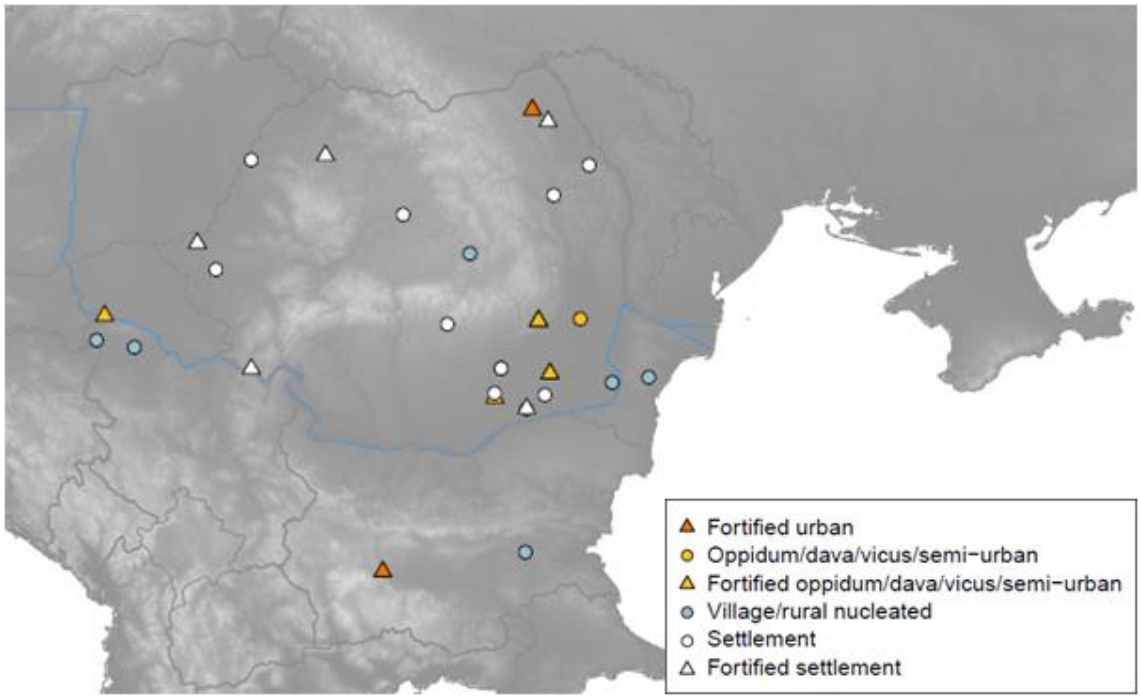


Figure 5.10: Late Iron Age site types.

5.5.2 The early Roman period

Sites of the early Roman period fall within eight site type categories — fortified urban, fortified semi-urban, rural nucleated, fortified rural nucleated, settlement, fortified settlement, military, and natural feature (Figure 5.11). Once again, the dataset includes a number of sites of unknown type, though these comprise a smaller proportion of the sample than was the case for the late Iron Age. Of all five periods, the early Roman sample includes the largest proportion of fortified sites relative to the number unfortified. Early Roman site types include a cluster of fortified semi-urban settlements centred on the southern end of the eastern Carpathians, at the centre of the Kingdom of Dacia. The military camp at Novae (Veliko Tarnovo Province, Bulgaria) (Makowiecki and Makowiecka 2002) demonstrates the

establishment of a Roman military presence along the Danube in this period. The single natural feature included in the sample is a peat bog at Lozna (Botoșani County, Romania), the site of deposition of a faunal assemblage deriving from household waste, dated to the Dacian period in this region (Haimovici and Șadurschi 1981).

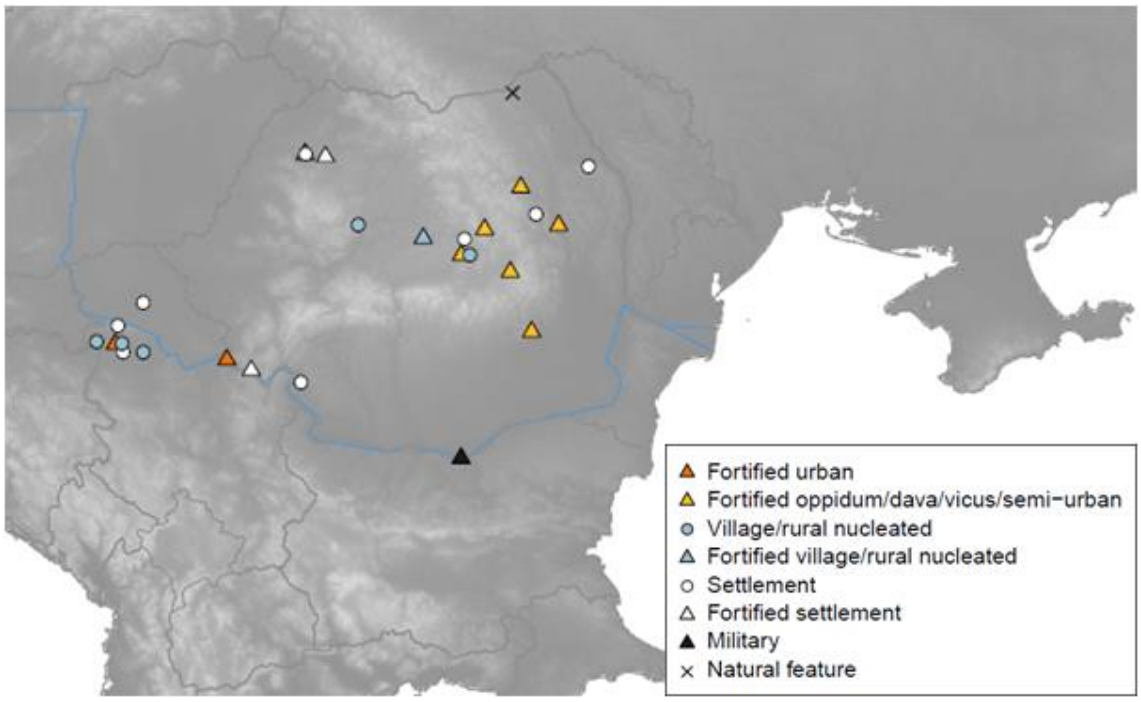


Figure 5.11: Early Roman site types.

5.5.3 The mid-Roman period

The mid-Roman dataset includes sites in nine categories — urban, fortified urban, semi-urban, rural nucleated, fortified rural nucleated, settlement, *mansio*, villa, and military — the largest number for any of the five periods (Figure 5.12). The Roman military presence is evident across the full west-east span of the Balkan provinces, and in the newly-established province of Dacia, where the development of urban settlements — at Apulum, Napoca, Porolissum and Ulpia Traiana Sarmisegetusa (Alba, Cluj, Sălaj and Hunedoara counties respectively) — can also be seen in this period (Donev 2019, 39). The distribution of both urban and military sites across the study region in the mid-Roman period provides a good opportunity to evaluate spatial variation in animal exploitation at these site types between each of the seven climatic and environmental zones, and between regions subject to varying levels of Roman control. The first *mansio* included in the study, at Niševac-Svrljig (Nišava District, Serbia) (Stojanović 2013), dates to this period, while the *villa rustica* — an

agricultural villa estate — also appears in the sample for the first time, with two examples in Dobrogea and one on the Danube at Gârla Mare (Mehedinți County, Romania) (El Susi 2001). Uniquely across the seven zones, no site type data were available for sites in Moldavia, beyond the recognition that the faunal assemblages originated from settlement sites.

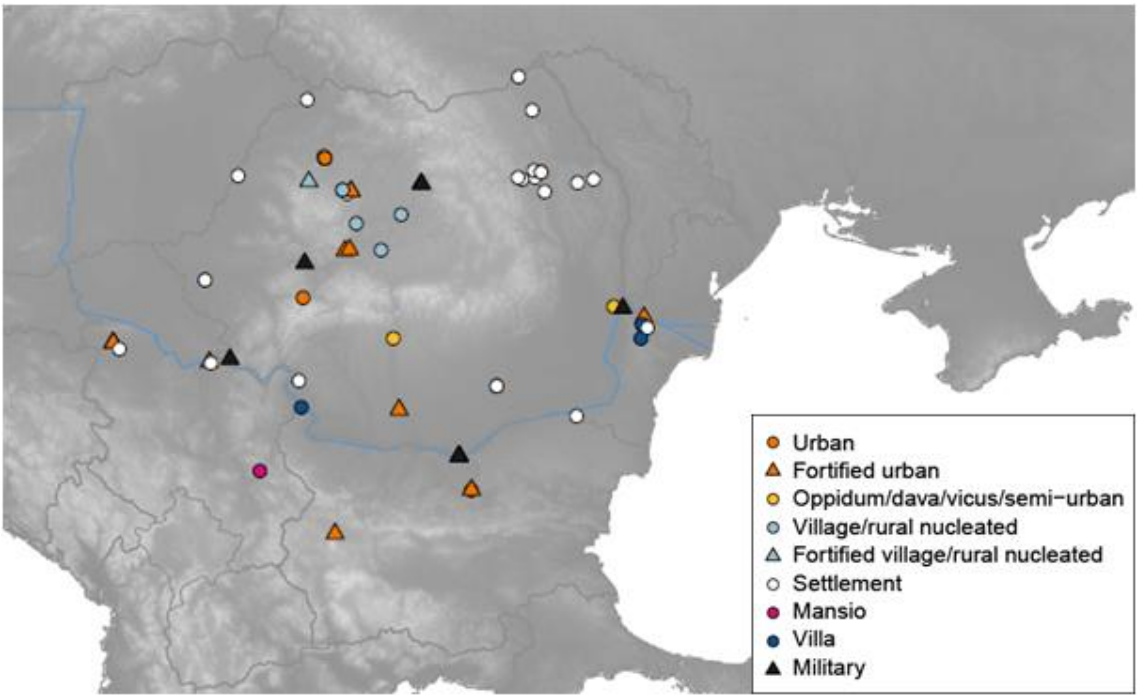


Figure 5.12: Mid-Roman site types.

5.5.4 The late Roman period

The late Roman dataset includes sites in eight categories — fortified urban, fortified semi-urban, rural nucleated, settlement, fortified settlement, *mansio*, villa, and military (Figure 5.13). Once again, no site type data were available for sites in Moldavia; in contrast to the mid-Roman period, this is also the case for Transylvania in the late Roman period. The potential to evaluate the influence of site type on animal exploitation north of the Danube is therefore limited in this period, both in post-Roman Dacia and beyond. In the Balkan provinces, a range of site types are included in the late Roman sample, including both unfortified and fortified sites, and settlements ranging from urban to rural. The wide distribution of fortified urban sites across the Balkan provinces facilitates the analysis of temporal change in animal exploitation at this site type by comparison with the preceding period. The settlement at Novae, a military camp in the preceding two periods, had developed

into a fortified urban settlement by the late Roman period (Makowiecki and Makowiecka 2002), while the nearby settlement at Iatrus (Krivina) (Ruse Province, Bulgaria), established as a castrum in the early fourth century CE at the start of the late Roman period, had already developed into a semi-urban fortified settlement by the late fourth century (Bartosiewicz and Choyke 1991).

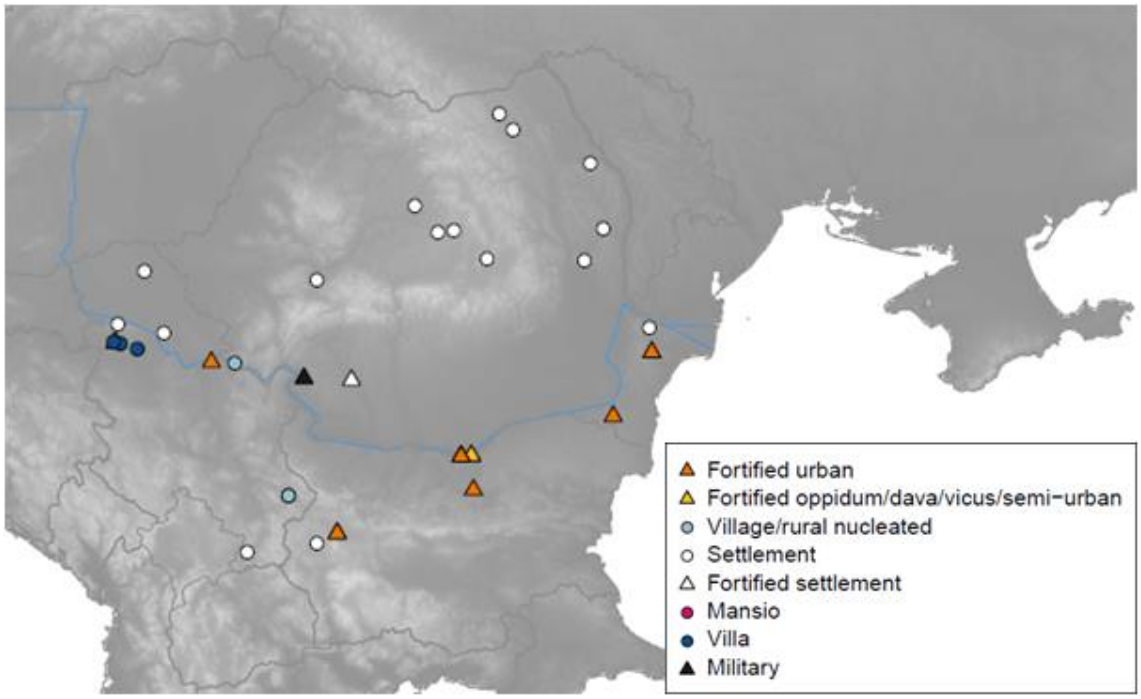


Figure 5.13: Late Roman site types.

5.5.5 The early Byzantine period

Sites of the early Byzantine period fall within six categories — fortified urban, fortified semi-urban, rural nucleated, settlement, fortified settlement, and military (Figure 5.14). As in the preceding period, fewer site type data were available to the north of the Danube than to the south. The early Byzantine dataset includes faunal assemblages from pre-feudal levels at Apulum, the only urban settlement included in the sample for Dacia in this period (Georoceanu, Lisovschi-Chelețeanu and Georoceanu 1977). In the Balkan provinces, all sites included in the early Byzantine sample are fortified urban, semi-urban or military sites. In the western Balkan provinces, the sample consists of the fortified urban settlements at Lokalitet 85 (Srem District, Serbia) (Nedeljković 2009) and Caričin Grad (Jablanica District, Serbia), the probable site of the city Justiniana Prima, founded by the Emperor Justinian I in the mid-sixth century CE (Baron *et al*. 2019). In central Bulgaria, data were available from Novae,

Iatrus (Krivina) and the fortified urban settlement at Nicopolis ad Istrum (Veliko Tarnovo province) (Beech 2007), as in the previous period, facilitating comparison between these two periods in this region. In Dobrogea, the sample includes the fortress at Capidava (Constanța County) on the Danube, and the Black Sea coast fortresses at Ovidiu (Constanța County) and Argamum (Jurilovca) (Tulcea County) (Haimovici *et al*. 2006; Stanc 2006; Haimovici 2007b).

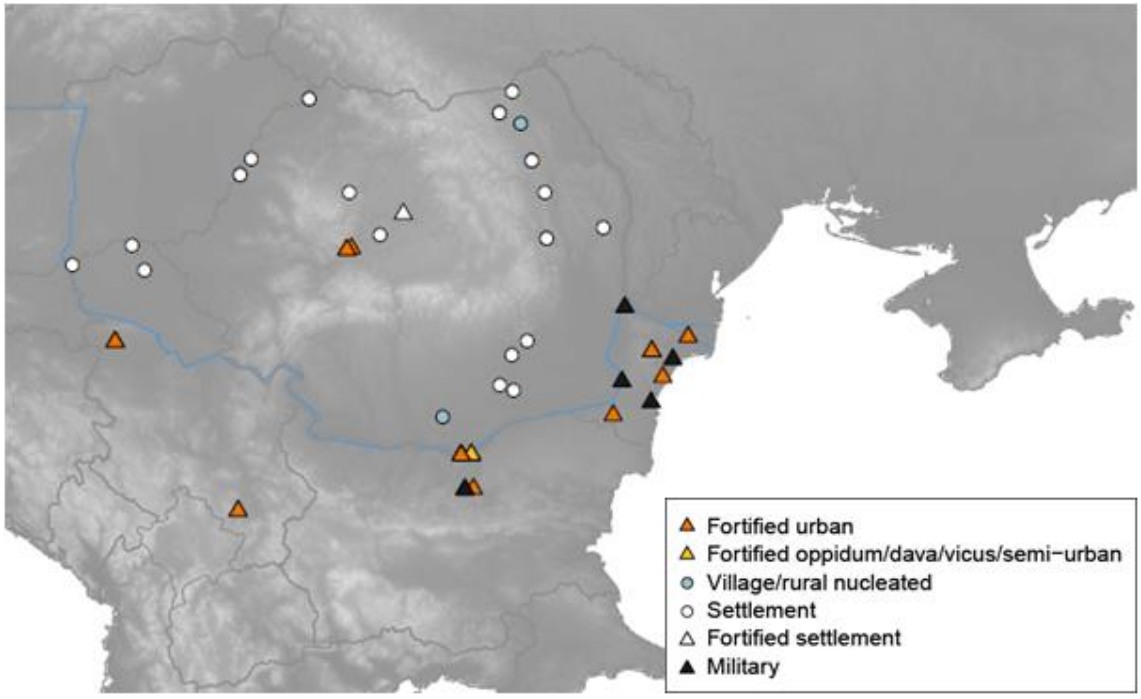


Figure 5.14: Early Byzantine site types.

5.6 Summary

The dataset consists of site, phase and zooarchaeological data from 243 phases of activity at 172 sites across modern Serbia, Bulgaria and Romania. The sites are distributed between seven zones, each with different climatic and environmental characteristics, and between three regions, each subject to a varying extent of direct Roman control. The analysis of zooarchaeological data with respect to region is key in the evaluation of spatial variation in the timing and extent of cultural and economic change through the period of Roman political influence in southeast Europe. Evidence for variation in animal exploitation practice across the three regions will allow insight into cultural and economic change on a broad regional scale. The analysis of zooarchaeological data with respect to climatic and environmental zone will allow evaluation of the extent of influence of environmental context on animal

exploitation practice in each region, enabling any intraregional patterns to be identified and understood.

6 Animal husbandry and the productive economy

6.1 Introduction

This chapter presents the analysis of livestock data, analysing livestock relative abundance, age, and morphological data in order to provide an insight into spatial and temporal variation in animal husbandry and the productive economy across the studied sites. First, the relative abundance of the three principal livestock taxa — cattle, sheep/goat and pigs — is considered with reference to site type and period, and is then analysed in relation to the varied extent of Roman administrative control across the three regions that comprise the study region — the Balkan provinces, Dacia, and the area beyond the Empire. The chapter then considers intraregional patterns in livestock relative abundance. It then analyses the relative abundance of each livestock taxon individually, discussing the results of statistical testing and considering the extent of evidence for any intraperiod change in relative abundance. Finally, the chapter discusses patterns in livestock age and morphology.

6.2 Livestock relative abundance by period

6.2.1 Introduction

This and the following two sections will evaluate spatial and temporal variation in livestock relative abundance with regard to site type. This section focuses on temporal change in livestock exploitation across the study region as a whole. Figure 6.1, A to E, shows relative abundance of cattle, sheep/goat and pigs by site type and period. On each ternary plot, cattle abundance is shown on the left axis, increasing towards the top of the graph. Sheep/goat abundance is shown on the right axis, increasing towards the lower right, while pig abundance is shown on the lower axis, increasing from right to left. Sites exhibiting specialised cattle husbandry thus plot towards the top of the graph, sites specialising in sheep/goat husbandry plot towards the lower right, while sites specialising in pig husbandry plot towards the lower left. Sites that plot towards the centre feature more balanced proportions of the three taxa, demonstrating more generalised, mixed-species husbandry practice.

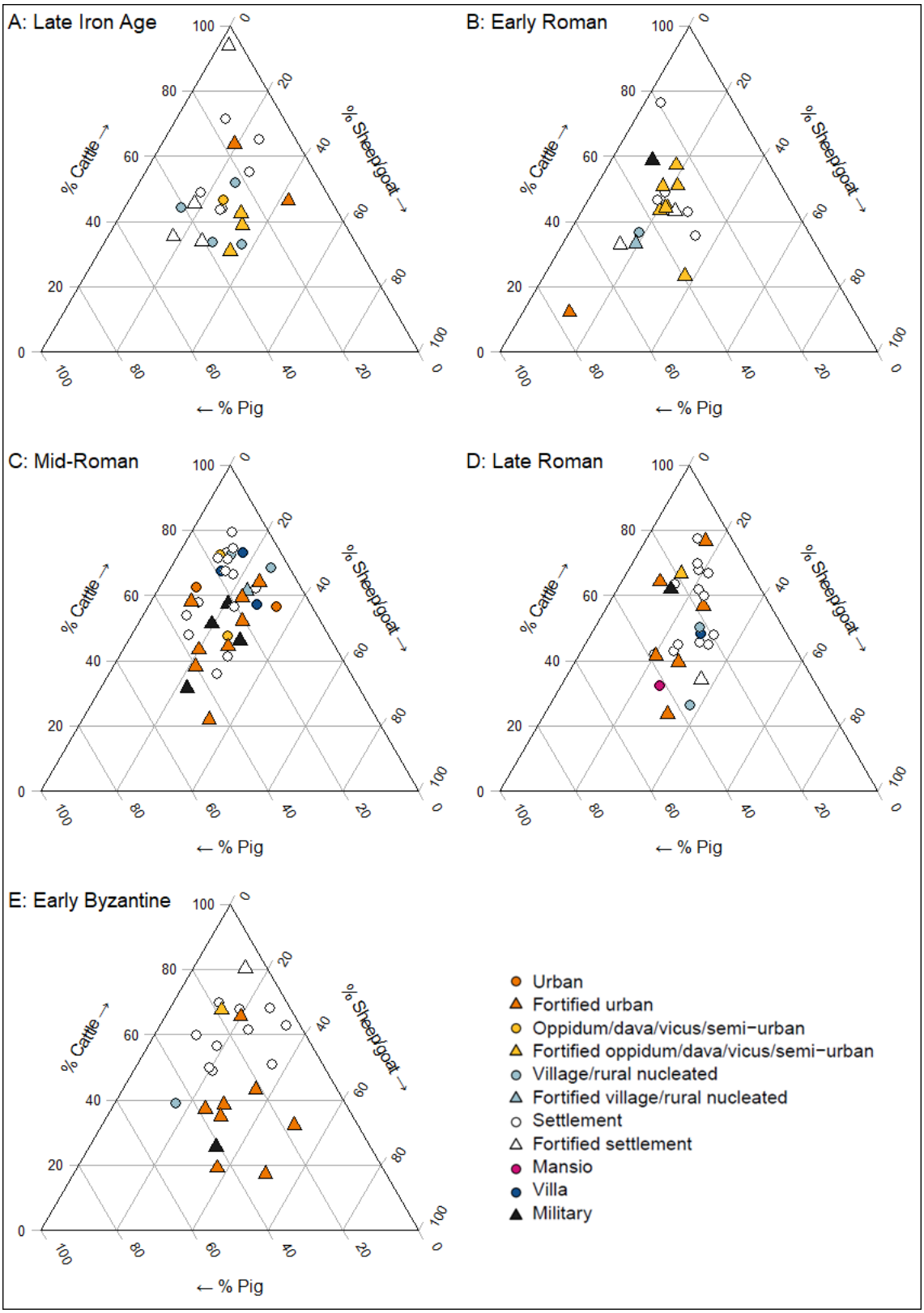


Figure 6.1: Livestock relative abundance by site type and period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine.

Due to the greater likelihood of the recovery of the bones of larger taxa than those of smaller taxa when bones are recovered by hand collection — the likely recovery method for the

majority of faunal assemblages included in this study — it is possible that larger species, such as cattle, will be overrepresented in the assemblage relative to smaller taxa, such as sheep/goat or pigs. In such cases, the apparent relative abundance of taxa may not accurately represent the true extent of reliance on each taxon at a site.

The patterns in animal husbandry observed across the majority of regions and periods considered below are such that any recovery bias is unlikely to have significantly impacted the conclusions drawn in this thesis, however. For the most part, husbandry practice in the study region ranges from fairly generalised with a slight cattle focus, to highly specialised in cattle. Where generalised husbandry with a slight cattle focus is observed, any increase in sheep/goat or pig abundance would be unlikely to swing the balance away from cattle to the extent necessary to reveal specialised husbandry practice in either of the other two taxa. In regions and periods where specialised cattle husbandry is observed, there are generally sufficient sites exhibiting highly specialised cattle husbandry that any underrepresentation of sheep/goat or pigs is unlikely to have significantly changed the overall picture. On the small number of sites with a focus on pig exploitation, an increase in sheep/goat abundance would result in more generalised husbandry — a factor to be aware of in interpretation — but an increase in pig abundance would have little to no impact on the interpretation.

Thus, while it is important to be aware of the potential influence of recovery bias in any interpretation, it is unlikely that the principal conclusions drawn in this thesis would be significantly different had full sieving been undertaken on all sites included in the study.

6.2.2 The late Iron Age

In the late Iron Age (Figure 6.1A), the majority of sites exhibit fairly generalised husbandry with a slight cattle focus. At four sites, however, cattle constitute over 60% of the livestock NISP, demonstrating the practice of specialised cattle husbandry. Two fortified urban sites in the late Iron Age sample feature very low proportions of pigs, exhibiting a clear focus on herbivore husbandry. At Stâncești (Botoșani County, Romania), cattle constitute almost two-thirds of the livestock remains, while sheep/goat and pigs make up the remainder in fairly equal proportions (Haimovici 1974). At Adjiyska Vodenitsa, the probable site of a Greek *emporion*, there is a fairly equal emphasis on cattle and sheep/goat exploitation. Since the

husbandry of both cattle and sheep/goat requires access to pasture, the high proportion of these taxa at fortified urban settlements suggests either the procurement of livestock resources from communities practising herbivore husbandry in the surrounding region, or the direct exploitation of the extramural landscape by the urban inhabitants.

At all other site types in the late Iron Age sample, there is no clear differentiation in husbandry practice. At the four semi-urban sites, including the fortified *davae* at Cârlomănești (Buzău County, Romania) and Popești (Giurgiu County, Romania), and the unfortified *dava* at Grădiștea (Brăila County, Romania), cattle abundance ranges from 31% to 46% of the livestock NISP, sheep/goat from 25% to 35%, and pig from 26% to 34% (Udrescu 1977; 1985a; Tarcan-Hrișcu *et al*. 1996). At the four rural nucleated sites, cattle abundance ranges from 33% to 52%, sheep/goat from 15% to 37%, and pig from 23% to 41%. With the exception of the rural settlement at Bordușani-Popină (Ialomița County, Romania), a tell site with a low proportion of sheep/goat remains, the semi-urban and rural nucleated sites of the late Iron Age plot within broadly the same range (Bălașescu 1997). Animal husbandry at these sites was thus fairly generalised, with a slightly greater emphasis on cattle than the other livestock taxa in most cases, but not to the extent necessary to suggest specialised husbandry practice or specialised resource exploitation.

6.2.3 The early Roman period

In the early Roman period (Figure 6.1B), the abundance of pigs increases relative to that of cattle and sheep/goat across all site types. In the Iron Gates at Divici 'Grad' (Caraș-Severin County, Romania), the only urban site with taxonomic data for this period, pigs constitute 76% of the livestock remains (El Susi 1992). High wild boar and red deer abundance at this site suggests regular access to a wooded or forested environment, which could also have provided forage for domestic pigs (Wealleans 2013, 2076) in a husbandry practice adapted to the local environment. An alternative interpretation places greater emphasis on the role of changing political context. The suitability of pigs for the relatively confined urban intramural environment allows them to be raised as a meat source in this setting when disruption beyond the settlement limits the capacity for cattle and sheep/goat husbandry. Increased disruption to established food procurement systems can be hypothesised for the early Roman period, at which time conflict between Rome and Dacia likely impacted local communities in several regions, including the Iron Gates (Oltean 2007, 54). Further alternative stimuli for a pig focus

such as demographic pressures on land or a rise in arable farming (Nieto Espinet *et al.* 2021, 29) are not indicated by other archaeological and zooarchaeological evidence in this period.

No other site of the early Roman period exhibits such a high proportion of pig remains. Livestock exploitation at the fortified semi-urban sites in the sample ranges from fairly generalised to slightly focused on cattle. The proportion of pigs at these sites ranges from 25% to 39%. This lower pig abundance could be argued to provide support for the hypothesis that the pig focus at urban Divici 'Grad' is a consequence of environmental, rather than political, context, since military disruption to herbivore husbandry might reasonably be expected to impact several site types, and thus to have affected urban and semi-urban settlements alike. Six of the seven early Roman semi-urban sites are located at the southern end of the eastern Carpathians in eastern Dacia, however, away from the principal Roman-Dacian military encounters in this period. Disruption may not therefore have been of sufficient intensity in this part of the study region to have a discernible impact on animal exploitation. Roman influence on animal husbandry at Divici 'Grad' in the form of a disruptive military presence cannot therefore be ruled out.

There are some slight differences in livestock relative abundance between the seven fortified semi-urban sites and several of the remaining sites. A slight focus on pig exploitation can be discerned at two rural sites, though not to the extent necessary to indicate specialised husbandry. At the Roman military camp at Novae, situated at the border of the Empire on the Danube, cattle are more abundant than on any other site of the period. Cattle form 59% of the livestock NISP at this site, followed by pigs at 30%, then sheep/goat at 11%. The focus on cattle and, to a lesser extent, pigs at this military camp echoes the pattern identified at other military sites elsewhere in the Empire (King 1999a). High proportions of the two taxa that typically comprise the largest portion of the military livestock assemblage could suggest a degree of Roman influence over the supply of animal products to Novae, in the procurement of preferred resources. The similarity in livestock relative abundance here and on several semi-urban Dacian sites of the period indicates, however, that the extraction of livestock resources may not in this case have required any major adjustment to existing production and provisioning systems. Roman livestock exploitation thus appears to have relied upon existing local animal husbandry practice in this early occupation period.

6.2.4 The mid-Roman period

In the mid-Roman period (Figure 6.1C), livestock relative abundance changes once again. The period sees a clear increase in reliance on cattle, which now form over 50% of the livestock on more than two-thirds of sites. This increase is largely at the expense of pigs, which constitute less than 20% of the assemblage on half of all sites. On urban sites, cattle abundance ranges from 22% to 64%, sheep/goat from 10% to 34%, and pig from 9% to 44%. This variation indicates clear differences in animal exploitation and food provisioning at different urban settlements. Urban sites fall within two groups. At Lokalitet 85, Forum Serdica (Sofia City Province, Bulgaria) (Boev 2018), and Nicopolis ad Istrum, in the Balkan provinces, and Romula-Reșca (Olt County, Romania) (El Susi 2015) in the south of Roman Dacia, no taxon comprises more than 50% of the livestock NISP, indicating generalised husbandry practice in the south of the study region. On the remaining six urban sites, located further north in Dacia and in Dobrogea, cattle constitute more than 50% of the livestock, demonstrating preferential exploitation of this species. This may result from the practise of specialised cattle husbandry by inhabitants of the urban space in the surrounding extramural area, or a focus on the import of cattle products from other sites in the region.

The clearest variance in livestock relative abundance by site type in the mid-Roman period is the difference in cattle prevalence on urban and rural sites. Sites for which urban-rural status could not be ascertained will be considered here to be non-urban and categorised as rural sites, since larger or urban settlements are more likely to have been positively identified as such during excavation. Of the 20 mid-Roman rural sites, two-thirds have a cattle NISP greater than 60%, including the villages at Suceagu (Cluj County, Romania) and Micăsasa (Sibiu County, Romania) and the villas at Niculițel and Horia (Tulcea County, Romania) (Blăjan *et al*. 1978; Haimovici 1996; Gudea *et al*. 2006). Of the 10 urban sites, in contrast, only a fifth have a cattle NISP over 60%. A very high cattle NISP on rural settlements in the northern and eastern parts of the study region indicates these productive sites as a possible source for the cattle remains deposited at urban settlements in these regions. Rural exports may have provided the bulk of the cattle products exploited at urban settlements, with these consumer sites providing a market for surplus rural produce. Alternatively, rural exports may have provided a smaller supplement to products generated by urban populations raising their own animals in the extramural space.

Livestock relative abundance on military sites of the mid-Roman period falls within the range seen on urban sites. At Micia (Hunedoara County, Romania) (Udrescu 1985b) and Pojejena (Caraș-Severin County, Romania) (El Susi 1996), two military camps in Roman Dacia, there is a focus on the exploitation of cattle, which comprises over 50% of the livestock NISP at each site. At Novae, there is a clear change from the previous period, when cattle were most abundant, as pigs now become most common. The mid-Roman relative abundance exhibited at Novae follows the military pattern, albeit with a change in the principal species exploited, suggesting a possible change in dietary preference at the site. Alternatively, high pig abundance could reflect a need to raise animals within the intramural space during a period that saw conflict in the surrounding region (Tomas 2016, 22-23) — events that may have disrupted supply systems to the military camp. The similar pig abundance at the nearby urban settlement at Nicopolis ad Istrum provides support for this latter interpretation. Overall, while considerable site-specific variation is evident within certain site types in the mid-Roman period, cattle are most abundant on average on all site types, indicating an organised system of production and supply of cattle products to consumer sites.

6.2.5 The late Roman period

There is little overall change in livestock relative abundance in the late Roman period (Figure 6.1D). Across all site types combined, cattle abundance ranges from 24% to 77%, sheep/goat from 10% to 37%, and pig from 7% to 44%, representing a change of only two or three percentage points for each taxon relative to the previous period. There is a slight change in the average abundance of each taxon, as cattle are present in slightly lower numbers than in the mid-Roman period, and both sheep/goat and pigs become slightly more abundant. Once again, the magnitude of this change is fairly small. Within each site type, however, a somewhat greater degree of change can be discerned.

On urban sites, there is greater variation in cattle abundance than in the previous period, due largely to the high proportion of cattle at Exarch Joseph Street (Sofia City Province, Bulgaria) (Boev 2019). Despite this increase in variance, there is virtually no change in the average abundance of each taxon on urban sites of the late Roman period. In the mid-Roman period, cattle, sheep/goat and pigs formed on average 50%, 23% and 27%, respectively, of the urban assemblage; in the late Roman period, they comprise 50%, 22% and 28%. While mid-Roman urban sites were distributed across the study region, all urban sites in the late

Roman sample lie within the Balkan provinces. Comparison of urban sites in this region between the two periods reveals a slight increase in average cattle abundance and variance, the latter suggesting the emergence of a degree of regionalisation in urban exploitation and consumption practices in the south. No late Roman urban sites in the sample lie within post-Roman Dacia, so it is not possible to ascertain the extent of change in livestock exploitation on this site type in this region.

A greater degree of change in livestock relative abundance is evident on rural sites of the late Roman period. Of the 17 rural sites, only a third have a cattle NISP greater than 60% — half the proportion of the previous period. More than half of all rural sites have a cattle NISP below 50%. Relative reliance on both sheep/goat and pigs increases, these taxa each now constituting over 20% of the livestock on the majority of sites. Overall, animal husbandry becomes slightly less specialised on rural sites in the late Roman period, with a decline in focus on cattle. This change may in part result from increasing disruption in the study region — a move towards the husbandry of greater numbers of sheep/goat and pigs in preference to cattle would provide greater flexibility with regard to space availability and environment in times of uncertainty. The lack of change in livestock relative abundance on urban sites implies that the urban population were nevertheless able to extract animal resources from the surrounding region in similar ratios to the mid-Roman period, however. Changing livestock abundance on rural sites may thus indicate an enforced change in consumption practice on these sites, allowing a supply of cattle products to continue to reach urban sites.

The late Roman dataset includes the first *mansio* in the sample, at Pirot-Staro Vašarište (Pirot District, Serbia) (Vuković-Bogdanović, S and Pejić 2016). Pigs are the most abundant taxon at this fourth century site, comprising 42% of the livestock, followed by cattle at 32% and sheep/goat at 26%. Their high reproduction rate and relatively low space requirement would have made the exploitation of pigs a fairly economical practice on any site type, and may have made this species particularly suitable as a food source at the *mansio*. The fairly generalised consumption practice at Pirot-Staro Vašarište could indicate, however, that inhabitants of this site may have had little influence over resource acquisition, lacking the ability to obtain any particular resource in preference to another. It should however be noted that the deposition of fairly equal proportions of livestock taxa could be interpreted as evidence of a varied diet, indicating a high degree of choice in food provisioning.

At the single military site in the late Roman sample, the rural castrum at Hinova (Mehedinți County, Romania) in the Iron Gates, livestock relative abundance falls within the range exhibited on urban sites of the period (El Susi 1993). A particularly high proportion of large game was identified at this military site, these taxa forming 47% of the assemblage, and the suitability of the environmental context for large game exploitation is discussed below as a possible stimulus for this pattern. Similar livestock relative abundance at Hinova and at the nearby urban site Viminacium-amphitheatre (Braničevo District, Serbia), located upstream on the Danube (Vuković-Bogdanović 2018), demonstrates that the inhabitants of the castrum at Hinova were able to extract resources in similar proportions to their city-dwelling counterparts at Viminacium, with a particular focus on cattle products. High proportions of the taxon typically favoured by military communities (King 1999a) could indicate a degree of influence over animal resource acquisition at Hinova, providing support for the hypothesis that the high proportion of large game at the site is the result of a favourable environmental setting, and not a consequence of the enforced exploitation of more marginal food sources.

The exploitation of livestock changes little across the sample of sites as a whole from the mid- to late Roman period, both in terms of the average abundance of each taxon, and in the overall variance across all site types combined. The organised production and supply system indicated by the mid-Roman dataset thus appears to have remained in operation into the late Roman period, and urban sites in the Balkan provinces continued to consume high proportions of cattle products. Site-type-specific change is demonstrated by a decline in the post-mortem exploitation of cattle on rural sites, however. While there is thus little change to urban supply and consumption patterns, the increased disruption of the late Roman period may nevertheless have impacted animal husbandry at productive rural sites, influencing a change in livestock relative abundance at this site type. The apparent lack of disruption to urban provisioning indicates that the challenges to Roman political control in this period did not result in a major decline in Roman influence over the animal economy. The absence of urban sites from the post-Roman Dacian sample prevents analysis of the impact on Dacian urban provisioning of the loss of this region as a Roman province, however.

6.2.6 The early Byzantine period

In the early Byzantine period (Figure 6.1E), there is a clear increase in variation in livestock relative abundance. Cattle abundance ranges from 18% to 80% in this period, sheep/goat

from 11% to 51%, and pig from 4% to 45%, indicating more regionalised and localised animal exploitation practice, and less homogeneity across the study region than was evident in the previous two periods. In addition to an increase in variance in the early Byzantine period, average sheep/goat abundance increases slightly, with a corresponding slight decrease in cattle. The greater variation in livestock relative abundance across the sample as a whole is accompanied by the re-emergence of greater differences between site types in this period, showing greater parallels with the mid-Roman than the late Roman period.

On urban sites, livestock exploitation is for the most part fairly generalised, with no taxon forming more than 45% of the livestock on five of the eight sites. On the remaining three urban sites, however, the data indicate fairly specialised exploitation. At Histria (Constanța County, Romania), a fortified urban settlement located on the Black Sea coast in Dobrogea (Haimovici 2007a), cattle constitute 66% of the livestock, demonstrating a clear focus on this taxon at the site. On two further fortified urban sites, there is evidence for a slight focus on sheep/goat. At both Caričin Grad, in the Balkan provinces, and Apulum, in post-Roman Dacia, sheep/goat form 51% of the livestock. Pigs are the second most exploited taxon at the former site, while cattle take second place at the latter. The clear decline in urban cattle exploitation in the early Byzantine period indicates a change in the organised system of urban provisioning evident in the previous two periods. The range of exploitation practices evident on urban sites, from generalised in some cases, to specialised on various taxa in others, suggests increasingly regionalised approaches to resource acquisition, echoing the pattern identified for the period as a whole.

There are clear differences in livestock relative abundance on urban and rural sites in the early Byzantine period. In contrast to the fairly generalised exploitation evident on most urban sites, rural sites exhibit a clear focus on cattle. Of the twelve rural sites, three-quarters have a cattle NISP over 50%, and half have a cattle NISP over 60%. The distribution of urban and rural sites on the early Byzantine ternary plot shows a similar pattern to that observed for the mid-Roman period, albeit with a lower overall abundance of cattle. In both cases, the majority of rural sites plot above the group of urban sites, demonstrating more specialised livestock exploitation on rural sites in these two periods. The lower overall proportion of cattle in the early Byzantine period suggests, however, that although rural cattle exploitation may have to a certain extent recovered by this period, following its decline in the late Roman period, urban provisioning, which appeared to change very little in the late Roman period,

had by the early Byzantine period begun to undergo more substantial change. While increased rural cattle exploitation indicates greater stability, the urban dataset suggests that this was accompanied by a decrease in Roman influence over the productive economy across the study region.

At Dichin, in the Balkan provinces, the only military site in the early Byzantine sample for which taxonomic quantification data were available, pigs are the most common taxon, comprising 41% of the livestock, followed by sheep/goat at 33%, and cattle at 26% (Johnstone and Hammon 2019). The data suggest fairly generalised exploitation at the site, indicating either a wide range of dietary preferences, or the inability to extract favoured resources from the surrounding region in particularly high proportions. The nearby urban settlement at Nicopolis ad Istrum exhibits similar proportions of each taxon, suggesting that the latter hypothesis may be most likely. The similar livestock relative abundance at military sites and at urban settlements in their vicinity in the mid-Roman and early Byzantine periods indicates that resource availability at military sites was influenced by the same forces that determined resource availability at urban settlements in these periods.

6.2.7 Summary

Overall, the analysis of livestock exploitation by site type reveals several temporal trends. The late Iron Age to early Roman transition sees an increase in pigs and a decrease in herbivore husbandry, and the emergence of military resource acquisition that suggests the utilisation of existing production systems. The early Roman occupation thus appears to have stimulated little change in animal husbandry practice and livestock exploitation. In the mid-Roman period, the livestock data reveal the emergence of an organised system of cattle husbandry and exploitation, indicating increased Roman control over the animal economy. Clear site-type-based trends are evident, as rural production and consumption become highly specialised, providing a likely source for the large numbers of cattle remains deposited at many urban sites.

The late Roman period sees a slight decrease in cattle abundance, in particular at rural sites, though this taxon remains highly abundant on several urban sites. The data suggest little change in the extent of urban production and provisioning, though may indicate a change in

the nature of rural production systems and in the organisation of supply networks, with urban consumers prioritised. The degree of disruption to the functioning of economic systems indicated by the decline in rural cattle consumption may have been stimulated in part by political changes following the loss of Dacia as a Roman province. The lack of change on urban sites suggests, however, that either disruption was of limited extent, or food production and procurement systems were sufficiently robust to buffer variability in supply.

The transition to the early Byzantine period sees greater regionalisation in livestock exploitation, but also a return to the rural cattle focus of the mid-Roman period, suggesting increased stability. The emergence of more varied, regionalised livestock exploitation practice in the context of increased stability suggests the influence of social or cultural change, and a change in food and resource preferences, rather than a response to the disruption, or collapse, of provisioning systems. While the cattle-based economy and urban provisioning developed in the mid-Roman period may no longer have functioned to the extent that was once the case, specialised husbandry was practised once again, and communities responded in a variety of ways to the political changes that characterised the early Byzantine period.

6.3 Livestock relative abundance by period and region

6.3.1 Introduction

Having considered evidence for temporal change in the practice of animal husbandry and the exploitation of livestock resources across southeast Europe as a whole, the extent of spatial variation and the role played by varying political, social, cultural and economic contexts across the study region will now be evaluated. This section will consider spatial and temporal variation in livestock exploitation by region, across the Balkan provinces, Dacia, and the parts of the study region beyond the area of long-term Roman occupation.

6.3.2 The late Iron Age

Figure 6.2, A to C, shows the relative abundance of cattle, sheep/goat and pigs by site type, and across the three regions, in the late Iron Age. Prior to the earliest Roman occupation, livestock exploitation is fairly generalised across much of the study region. Only in the area

beyond the Empire is the abundance of any taxon high enough to indicate specialised exploitation — there is a clear focus on cattle on a third of all late Iron Age sites in this region. There is some evidence for a degree of differentiation by site type in the late Iron Age, though sample size for the Balkan provinces and Dacia is too small to draw any clear conclusions. Beyond the Empire, rural sites exhibit a higher proportion of cattle than semi-urban sites, but a slightly lower proportion of sheep/goat. Across the study region as a whole, pig abundance is somewhat lower at urban sites than at other site types. Overall, there is little evidence for specialisation anywhere other than the far northeast of the study region in this period.

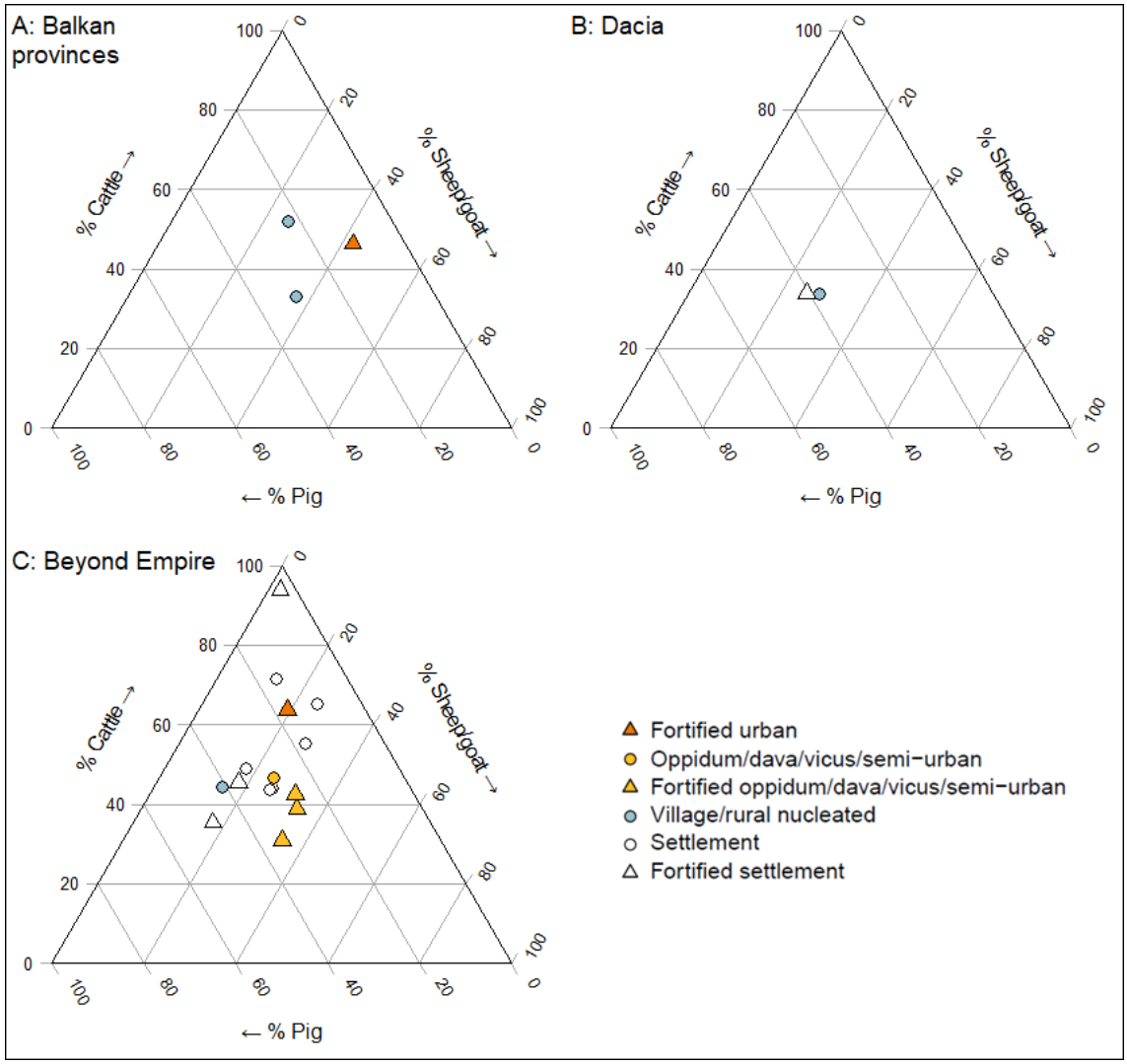


Figure 6.2: Late Iron Age livestock relative abundance by site type and region. A: Balkan provinces; B: Dacia; C: beyond the area of long-term Roman occupation.

6.3.3 The early Roman period

In the early Roman period (Figure 6.3, A to C), the data indicate a possible small increase in the abundance of cattle and pigs in the Balkan provinces, though the sample size is too small to draw clear conclusions for this region. A particularly high proportion of cattle at the military camp at Novae indicates specialised exploitation at this site, however, in contrast to the more generalised husbandry observed at rural sites in the Balkan provinces. It was suggested that the similar livestock relative abundance at Novae and at several semi-urban sites north of the Danube in Dacia indicated reliance on existing production and distribution systems by the inhabitants of the camp, perhaps suggesting little Roman control over the range of livestock resources received at the site. If, however, Roman military sites along the Danube were provisioned solely or principally from the regions already under Roman control to the south of the river, the higher proportion of cattle at Novae than at rural sites in the Balkan provinces could indicate the preferential extraction of favoured resources by the military, and thus a greater degree of Roman interaction with the local economy. The lack of taxonomic data from sites in close proximity to Novae, either to the north or south of the Danube, prevents analysis of the site within its immediate context in this period, however, making any conclusions drawn fairly tentative.

The increase in pigs observed for the early Roman period as a whole is most apparent in pre-Roman Dacia, where a focus on this species is seen on four sites — three rural and one urban. It was noted that political upheaval in this period may have provided a stimulus for the relatively high proportions of pigs seen in Dacia. Analysis of the taxonomic data by region reveals that it is only in Dacia that the abundance of pigs reaches the level required to infer specialised exploitation. The concurrence of focused Roman military activity (Oltean 2007, 54) and high pig abundance in Dacia in this period, and the lack of a similar level of pig exploitation elsewhere, provides support for the hypothesis that increasing disruption due to Roman activity in Dacia did indeed necessitate an increased reliance on pigs for meat at certain Dacian sites. Beyond the Empire, there is little change in livestock relative abundance in this period, with cattle abundance remaining slightly higher at rural than at semi-urban sites, though the sample size for this region is fairly small.

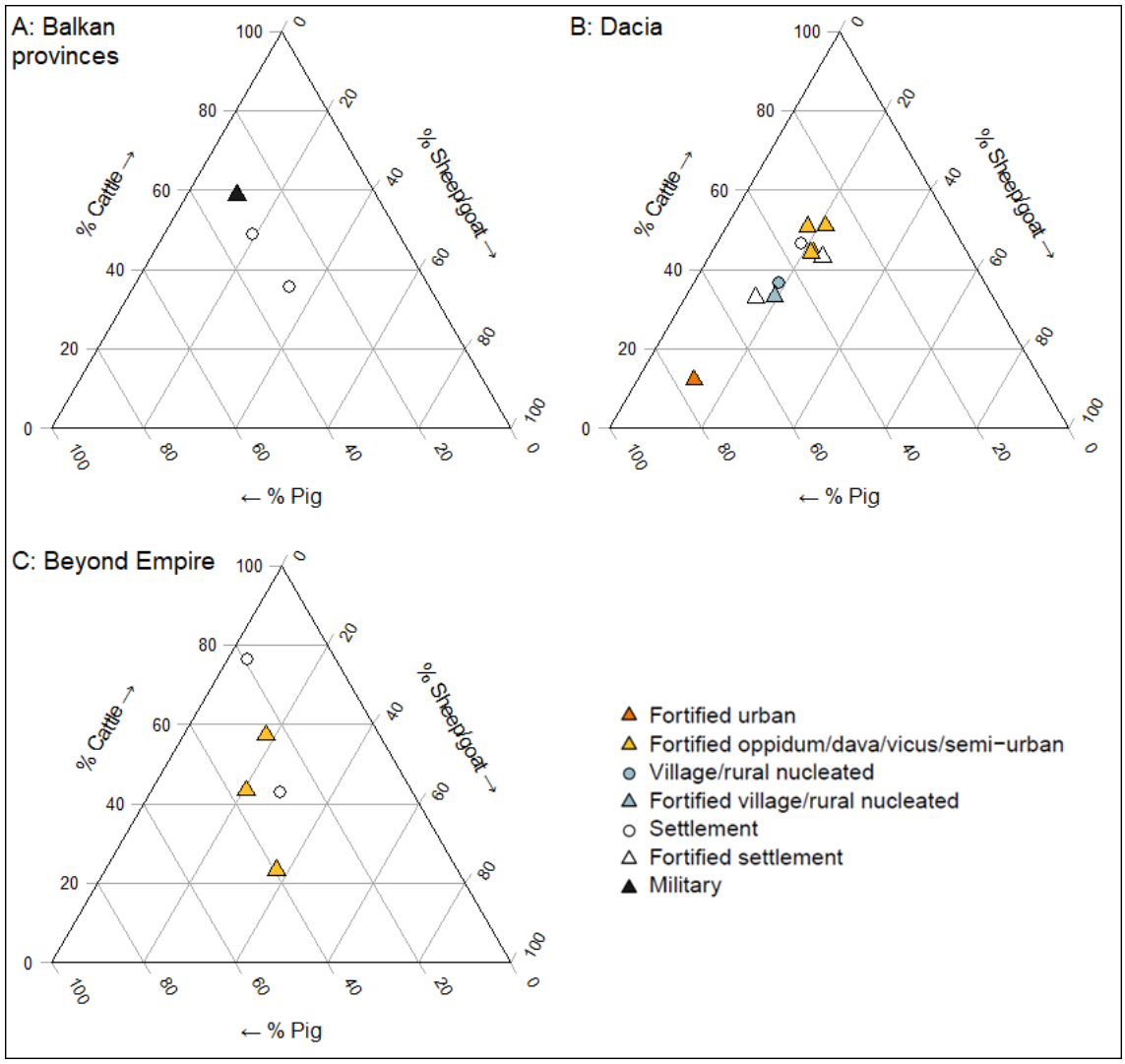


Figure 6.3: Early Roman livestock relative abundance by site type and region. A: Balkan provinces; B: Dacia; C: beyond the area of long-term Roman occupation.

6.3.4 The mid-Roman period

In the mid-Roman period (Figure 6.4, A to C), cattle become the most abundant livestock taxon in all three regions. In the Balkan provinces, more than half of all sites have a cattle NISP greater than 50%, indicating widespread specialised exploitation. Cattle abundance only falls below 40% at three sites in the Balkan provinces, all located in the far south of the study region — the possible influence of climate and environment on animal husbandry in the southern Balkan provinces is discussed below. The proportion of sites exhibiting specialised cattle exploitation is higher still in Dacia, where more than three-quarters of all sites have a cattle NISP greater than 50%. The similar patterns of livestock exploitation in these two regions indicate that the establishment of a cattle-focused economy was simultaneous in the region of longer-term Roman occupation to the south of the Danube and in newly-established

Roman Dacia. It has been argued that Roman mechanisms for territorial expansion and the establishment of control in newly-acquired regions were well-developed by the second century CE (Oltean 2007, 1). The high cattle abundance at Dacian sites indicates the early appearance of cattle-focused husbandry here, supporting the argument that the establishment of Roman control — in this case over the productive economy — was relatively rapid in the new province.

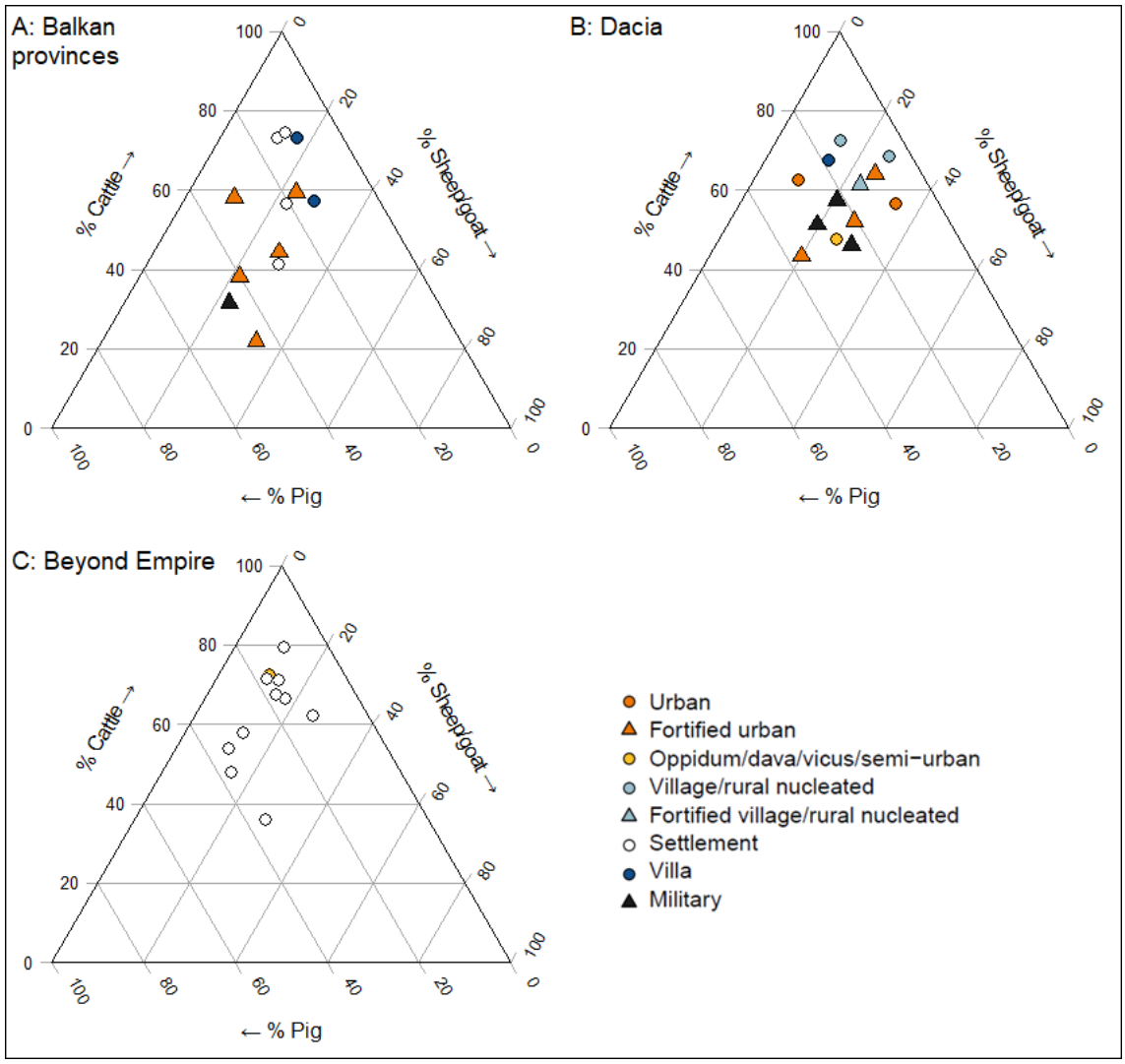


Figure 6.4: Mid-Roman livestock relative abundance by site type and region. A: Balkan provinces; B: Dacia; C: beyond the area of long-term Roman occupation.

There is some evidence to suggest that livestock exploitation varied according to site type in the mid-Roman period. In the Balkan provinces, cattle abundance is higher and pig abundance lower at rural sites than at urban and military sites. All six rural sites in the sample are located in the Pannonian Plain and Dobrogea, however, while the three sites with the lowest cattle abundance — two urban and one military — are located in the far south of the

study region. Apparent variation in livestock relative abundance by site type may therefore have resulted at least in part from the varied climatic and environmental contexts of the sites. In Dacia, cattle abundance is also higher on average at rural sites than at either urban or military sites. In this region, sites of each type are widely distributed between several climatic and environmental zones, indicating that variance in cattle abundance is indeed the result of varied exploitation on different site types.

Little information regarding site type was available for the area beyond the Empire in this period. Overall, however, sites in this region exhibit a continued focus on cattle. While this focus may simply represent the continued implementation of long-standing practices in the northeast of the study region, an increase in the proportion of sites with a cattle NISP greater than 50% could indicate the influence of the cattle-focused Roman economic system beyond the Empire. Whether as a source of cattle products for the Empire, or as a consumer of resources obtained from the neighbouring Roman provinces — or both — the area beyond the Empire sees an increase in cattle abundance at the height of the Roman occupation, raising the possibility of the influence of cross-border political, social or economic links on animal exploitation in this period. The high incidence of specialised husbandry in provinces across Europe during the Roman occupation indicates that the mid-Roman cattle focus in the provinces of southeast Europe is arguably more likely a consequence of the integration of southeast Europe into the Roman economic network than a result of the spread into occupied regions of practices originating beyond the Empire. This is supported by the lack of evidence for the spread of specialised cattle husbandry into occupied regions in earlier periods, despite high cattle abundance beyond the Empire throughout the study period.

6.3.5 The late Roman period

In the late Roman period (Figure 6.5, A to C), cattle abundance appears to remain high in the area beyond the Empire, though the sample size is fairly small. Cattle abundance also remains high on certain sites in the Balkan provinces, but is lower in Dacia than was the case during its occupation. In the Balkan provinces, the average abundance of each livestock taxon remains similar to the previous period. There is a slight decline in cattle abundance, but a slight increase in both sheep/goat and pigs. Though cattle abundance changes only slightly overall in the Balkan provinces, there is a clear change in the exploitation of this taxon by site type. On rural sites, average cattle abundance falls from 63% in the mid-Roman period to

46% in the late Roman period, while on urban sites, average cattle abundance increases from 44% to 50%. A decline in the deposition of cattle at rural sites, but not at urban settlements, was argued to result from the continued extraction of cattle products by urban communities from a decreasing supply.

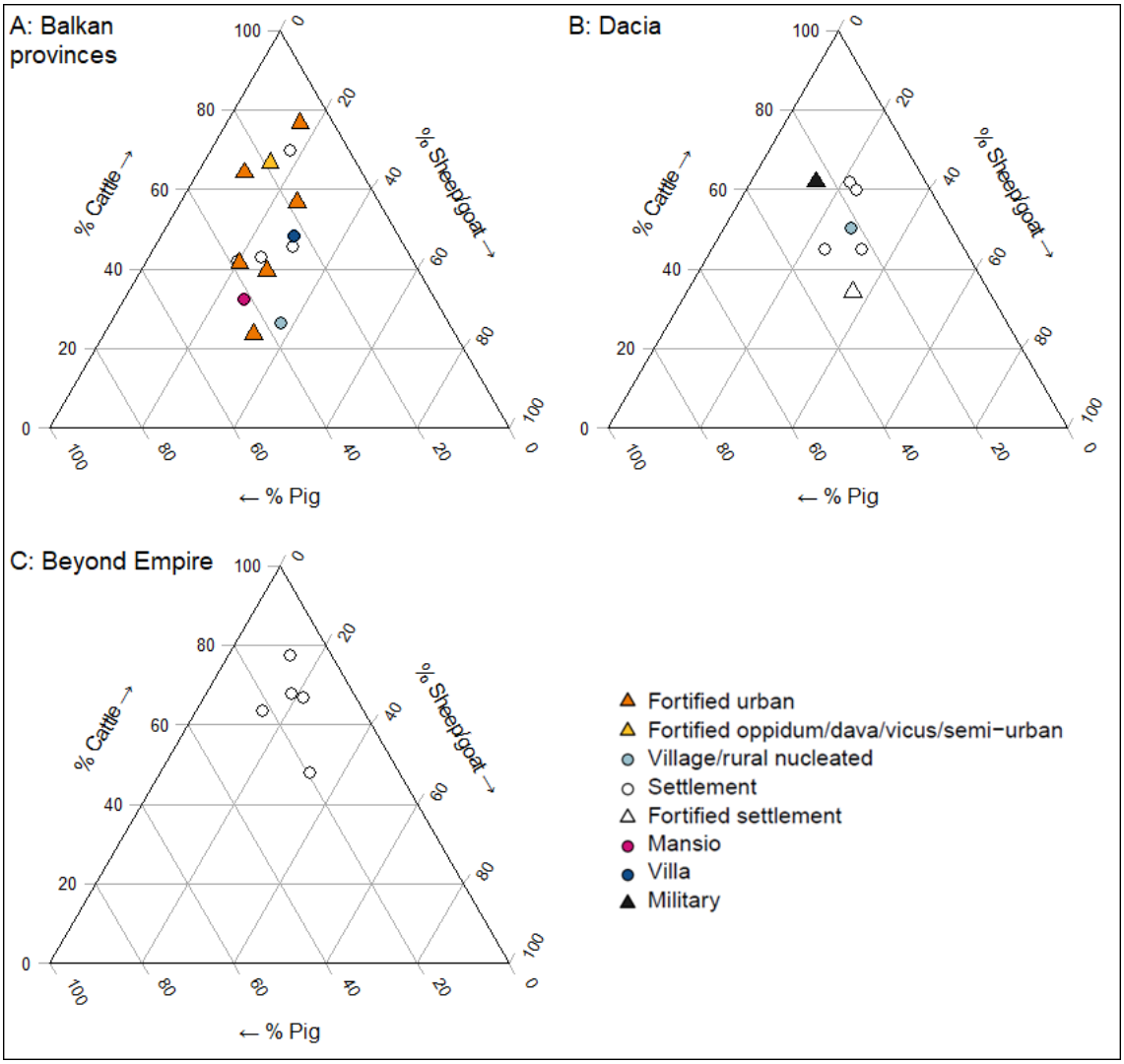


Figure 6.5: Late Roman livestock relative abundance by site type and region. A: Balkan provinces; B: Dacia; C: beyond the area of long-term Roman occupation.

In post-Roman Dacia, while average cattle abundance falls from 67% in the mid-Roman period to 49% in the late Roman period, there is a continued cattle focus overall. High cattle abundance during the Roman occupation of Dacia indicates that the climatic and environmental suitability of the region for cattle husbandry was fully exploited by the Roman occupiers; somewhat lower cattle abundance following the withdrawal of Rome suggests that the full integration of Dacian settlements into the Roman economic system may not have persisted beyond the end of the occupation. The small decline in cattle abundance in late

Roman Dacia could suggest that once the demand for cattle products by Roman urban communities within Dacia disappeared, a very high cattle focus in this area would no longer need to be maintained, with declining access to Roman markets reducing the economic viability of the practice. Nevertheless, increased urban cattle abundance in the late Roman Balkan provinces, but decreased rural cattle abundance in the region, could suggest that urban communities of the Balkan provinces continued to be supplied to a certain extent from Dacian sites. Trade and exchange along the Danube border were only restricted from the late fourth century (Heather and Matthews 1991, 17, 19), so a degree of economic interaction may have been maintained for some time in the late Roman period.

6.3.6 The early Byzantine period

In the early Byzantine period (Figure 6.6, A to C), there is little change in animal husbandry in the area beyond the Empire. Cattle abundance decreases slightly, though this taxon continues to constitute more than 50% of the livestock on over three-quarters of sites, indicating continued specialised exploitation. In the Balkan provinces, average cattle abundance falls to 39%, a decrease of nine percentage points relative to the late Roman period. This change is accompanied by an increase in both sheep/goat and pigs, with these two taxa each forming 31% of the livestock NISP in the early Byzantine period. While the composition of the sample for the Balkan provinces precludes the analysis of early Byzantine rural exploitation, the data reveal a clear decline in cattle abundance at urban settlements. The production and provisioning system established in the mid-Roman period, and maintained through the late Roman period, thus appears by the early Byzantine period to have ceased to function to the extent necessary to maintain a supply of cattle products in the quantities required for specialised exploitation to all but a few consumer sites.

The increased variation in livestock exploitation observed for the early Byzantine period as a whole is most apparent in Dacia, though the sample size is too small to draw clear conclusions for the region. Cattle abundance is particularly high at two rural sites — Sânmiclăuș 'Răstoci' (Alba County, Romania), where cattle comprise 63% of the livestock, and Morești (Mureș County, Romania), where cattle comprise 80% of the livestock (Georoceanu *et al*. 1977; Haimovici 1979; National Archaeological Record of Romania (RAN) 2022). At both sites, pigs form less than 6% of the assemblage. The data suggest differences in livestock exploitation at rural and urban sites in early Byzantine Dacia. While

at rural sites cattle form on average 64% of the livestock NISP, followed by sheep/goat at 22%, at the single urban site in the sample sheep/goat are most abundant at 51%, followed by cattle at 32%. The apparent considerable variation in Dacia in the early Byzantine period indicates increasingly localised and regionalised husbandry and exploitation practices, and the absence of an overarching economic system across the region as a whole. While a continued late Roman cattle focus suggests that Roman economic influence in Dacia may only have declined slightly in the immediate post-occupation period, early Byzantine patterns indicate that the changes in livestock exploitation implemented under Roman rule no longer played any meaningful role by the fifth century.

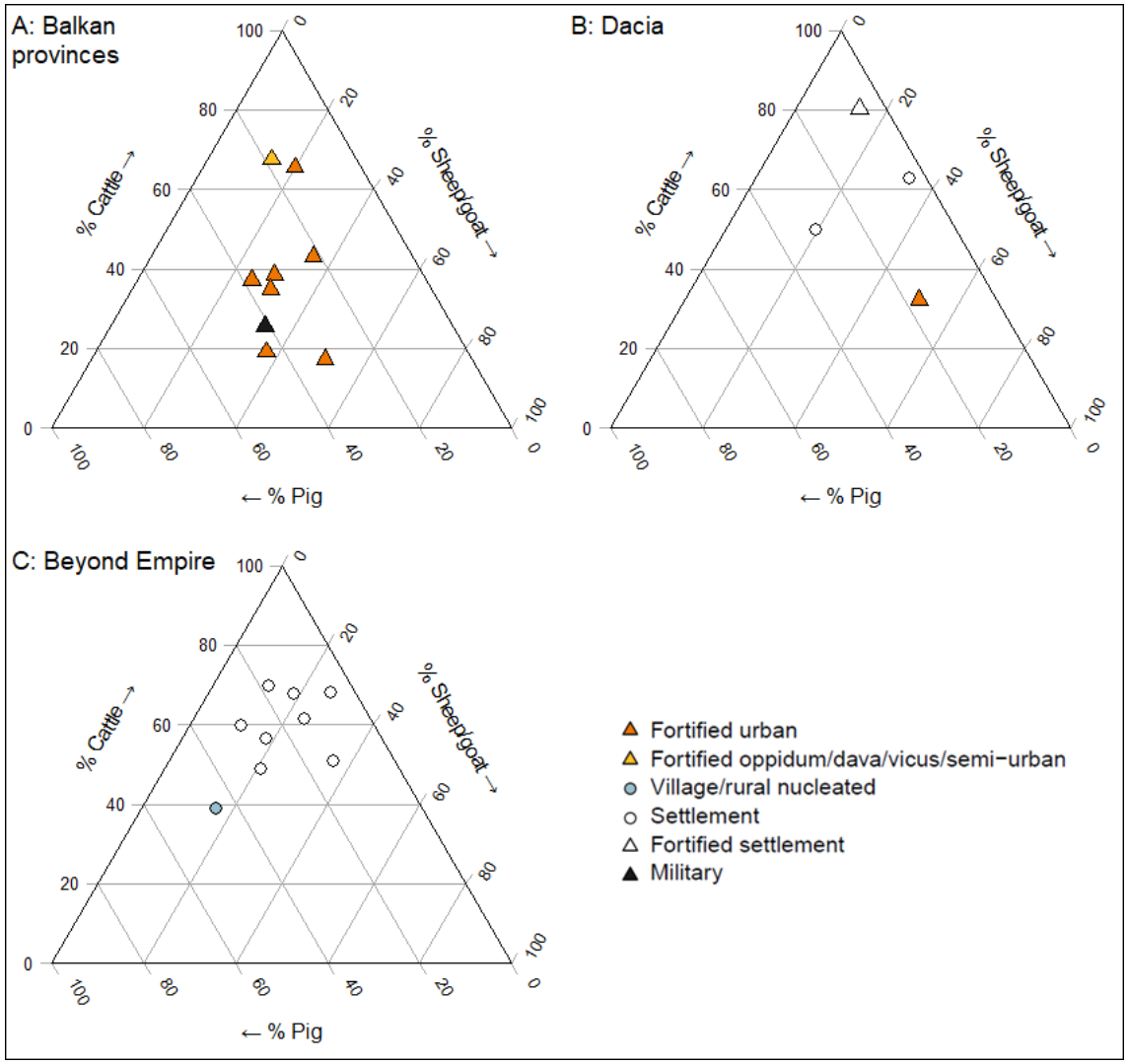


Figure 6.6: Early Byzantine livestock relative abundance by site type and region. A: Balkan provinces; B: Dacia; C: beyond the area of long-term Roman occupation.

6.3.7 Summary

Figure 6.7, A to C, shows relative abundance of cattle, sheep/goat and pigs by period and region. In the Balkan provinces, the earliest Roman occupation results in relatively little change, with fairly generalised late Iron Age husbandry continuing into the early Roman period. By the mid-Roman period, clearer changes are observed, with the emergence of specialised cattle husbandry at many sites, indicating greater Roman economic control over the region south of the Danube. This pattern continues into the late Roman period. The clearest late Roman changes are observed in the site type data, discussed above. By the early Byzantine period, husbandry in the Balkan provinces becomes somewhat more generalised overall, with fewer sites exhibiting specialised cattle exploitation, and more sites showing fairly equal proportions of the three livestock taxa. The site-type structure of the early Byzantine sample for the Balkan provinces likely influences the picture to a certain extent. There are no rural sites in the sample — a site type that exhibits specialised cattle husbandry elsewhere in the study region in this period. Nevertheless, fairly generalised exploitation at consumer sites indicates a decline in Roman influence over production and provisioning. Overall, Roman economic control of the Balkan provinces appears to have been greatest in the mid-Roman period, with a gradual decline thereafter.

In Dacia, the early Roman period sees a clear increase in reliance on pigs, interpreted as evidence for increased disruption as a result of Roman military campaigns north of the Danube. Pigs are least abundant in eastern Dacia, beyond the main area of military activity. In the mid-Roman period, there is a very clear shift in livestock exploitation, concurrent with the Roman occupation. Specialised cattle husbandry is observed at the majority of sites, with a concurrent — and very clear — decline in reliance on pigs. The livestock data indicate the rapid establishment of Roman economic control in Dacia, with little evidence for the persistence of earlier exploitation patterns. In the late Roman period, despite a decline in Roman political influence north of the river following withdrawal from Dacia, there is only a small decrease in cattle abundance. Specialised cattle husbandry continues to be practised on several sites, demonstrating that the economic practices put in place under Roman rule outlasted the period of direct control. In the early Byzantine period, while certain sites exhibit a clear focus on cattle, husbandry practice is characterised by considerable intersite variation overall. The data suggest that within a few centuries of the end of the Roman occupation, the economic system established under Roman rule had ceased to function.

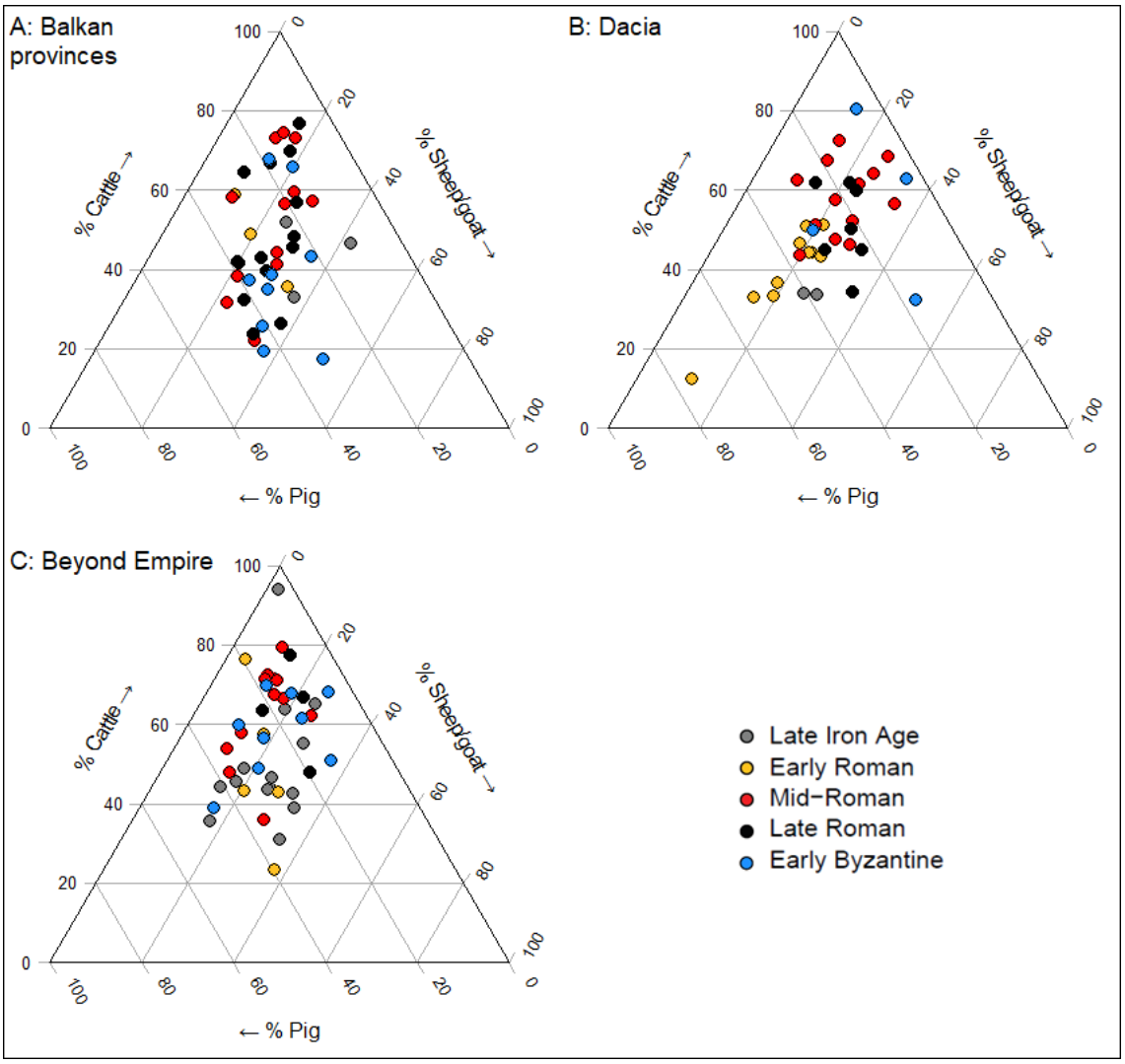


Figure 6.7: Livestock relative abundance by period and region. A: Balkan provinces; B: Dacia; C: beyond the area of long-term Roman occupation.

Beyond the Empire, late Iron Age husbandry practice focuses on the exploitation of cattle, with fairly specialised practice seen at a number of sites. In the early Roman period, there is a slight decrease in cattle abundance, but this is insufficient to indicate any overall change in husbandry practice. The cattle focus continues into the mid-Roman period, with specialised husbandry of this taxon now evident at the majority of sites. In the late Roman period, there is little change in practice, while in the early Byzantine period there is a slight decrease in cattle abundance. While cattle were clearly the principal focus of husbandry practice beyond the Empire throughout the study period, the increased proportion of sites exhibiting high cattle values in the mid- and late Roman periods could be interpreted as evidence for the influence of the Roman economic system beyond occupied areas in these periods. Any such influence would only have had a fairly small impact on husbandry practice beyond the Empire, however, given the already high proportion of cattle present in earlier periods.

6.4 Intraregional patterns in livestock relative abundance

6.4.1 Introduction

This section will explore intraregional patterns in livestock relative abundance, via analysis of subregions for each of the three regions. In the Balkan provinces, the data are divided between a northeastern subregion, comprising sites located in the southern Pannonian Plain; a northwestern subregion, comprising sites in Dobrogea; and a southern subregion, which comprises sites in southeast Serbia and western Bulgaria, and central Bulgaria. In Dacia, the data are divided between northern and southern subregions, the former comprising sites in Transylvania, and the latter sites in the southeastern Pannonian Plain and Oltenia. Beyond the Empire, the data are divided between a northwestern subregion, comprising sites in the central and northern Pannonian Plain; a northeastern subregion, comprising sites in Moldavia; and a southeastern subregion, comprising sites in Muntenia.

This section will explore differences between subregions with regard to both their varying climatic and environmental contexts, and their varying political histories. For the Balkan provinces, the analysis focuses on climatic and environmental differences between the north and the south, and on the varying levels of political and economic disruption in different subregions in late Antiquity. For Dacia, the analysis considers climate and environment, and also considers the varying degree of disruption due to military action in the region. Beyond the Empire, the analysis concerns climate and environment, and the different political contexts of the western and eastern subregions.

6.4.2 The Balkan provinces

Figure 6.8, A to C, shows relative abundance of cattle, sheep/goat and pigs by subregion for the Balkan provinces. Clear differences in relative abundance are apparent between each region, in particular with regard to the extent of reliance on cattle. In Dobrogea, average cattle NISP is the highest of the three subregions at 61%, followed by sheep/goat at 22%, and pigs at 17%. In this subregion, four-fifths of all sites have a cattle NISP of over 50%, with half of all sites exhibiting a cattle NISP over 60%, revealing a clear focus on cattle husbandry in the northeast of the Balkan provinces. In the Pannonian Plain, in the northwest of the Balkan provinces, average cattle NISP is somewhat lower at 48%, followed by pigs at 29%,

and sheep/goat at 24%. In the southern subregion, average cattle NISP is the lowest of the three subregions at 39%, with pigs at 32%, and sheep/goat at 24%, indicating much more generalised husbandry practice, though a clear focus on cattle is apparent at four sites. In the southern subregion, however, pigs exceed cattle in abundance on around two-fifths of sites, something that does not occur in either northern subregion.

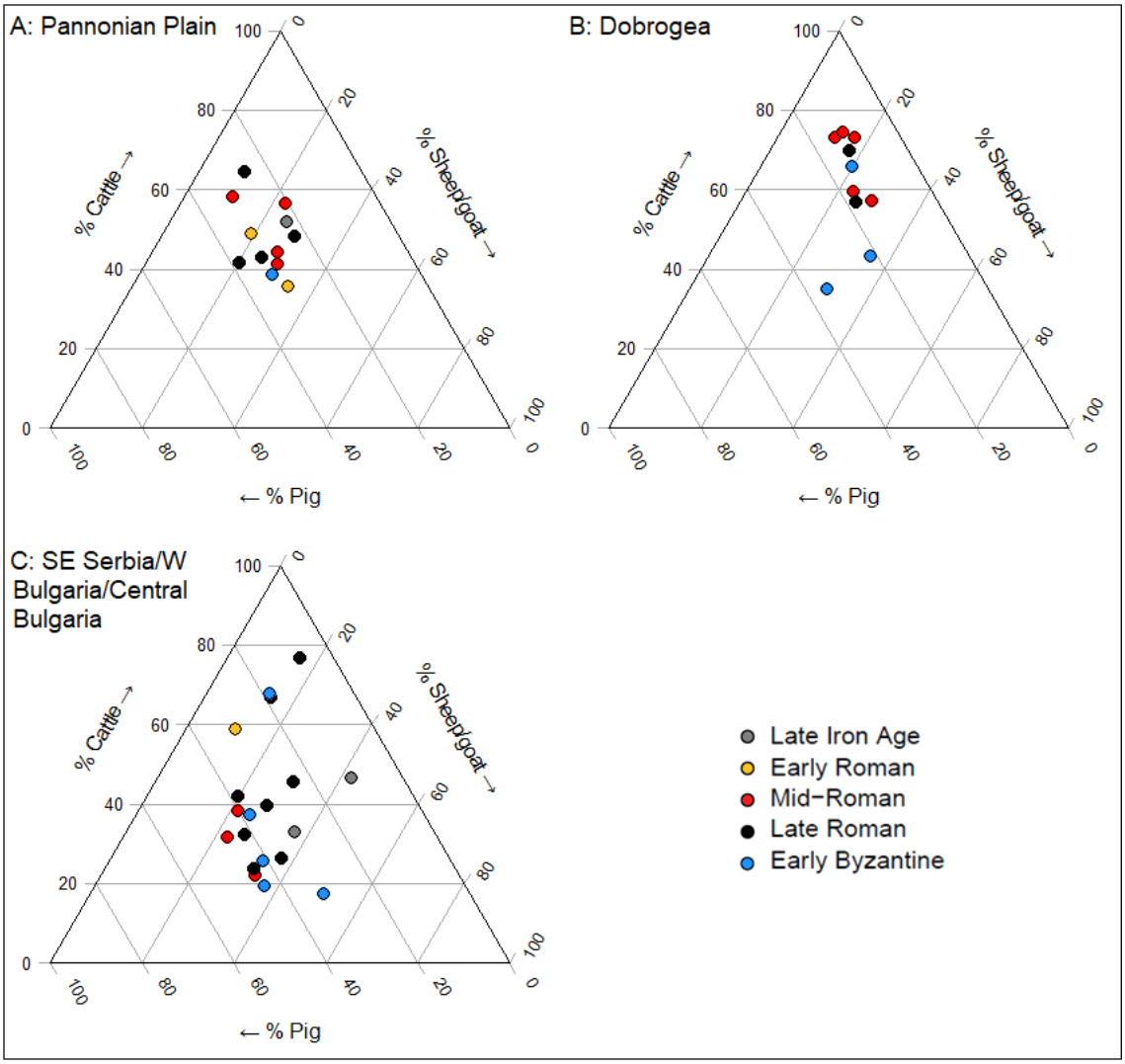


Figure 6.8: Livestock relative abundance by subregion in the Balkan provinces. A: Pannonian Plain; B: Dobrogea; C: SE Serbia/W Bulgaria/Central Bulgaria.

In order to determine whether this intraregional pattern is most likely a product of different climatic and environmental contexts or of other factors such as different political and cultural histories, it is useful to assess the extent of temporal change in each subregion. Where intraregional patterns in livestock relative abundance persist across periods of major political change, it can be argued that climate and environment present a more likely stimulus for intraregional differences than would otherwise be the case. Political and economic stability

began to decline in the Balkan provinces from the late Roman period, so changes in livestock relative abundance between the late Iron Age, early Roman and mid-Roman periods, on the one hand, and the late Roman and early Byzantine periods — late Antiquity — on the other, will be considered here.

Across both northern subregions combined, there is little evidence for temporal change in livestock relative abundance — over the first three periods, average cattle NISP is 56%, pig 22%, and sheep/goat 22%; in late Antiquity, average cattle NISP is 51%, pig 25%, and sheep/goat 24%. In the southern subregion, there is also little evidence for temporal change, with a difference of only a few percentage points evident across the period division in question. Across the first three periods, average cattle NISP in the southern subregion is 38%, with pigs at 34%, and sheep/goat at 28%; in late Antiquity, average cattle NISP is 40%, pig 32%, and sheep/goat 28%. The data suggest, therefore, that intraregional differences in livestock relative abundance in the Balkan provinces are more likely a result of different climatic and environmental contexts than of major political change. The mountainous terrain characterising southeast Serbia and western Bulgaria, and the warmer climate in the south as a whole, can both be posited as possible factors influencing the lower cattle abundance and greater reliance on sheep/goat and pigs evident in the southern subregion. While the mid-Roman period sees a clear overall increase in specialised cattle husbandry then, the establishment of a cattle-based economy in the south may have been constrained by the environmental context and the warmer climate.

6.4.3 Dacia

Figure 6.9, A and B, shows relative abundance of cattle, sheep/goat and pigs by subregion for Dacia. In Transylvania, in the north, average cattle NISP is 52%, with pigs and sheep/goat each at 24%. Nine of the twenty-six sites in the sample exhibit cattle frequencies of over 60%. Overall, the data reveal a focus on cattle in northern Dacia, with around a third of all sites exhibiting highly specialised cattle husbandry. In the southeastern Pannonian Plain and Oltenia, in the south of Dacia, husbandry practice is somewhat more generalised. Average cattle NISP in this subregion is 45%, followed by pigs at 33%, and sheep/goat at 22%, indicating a greater reliance on pigs in the south of Dacia than in the north. When the site at Divici ‘Grad’, where pigs comprise 76% of the livestock, is removed from the sample, however, the difference observed between the northern and southern subregions is much

smaller — cattle abundance falls to 48% in the south, with pigs at 29%, and sheep/goat at 23%. The influence of a single highly pig-focused site in a relatively small sample is thus the cause of at least some of the intraregional variation observed in Dacia.

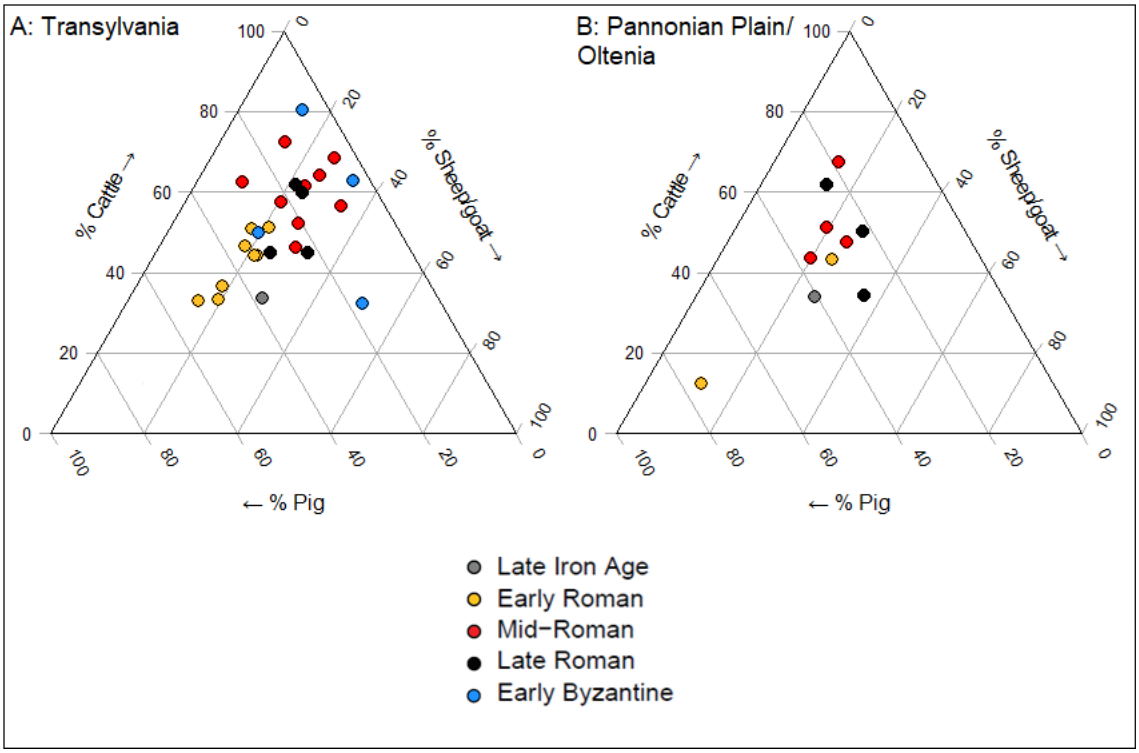


Figure 6.9: Livestock relative abundance by subregion in Dacia. A: Transylvania; B: Pannonian Plain/Oltenia.

In Transylvania, there is a clear shift towards higher cattle abundance and lower pig abundance in the mid-Roman period, with all but one mid-Roman site exhibiting cattle frequencies of over 50%. While average cattle abundance for the Pannonian Plain and Oltenia is somewhat lower than is the case for Transylvania, the subregion nevertheless exhibits a shift towards higher cattle abundance and lower pig abundance from the mid-Roman period, though the sample is fairly small. Overall, the data suggest that fairly similar processes of change occurred in both subregions, albeit with a greater cattle focus in the north. While a higher frequency of military action nearer to the Roman border along the Danube could be posited in some regions as a stimulus for a higher proportion of the taxon most suited to intramural husbandry, these disruptions may not have been of sufficient duration of intensity to have an archaeologically-discernible impact on husbandry practice. Since many of the sites in the southern subregion lie within or in close proximity to the Iron Gates, however, the

more abundant agricultural land of Transylvania, with its relatively mild climate, may provide a more likely stimulus for the higher proportions of cattle in the north.

6.4.4 Beyond the Empire

Figure 6.10, A to C, shows relative abundance of cattle, sheep/goat and pigs by subregion for the area beyond the Empire. The greatest evidence for specialised husbandry practice is found in Moldavia, in the northeast of the study region, where cattle comprise 63% of the livestock on average, followed by pigs at 21%, and sheep/goat at 15%. In the Pannonian Plain, in the northwest of the study region, average cattle NISP is lower at 52%, with sheep/goat at 27%, and pigs at 21%, while in Muntenia, in the southeast of the area beyond the Empire, average cattle NISP is 49%, pig 28%, and sheep/goat 23%. The data reveal a clear focus on cattle husbandry in Moldavia, where this taxon exceeds 60% of the livestock on two-thirds of all sites. Husbandry practice is somewhat less specialised in the Pannonian Plain and in Muntenia, though a focus on cattle is nevertheless evident. While few clear temporal trends emerge in the Moldavian dataset, with high cattle frequencies persistent throughout the study period, there is some suggestion of a possible increase over time in cattle abundance in Muntenia, though the sample is too small to draw any clear conclusions.

The high cattle frequencies evident in Moldavia, with its somewhat less temperate climate than other parts of the study region, could suggest that even in zones exhibiting climatic conditions less ideal for husbandry, the severity of the climate may be insufficient to have had a major impact on the forms of husbandry practised. While many parts of Europe see an increase in cattle abundance during the Roman period — including both the Balkan provinces and Dacia — the Moldavian dataset reiterates that specialised cattle husbandry is a practice that also exists prior to, and outside of, the Roman occupation. Whether due to a cultural practice or dietary preference, or as a result of a suitable environment, the data suggest that a focus on cattle husbandry is a Moldavian practice, with similarly high proportions of this taxon only seen in one other subregion — in Dobrogea.

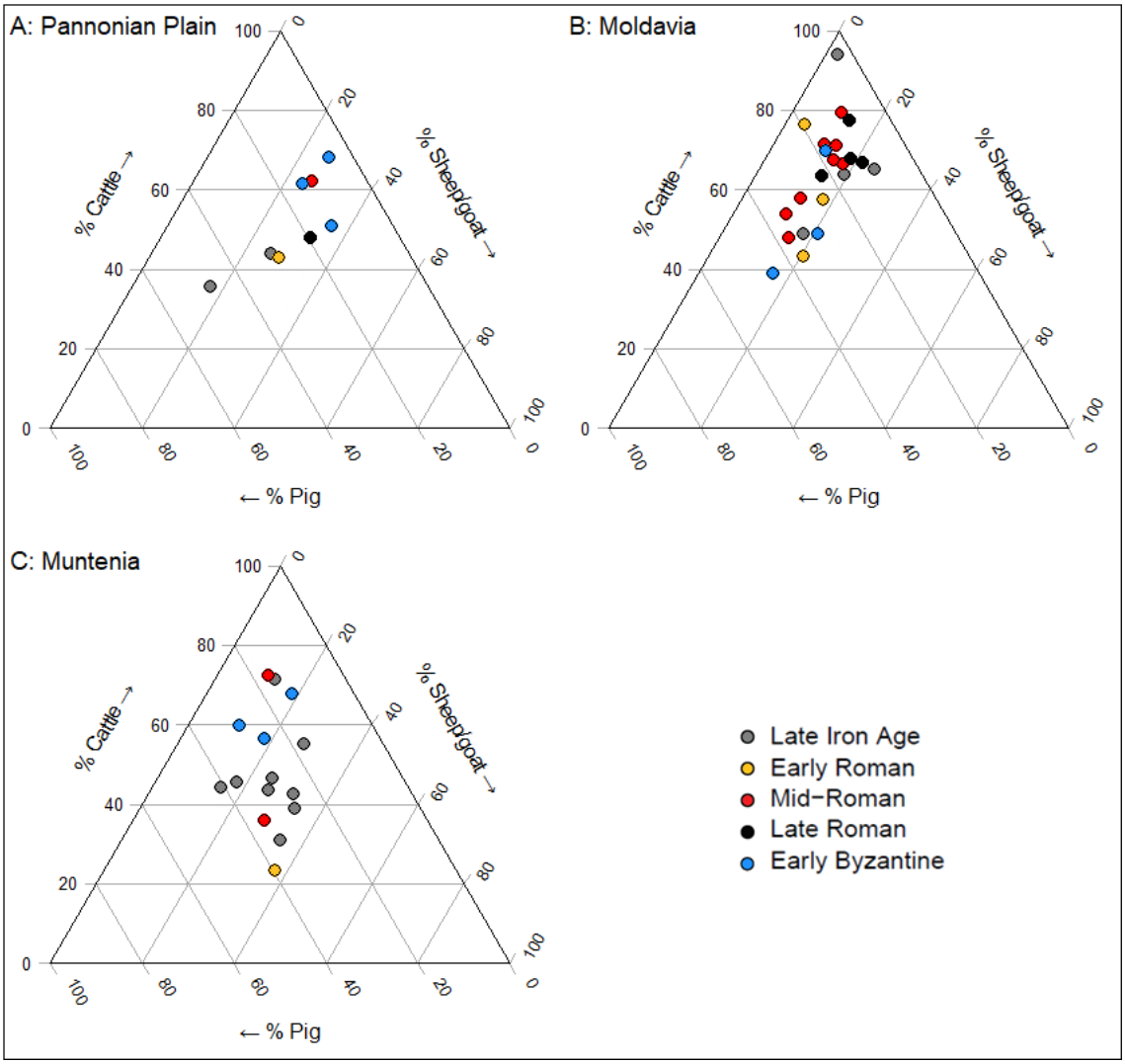


Figure 6.10: Livestock relative abundance by subregion beyond the Empire. A: Pannonian Plain; B: Moldavia; C: Muntenia.

6.4.5 Summary

Overall, the analysis of livestock relative abundance by subregion reveals several intraregional differences in husbandry practice. In all three regions, cattle abundance is for the most part higher in the north than in the south of the region. An increase in cattle abundance with increasing latitude is a pattern that holds for the study region as a whole. In the northern Balkan provinces, and in the southern parts of both Dacia and the area beyond the Empire — all of which lie on a similar latitude — cattle abundance is somewhat higher than in the southern Balkan provinces, but is somewhat lower than in the northernmost parts of the study region. The only exception to this pattern is Dobrogea, where average cattle abundance is second highest of all subregions. This contrast to other subregions on a similar latitude could suggest that the cattle focus evident in Dobrogea is a culturally- or

economically-stimulated practice, at odds with the north-south cattle gradient correlated with a north-south temperature gradient in evidence in the remainder of the study region. The Dobrogean sample is not particularly large, however, and more data would be necessary to draw clear conclusions about this region.

While the analysis of livestock relative abundance by period and region revealed many changes in livestock exploitation correlated with major political, cultural and economic changes in the study region, the analysis of the data by subregion demonstrates that variation in climatic and environmental context also likely played a role in influencing — though not determining — the forms of husbandry practised across the study region.

6.5 Livestock relative abundance by taxon

6.5.1 Introduction

This section will summarise spatial and temporal trends in the relative abundance of each livestock taxon, and present the statistical analysis of the NISP data. Intraperiod change in relative abundance is then considered for each taxon, in order to determine whether more gradual processes of temporal change than can be discerned in the analysis of the data by period occurred for any taxon. The section begins with the analysis of the cattle data, followed by sheep/goat, and then pigs.

6.5.2 Cattle

Figure 6.11 shows cattle relative abundance by period and region. There is little change overall in cattle abundance from the late Iron Age to the early Roman period, with a similar degree of reliance on this taxon both before and after the start of the earliest Roman occupation. The mid-Roman period sees a clear increase in average cattle abundance, and a small increase in the interquartile range. A much greater share of sites in the sample exhibit cattle frequencies of over 50% than in the previous two periods, though there is continued substantial intersite variation in the extent of reliance on this taxon. There is a clear decrease in average cattle abundance in the late Roman period, though the median remains higher than was the case in the late Iron Age and the early Roman period. The transition to the early Byzantine period sees little further change in cattle abundance. The wide dispersion of values

reveals a wide range of site-specific approaches to cattle exploitation in the early Byzantine period, with almost double the interquartile range than was seen for the late Iron Age and the early Roman period.

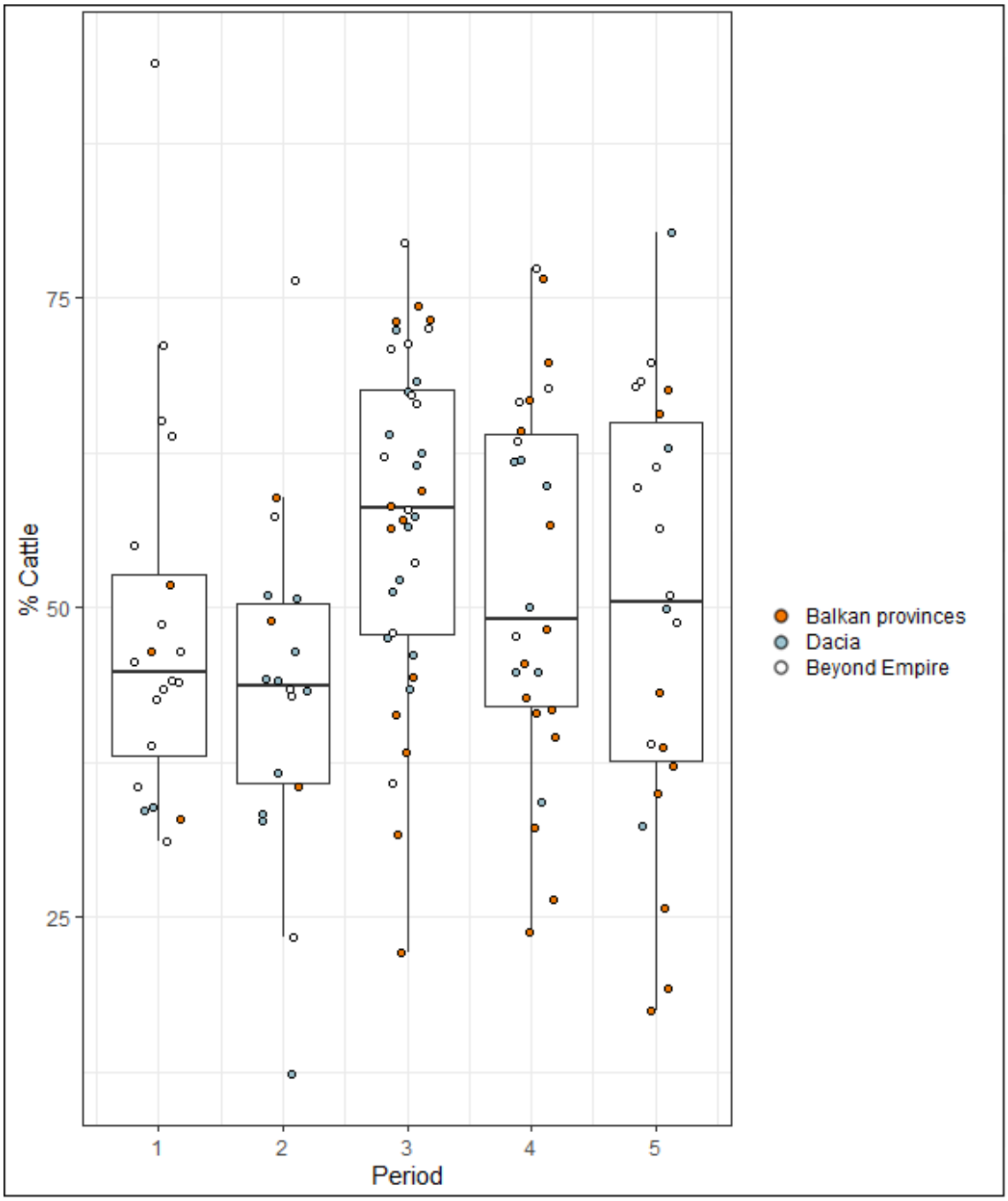


Figure 6.11: Cattle abundance as a percentage of total livestock NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

A Wilcoxon rank sum test was used to determine whether any of the observed differences in cattle abundance between periods are statistically significant (Table 6.1). Sites across all three

regions were grouped together for each period for significance testing. The test was performed for all possible pair combinations for the five periods, in order to consider not only the extent of temporal change in cattle abundance through the study period, but also the extent of variance for the dataset as a whole. The results of the test indicate that there are no statistically significant differences in cattle abundance between any pair combination other than the early Roman and mid-Roman periods. These two periods have the lowest and highest median cattle values respectively; the result of the Wilcoxon rank sum test confirms that a relatively major change in cattle exploitation took place between the two periods.

Table 6.1: Wilcoxon rank sum test for cattle abundance by period. *p* values in **bold** are statistically significant; *significant ($p \leq 0.05$), **highly significant ($p \leq 0.01$).

Period	Late Iron Age	Early Roman period	Mid-Roman period	Late Roman period	Early Byzantine period
Late Iron Age					
Early Roman period	0.66				
Mid-Roman period	0.06	****0.01**			
Late Roman period	0.44	0.26	0.42		
Early Byzantine period	0.66	0.42	0.31	0.69	

A Wilcoxon rank sum test was also used to determine whether any of the differences in cattle abundance between regions are statistically significant (Table 6.2). Sites across all five periods were grouped together for each region for significance testing. The results of the test indicate no statistically significant difference in cattle abundance between the Balkan provinces and Dacia, suggesting that the much longer occupation of the former region did not result in significantly different patterns of cattle exploitation here than in the latter region. The results of the test indicate a statistically significant difference in cattle abundance both between the Balkan provinces and the area beyond the Empire, and between Dacia and the latter region. This result indicates a significant difference in practice between Roman-occupied and non-Roman-occupied regions. Thus despite the appearance of highly specialised cattle husbandry in the Balkan provinces and in Dacia in the mid-Roman period, cattle abundance in these two regions for the study period as a whole is significantly lower than in the area beyond the Empire, where specialisation is seen throughout the study period.

Table 6.2: Wilcoxon rank sum test for cattle abundance by region. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Area	Balkan provinces	Dacia	Beyond the Empire
Balkan provinces			
Dacia	0.33		
Beyond the Empire	***0.02**	***0.04**	

In order to reveal the extent of intraperiod temporal variation in cattle exploitation, Figure 6.12 shows cattle abundance by phase. Cattle percentages are not pooled for multiphase sites that fall within the same period, but are plotted as a separate horizontal bar for each phase, with the start and end point of each bar corresponding to the start and end date of each phase. Colour of shading indicates abundance, on a scale from yellow (low abundance) to black (high abundance). Where multiple phases share the same date range, such as is the case for the set of phases dated 100-300 CE, these are arranged in ascending order of cattle abundance. This should not be interpreted as evidence for increasing cattle abundance over time within the shared date range, but rather shows the range of cattle abundance within that date range. Overall, few clear intraperiod temporal trends emerge — in part, due to the considerable overlap of phases within several of the periods. However, a greater number of phases feature highly specialised cattle exploitation — with cattle abundance greater than 60% — in the earlier part of the late Iron Age than in the later part, suggesting a possible gradual decline in reliance on cattle beginning prior to the start of the early Roman period.

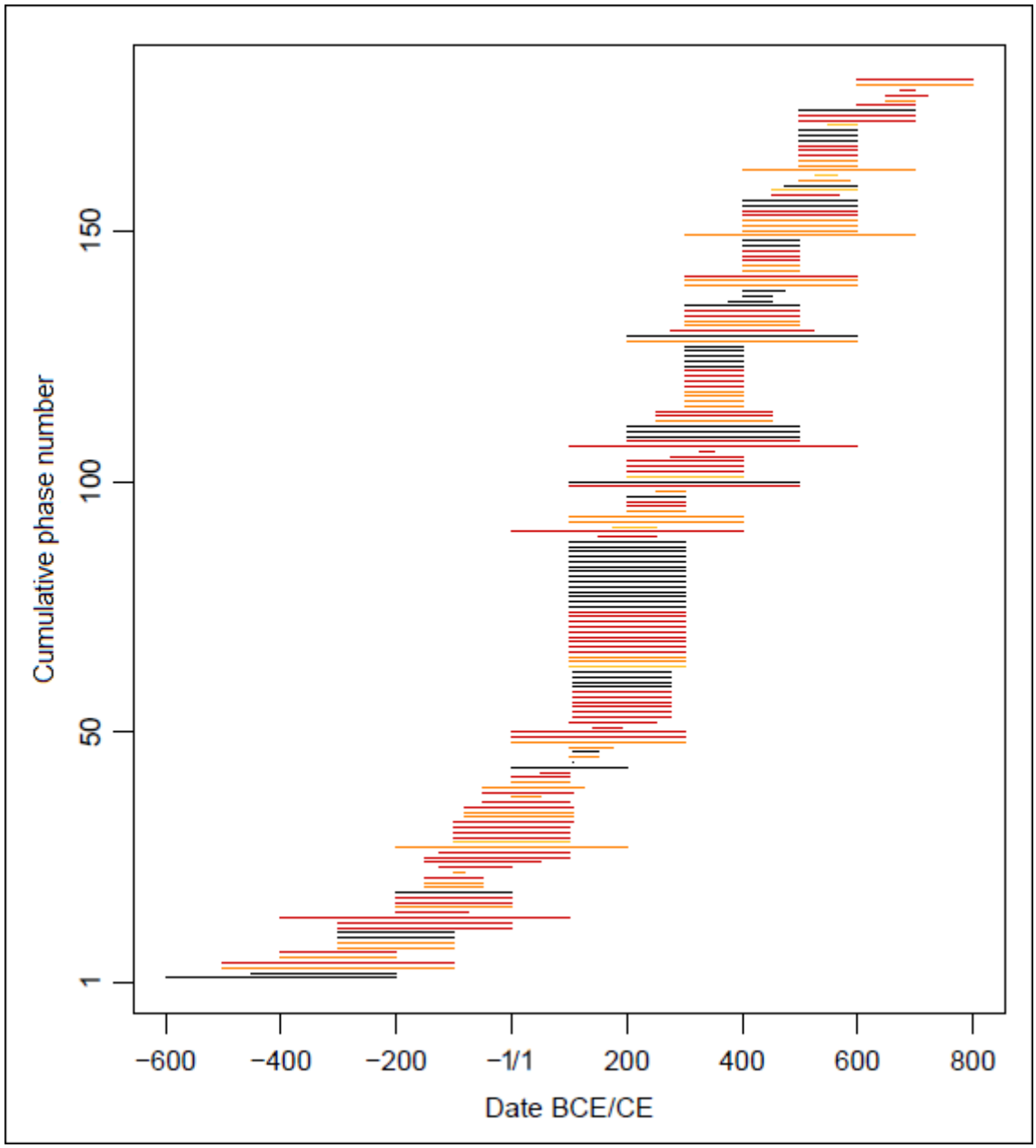


Figure 6.12: Cattle abundance (C) as a percentage of total livestock NISP by phase. Yellow: C<20%; orange: 20%≤C<40%; red: 40%≤C<60%; black: C≥60%.

6.5.3 Sheep/goat

Figure 6.13 shows sheep/goat relative abundance by period and region. The data show a clear decrease in the median and the interquartile range from the late Iron Age to the early Roman period. While there is considerable variation in the extent of reliance on sheep/goat in the late Iron Age, by the early Roman period this taxon forms a smaller and more consistent proportion of the livestock exploited. In the mid-Roman period, there is little change in the median, but a clear increase in the interquartile range, indicating little overall change in

reliance on sheep/goat, but greater variation between sites than was the case in the early Roman period. In the late Roman period, there is an increase in average sheep/goat abundance, but little to no further change is evident in the early Byzantine period.

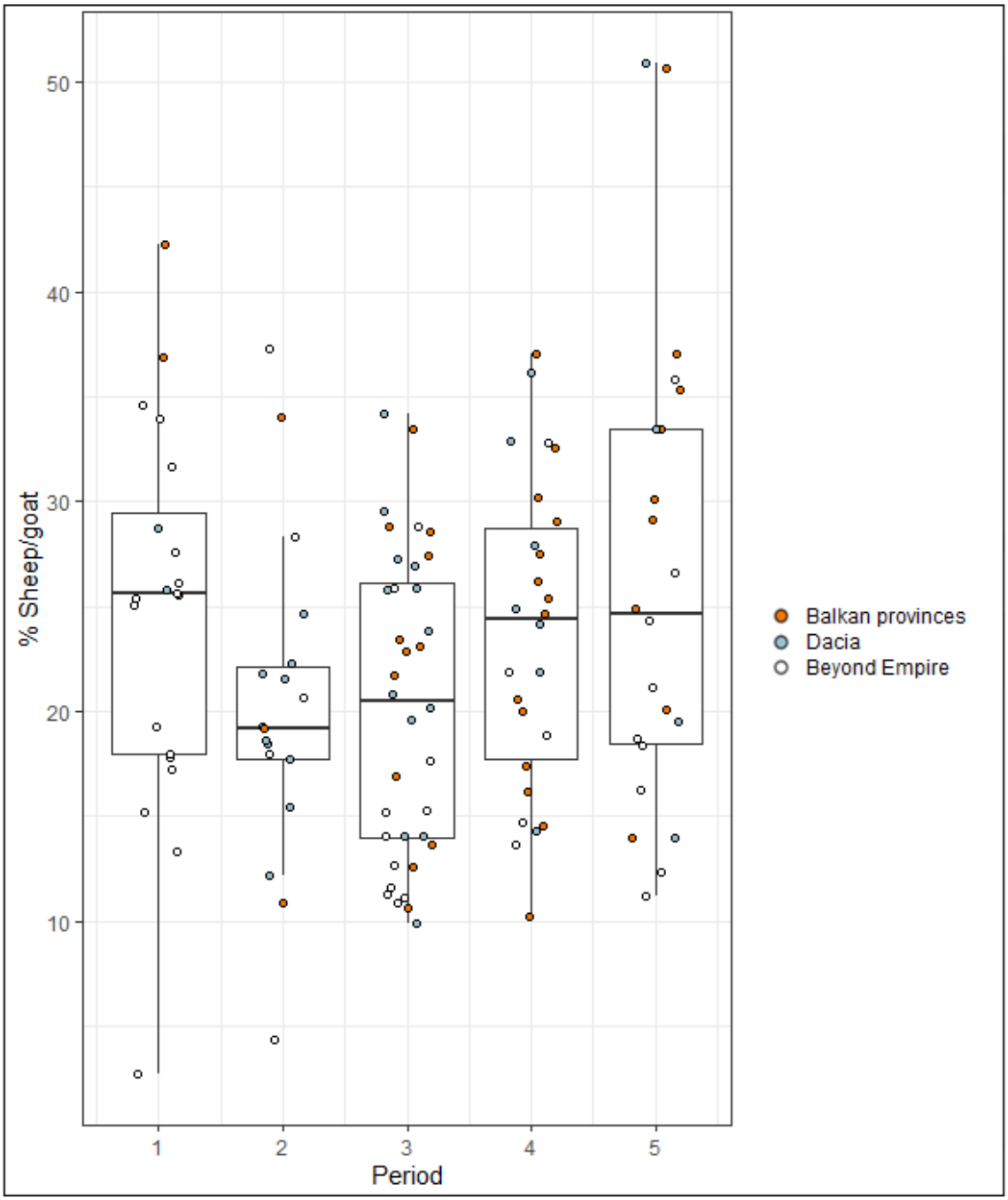


Figure 6.13: Sheep/goat abundance as a percentage of total livestock NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

A Wilcoxon rank sum test was used to determine whether any of the observed differences in sheep/goat abundance between periods are statistically significant (Table 6.3). The results of the test indicate that there are no statistically significant differences in sheep/goat abundance

between any of the five periods. Given the considerable overlap in the interquartile range of sheep/goat abundance for each period, this result is unsurprising.

Table 6.3: Wilcoxon rank sum test for sheep/goat abundance by period. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Period	Late Iron Age	Early Roman period	Mid-Roman period	Late Roman period	Early Byzantine period
Late Iron Age					
Early Roman period	0.34				
Mid-Roman period	0.34	1.00			
Late Roman period	0.82	0.34	0.34		
Early Byzantine period	0.94	0.48	0.34	1.00	

A Wilcoxon rank sum test was also used to determine whether any of the differences in sheep/goat abundance between regions are statistically significant (Table 6.4). The results of the test indicate no statistically significant difference in sheep/goat abundance between the Balkan provinces and Dacia. This result suggests little difference in reliance on sheep/goat despite very different political trajectories in the two regions. The results of the test indicate a statistically significant difference in sheep/goat abundance between the Balkan provinces and the area beyond the Empire, and between Dacia and the latter region. This result echoes that observed for cattle, where abundance was significantly higher beyond the Empire than elsewhere. In the case of sheep/goat, however, abundance is significantly lower beyond the Empire, where this taxon comprises less than 20% of the livestock NISP on more than half of all sites. Since cattle abundance beyond the Empire was sufficiently high to indicate a focus on the specialised husbandry of this taxon, the relatively lower extent of reliance on sheep/goat is unsurprising.

Table 6.4: Wilcoxon rank sum test for sheep/goat abundance by region. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Area	Balkan provinces	Dacia	Beyond the Empire
Balkan provinces			
Dacia	0.23		
Beyond the Empire	****0.005**	****0.007**	

Figure 6.14 shows sheep/goat abundance by phase. The abundance of this taxon is considerably lower than that of cattle overall, exceeding 40% of the livestock NISP in less

than a twentieth of all phases, and only exceeding 60% in a single phase. There are no clear intraperiod temporal trends in sheep/goat exploitation.

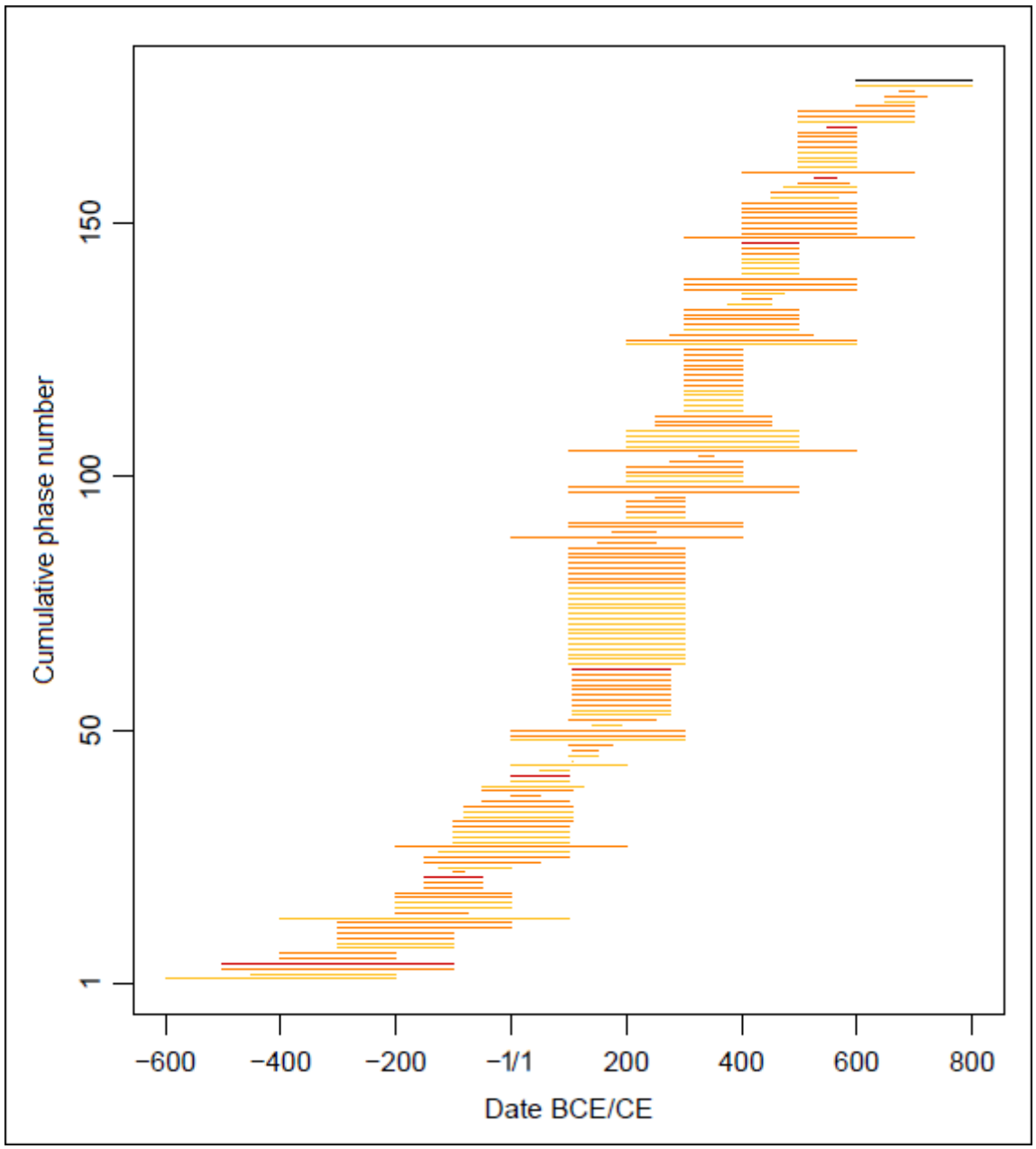


Figure 6.14: Sheep/goat abundance (SG) as a percentage of total livestock NISP by phase. Yellow: SG<20%; orange: 20%≤SG<40%; red: 40%≤SG<60%; black: SG≥60%.

6.5.4 Pigs

Figure 6.15 shows pig relative abundance by period and region. From the late Iron Age to the early Roman period, there is a small increase in the median and a decrease in the interquartile range. The data therefore indicate increased reliance on pigs in this period, and a decrease in

variation in practice between sites. In the mid-Roman period, there is a clear decrease in average pig abundance, and the interquartile range returns to approximately its late Iron Age level.

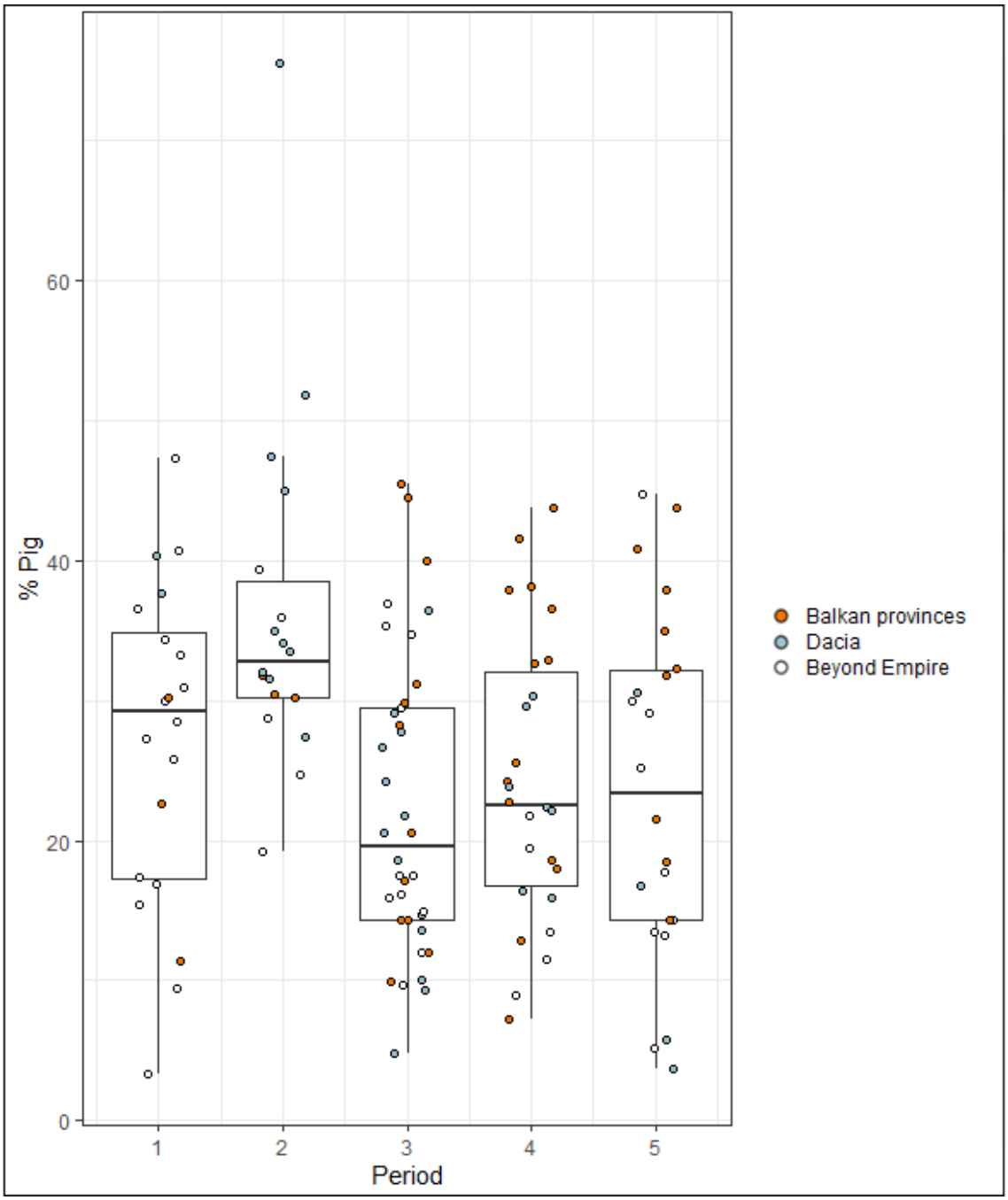


Figure 6.15: Pig abundance as a percentage of total livestock NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Thereafter, there is little change in pig exploitation, though the median increases slightly period-by-period. The data thus indicate much greater reliance on pigs in the early Roman period than at any other time. Pig abundance falls to its lowest level in the mid-Roman

period, and increases very slightly in each of the following periods. Period-by-period change in pig abundance is for the most part the reverse of that observed for cattle, with a similar magnitude of change across several period transitions; a direct relationship in the extent of reliance on each taxon is thus indicated.

A Wilcoxon rank sum test was used to determine whether any of the observed differences in pig abundance between periods are statistically significant (Table 6.5). The results of the test indicate a statistically significant difference in pig abundance between the early Roman period and each of the subsequent periods, but not between the early Roman period and the late Iron Age. The result indicates that reliance on pig was sufficiently high in the late Iron Age that this period is statistically indistinguishable from the early Roman period, when the importance of pig was at its height. The significantly lower abundance of pig in the later three periods coincides with an increase in the importance of cattle, and is likely the result of the development of an economy focused on cattle husbandry, in operation from the mid-Roman period.

Table 6.5: Wilcoxon rank sum test for pig abundance by period. *p* values in **bold** are statistically significant; *significant ($p \leq 0.05$), **highly significant ($p \leq 0.01$).

Period	Late Iron Age	Early Roman period	Mid-Roman period	Late Roman period	Early Byzantine period
Late Iron Age					
Early Roman period	0.11				
Mid-Roman period	0.24	****0.001**			
Late Roman period	0.54	****0.007**	0.54		
Early Byzantine period	0.54	***0.02**	0.77	0.77	

A Wilcoxon rank sum test was also used to determine whether any of the differences in pig abundance between regions are statistically significant (Table 6.6). The results of the test indicate no statistically significant difference in pig abundance between any of the three regions. Though certain regions do exhibit greater proportions of pigs than other regions in several periods — the area beyond the Empire in the late Iron Age, Dacia in the early Roman period, and the Balkan provinces thereafter — when the samples for all five periods are grouped together for each region for significance testing, these differences are not sufficient to result in statistically significant differences between regions.

Table 6.6: Wilcoxon rank sum test for pig abundance by region. *p* values in **bold** are statistically significant; *significant ($p \leq 0.05$), **highly significant ($p \leq 0.01$).

Area	Balkan provinces	Dacia	Beyond the Empire
Balkan provinces			
Dacia	0.36		
Beyond the Empire	0.36	0.85	

Figure 6.16 shows pig abundance by phase. In both the late Iron Age and the early Byzantine period, intraperiod change in pig abundance can be discerned. The late Iron Age sees an increase in pig abundance over time, with many fewer phases falling within the lowest category — with pigs comprising less than 20% of the livestock NISP — in the earlier part of the late Iron Age than the later part. The data thus indicate that pig abundance increased gradually through the first two periods, with an increase prior to the earliest Roman occupation in the study region. This evidence is consistent with the interpretation that increased reliance on pigs was a consequence of increasing Roman military activity in southeast Europe, and suggests that the earliest Roman activity beyond the study region to the south and the west had an impact that reached beyond the region under direct Roman control in this early period of territorial expansion. In the early Byzantine period, a slight increase in pig abundance from the earlier part of the period to the later part is also seen.

It was noted that increases in pig abundance by period generally correspond to decreases in cattle abundance, and vice versa. While an increase in the abundance of one livestock taxon will inevitably result in a decrease in the abundance of others when ratios of livestock taxa are analysed, the close association between changes in cattle and pigs, and the apparent independence of changes in sheep/goat abundance, indicates that increases in pig abundance are a direct result of decreases in the exploitation of cattle, or vice versa. Given the growing Roman military influence in southeast Europe in the early part of the study period, it is likely that increasing pig abundance in this early period is a direct result of decreasing reliance on — and perhaps decreasing ability to practise the husbandry of — cattle. Towards the end of the study period, the observed decrease in cattle abundance and corresponding increase in pig exploitation could be interpreted as evidence for increased disruption to the practise of cattle husbandry, as a consequence of declining Roman political influence and increasing instability in the study region.

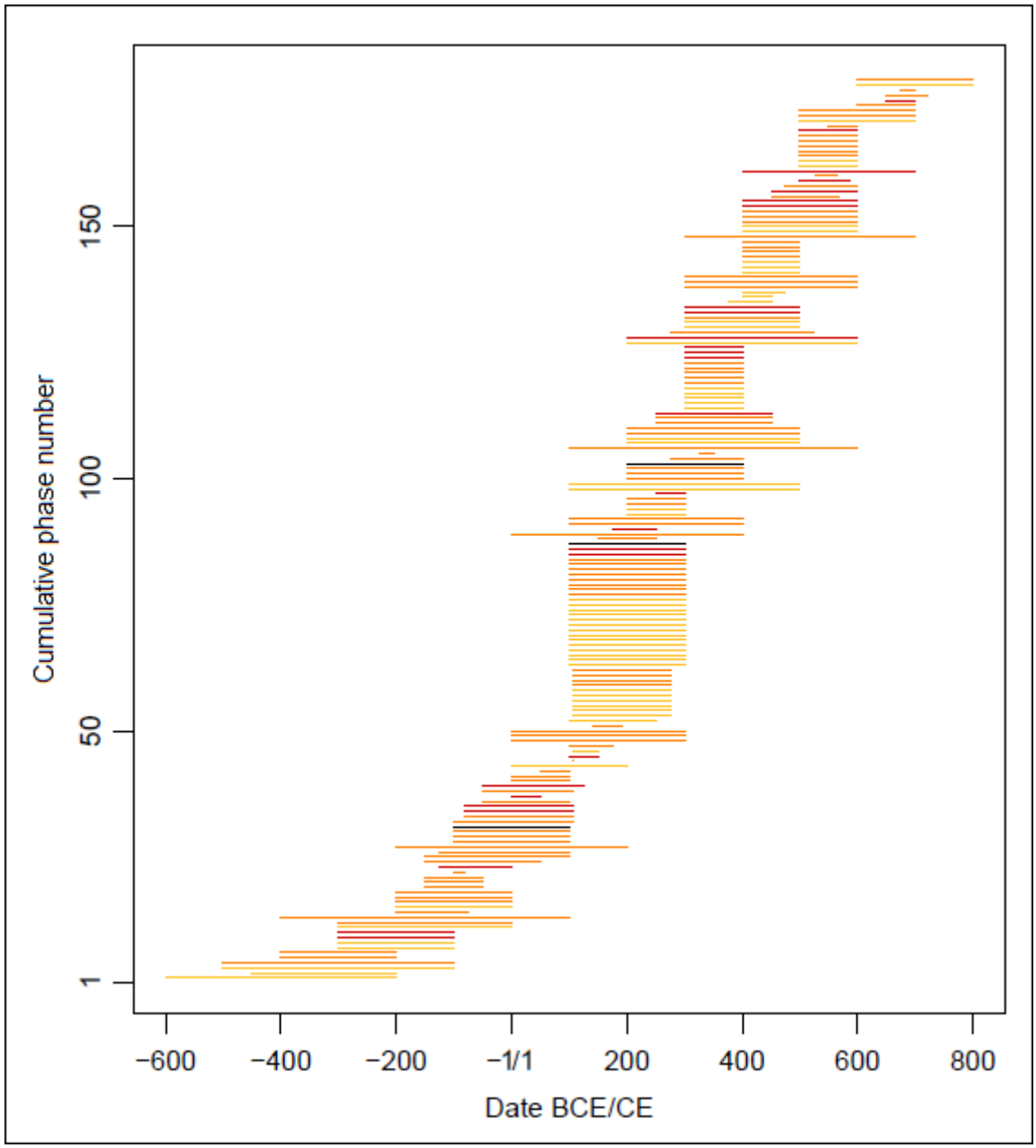


Figure 6.16: Pig abundance (P) as a percentage of total livestock NISP by phase. Yellow: P<20%; orange: 20%≤P<40%; red: 40%≤P<60%; black: P≥60%.

6.5.5 Summary

Overall, the analysis of livestock relative abundance by taxon, and the performance of statistical testing, demonstrate that while many changes in animal husbandry are evident for particular regions in particular periods, these changes are not always of sufficient magnitude to result in a statistically significant difference between the relevant periods or regions when the data are pooled for the study period or the study region as a whole. There is, however, clear evidence that the study region saw significantly greater reliance on pigs in the early

Roman period than in any subsequent period, and saw a significant increase in specialised cattle husbandry in the mid-Roman period. Across the study period as a whole, cattle are significantly more abundant beyond the Empire than within occupied regions; the converse is true for sheep/goat. Though clear increases in the extent of reliance on cattle are seen in the Balkan provinces and Dacia in the mid-Roman period, the abundance of this taxon is sufficiently low overall to result in a statistical difference between these two regions and the area beyond the Empire. While the analysis of intraperiod change in livestock relative abundance is limited by the similar date range of the phases in most periods, the data suggest that a decline in the abundance of cattle and an increase in reliance on pigs began prior to the earliest Roman occupation in the study region.

6.6 Livestock age

6.6.1 Introduction

This section presents the analysis of the livestock age data. Spatial and temporal trends are first analysed for each taxon, followed by site-type-based trends. The analysis begins with cattle, followed by sheep/goat, and then pigs.

6.6.2 Cattle

Figure 6.17, A to E, shows the ratio of very young, young and adult cattle at each site in each period. No very young individuals were recovered from any site in the late Iron Age and early Roman samples, so no insight into the organisation of cattle breeding on the basis of foetal and neonatal cattle distribution is possible for these periods. In late Iron Age Dacia, young individuals comprise more than 50% of the cattle remains at two-thirds of the sites; at four sites, young cattle comprise 60% or more of the remains. Though the taxonomic data reveal fairly generalised husbandry practice at many late Iron Age Dacian sites, the age data suggest specialisation in meat production as the primary form of cattle exploitation, though mixed exploitation for meat and dairy is also possible. Elsewhere in the study region, the small amount of available data suggests cattle husbandry focused on the exploitation of adults, which may have been raised for dairy production, or used as traction animals.

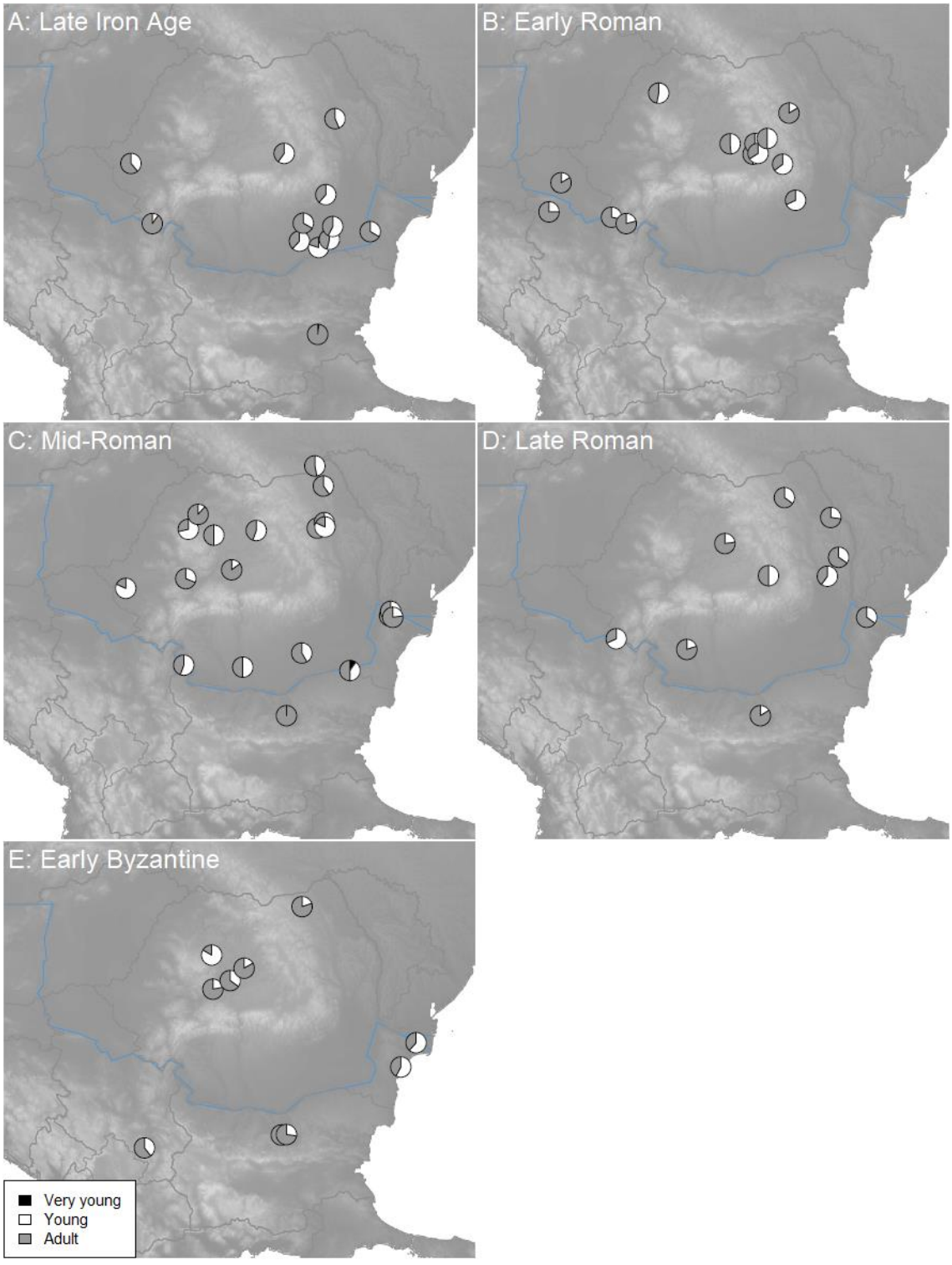


Figure 6.17: Cattle age by period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine. Minimum sample size = 5 specimens.

There are few changes in patterns of exploitation between the late Iron Age and the early Roman period. Sites in the Kingdom of Dacia once again exhibit a focus on young cattle, indicating primary exploitation for meat or mixed meat and dairy production. Elsewhere, the higher proportion of adults indicates a continued focus on dairy production, or the use of

cattle as work animals. There appears to be little change in the Balkan provinces, now under Roman occupation, where adults remain most abundant, though the sample size is too small to draw clear conclusions.

In the mid-Roman period, there is some evidence for a degree of change across the study region, and perhaps some limited change in the regional organisation of husbandry practice and production. In the Balkan provinces, adult cattle continue to dominate at most sites, though not at the rural Dobrogean settlement at Ostrov-Ferma 4 (Constanța County, Romania), where young individuals comprise 40% of the cattle remains, and the recovery of a neonatal individual indicates the breeding of cattle on site (Bălășescu and Radu 2013). In Roman-occupied Dacia, a wide range of exploitation practices can be observed. Young individuals range from 12% to 71% of the cattle remains, variously indicating a focus on meat or dairy production, or arable farming utilising adult cattle for ploughing. Beyond the Empire, there is a clear focus on young cattle at two sites, but fairly generalised exploitation at the remaining sites.

In the late Roman period, young individuals comprise 50% or more of the cattle remains at a smaller proportion of sites than in any previous period, indicating a decline in husbandry practice primarily focused on meat production. The available data suggest little change in husbandry practice in the Balkan provinces, where adult cattle continue to dominate, though the sample size is once again small. The Dacian sample for the late Roman period is also too small to draw clear conclusions, but suggests that the region continued to be characterised by wide variation in age distribution. Thus despite something of a decrease in cattle abundance relative to other livestock following the cessation of Roman occupation in Dacia, there appears to have been little change in the extent of variation in approaches to cattle exploitation in the region. Beyond the Empire, the abundance of young individuals falls from 47% on average in the mid-Roman period to 39% in the late Roman period, perhaps indicating a slight decline in cattle exploitation primarily for meat, despite no change in the abundance of cattle relative to other livestock in the region between the two periods.

In the early Byzantine period, young individuals comprise 50% or more of the cattle remains on the same proportion of sites as in the previous period. The data reveal a continued focus on the exploitation of adult cattle across much of the study region, indicating dairy production or the use of cattle for traction. Only in Dobrogea is there any evidence for a

regional pattern in exploitation — young individuals comprise more than 50% of the cattle remains at both Dobrogean sites. Across the study period as a whole, the abundance of young cattle declines over time, indicating a progressive reduction in focus on meat production. The increased abundance of adult cattle in later periods suggests the development of more generalised exploitation practices, perhaps as a result of an increasing need to extract the maximum possible yield in terms of work and secondary products from each individual before their use in meat production.

Analysis of cattle age by site type reveals temporal change in site-type-based exploitation patterns. Figure 6.18 shows the percentage of adult cattle by site type and period, with this percentage calculated relative to both ‘very young’ and ‘young’ individuals, combined in the plot into a single ‘non-adult’ category. In the late Iron Age, adult cattle are generally more abundant on rural than on semi-urban sites. The use of cattle as traction animals in arable farming on rural sites, with a possible secondary role in meat production, provides a likely explanation for the pattern observed, while the higher proportion of young individuals at semi-urban sites indicates a focus on the import of meat from cattle of prime age. There is little change in the early Roman period, though a higher proportion of adult animals were reaching certain urban and semi-urban sites. A higher proportion of adult cattle at these sites could result from a degree of control over urban supply on the part of rural producers, exporting meat from adult cattle to urban sites only once these animals had first been utilised for other functions.

In the mid-Roman period, while the proportion of adult cattle at rural sites ranges from 18% to 85%, values cluster between 50% and 80%, revealing a continued focus on the exploitation of adults for work. At urban and military sites, abundance of adults also varies widely, but does not fall below 40%. The concentration of adults at certain consumer sites could indicate the influence of rural producers over urban and military supply, or instead the organisation of the economic system by a state focused on arable production — a system in which resources were fully utilised, and adult cattle were exploited for meat, leather and bone once their utility as working animals had been exhausted.

While the late Roman urban data are too limited to draw any conclusions regarding this site type, the available late Roman data across all site types are consistent with a continuity in practice from the mid-Roman period. In the early Byzantine period, there is a higher

proportion of young individuals on urban and military sites than in the mid-Roman period, though adults remain most abundant. The recovery of a single neonate from the military site at Dichin indicates cattle breeding thereabouts. Given the potential for this practice at Dichin, extramural cattle husbandry may also be postulated for other military and urban sites — high proportions of adults at such sites could thus indicate both dairy and arable production by these communities, followed by secondary exploitation for meat.

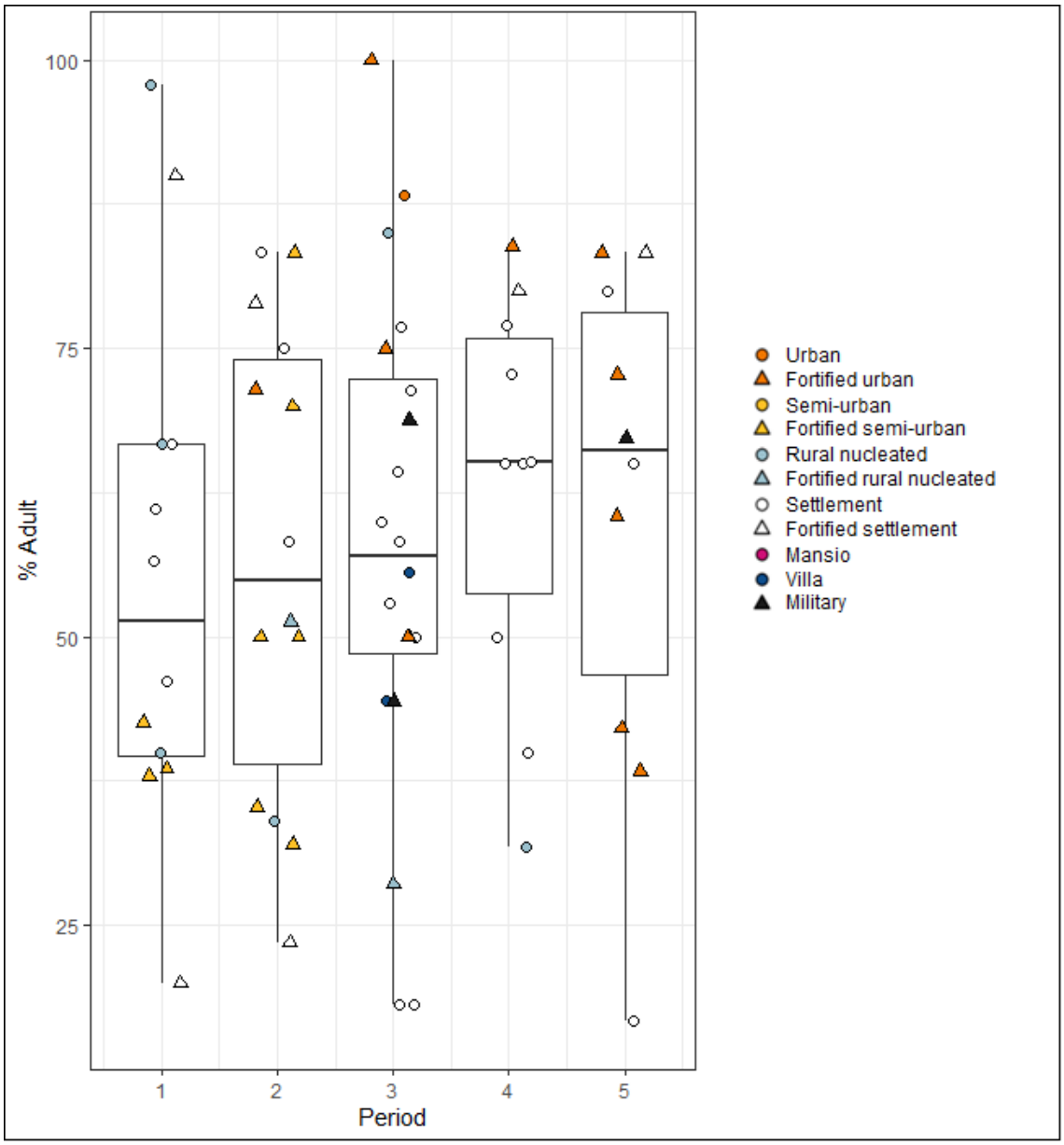


Figure 6.18: Cattle age by site type and period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine. Minimum sample size = 5 specimens.

6.6.3 Sheep/goat

Figure 6.19, A to E, shows sheep/goat age distribution by period. The presence of very young individuals at three late Iron Age sites, and at one mid-Roman and one early Byzantine site, indicates the presence of breeding populations, suggesting that a proportion of the sheep/goat products consumed at these sites may have been produced locally. In the late Iron Age, the majority of sites on which young individuals comprise 60% or more of the sheep/goat remains are located in late Iron Age Dacia. The higher proportion of young than adult individuals on these sites indicates exploitation primarily for meat, and echoes the pattern observed in the cattle data. In the far west of the study region at Giarmata-Baraj (Timiș County, Romania) (El Susi 2019), there is also a clear focus on the exploitation of sheep/goat for meat. Elsewhere, at the northern- and southernmost sites in the sample, adults comprise 75% or more of the remains, indicating exploitation primarily for dairy or wool production, and secondary exploitation for meat beyond prime age at these sites. In the early Roman period, the data reveal the culling of even greater proportions young sheep/goat in the Kingdom of Dacia than was the case in the previous period.

In the mid-Roman period, adults become more abundant than young individuals for the first time. In the eastern Balkan provinces, there is a slight focus on the exploitation of adults in Dobrogea, where this age group comprises between 56% and 67% of the sheep/goat remains. Further to the west at a site in central Bulgaria, young individuals predominate. In Roman-occupied Dacia, where the abundance of young individuals ranges from 15% to 65% of the remains, the data reveal the practise of a range of forms of sheep/goat husbandry. The data indicate exploitation primarily for meat at two sites, and for dairy or wool at three others, but suggest mixed husbandry practice at the final site in the Dacian sample. Beyond the Empire in Moldavia, adult individuals are most abundant, and range from 54% to 83% of the sheep/goat remains.

In the late Roman period, adults remain more abundant than young individuals across the fairly small sample of sites for which data were available. In this period, adults comprise 52% of the sheep/goat remains on average, a slight decrease relative to the previous period. A range of exploitation practices are in evidence once again. At two sites towards the east of the study region, young individuals comprise more than 70% of the sheep/goat remains, demonstrating a clear focus on exploitation for meat at these sites. Young sheep/goat are also

more abundant than adults at a single site in Dobrogea. Elsewhere, at the remaining four sites in the sample, adults generally predominate. Overall, the data indicate a continued slight focus on the husbandry of sheep/goat for dairy or wool production, though the sample continues to be characterised by considerable variation between sites.

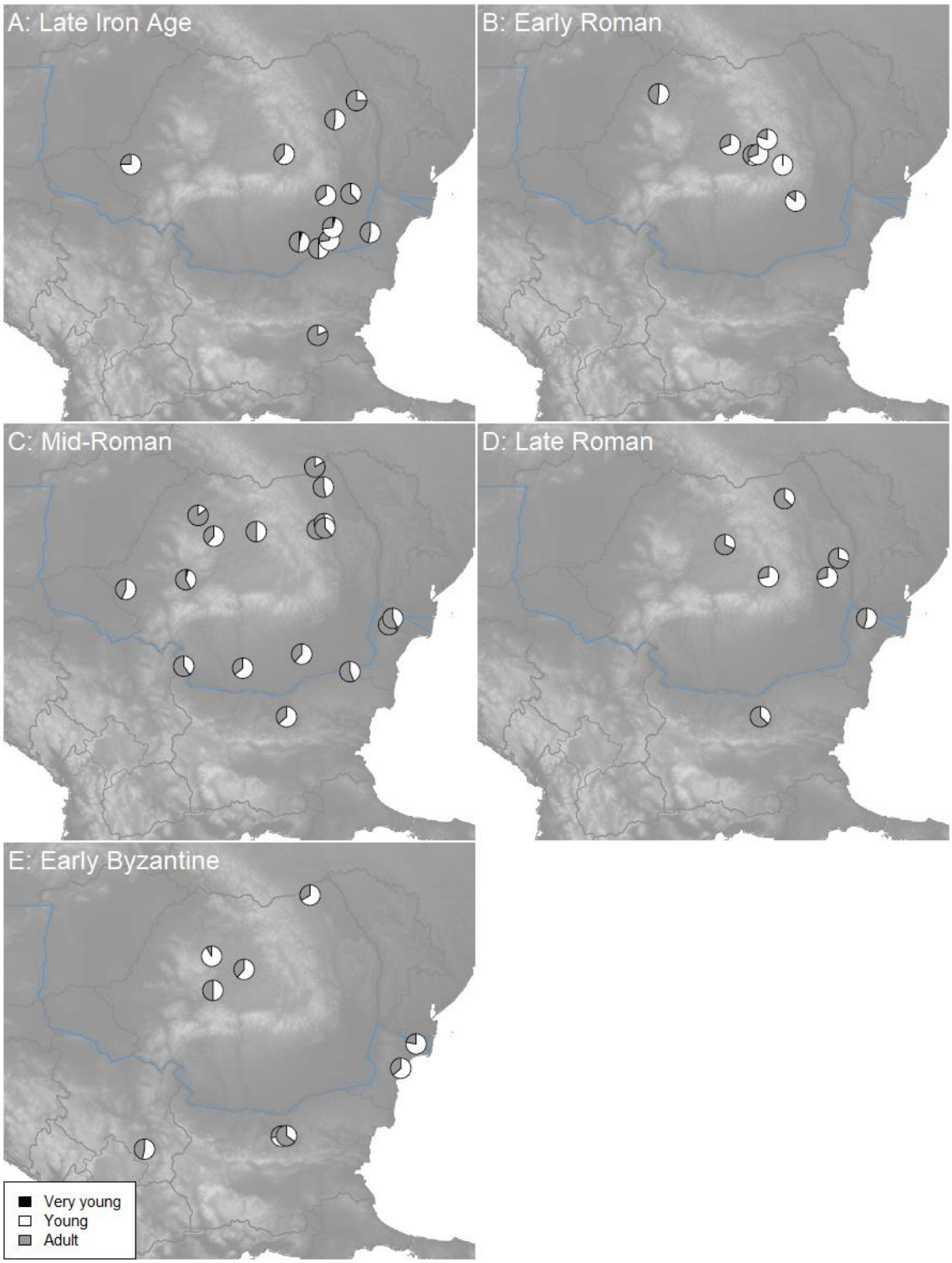


Figure 6.19: Sheep/goat age by period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine. Minimum sample size = 5 specimens.

In the early Byzantine period, there is an overall increase in the abundance of young individuals, though age distribution continues to vary considerably across the study region. In the Balkan provinces, exploitation variously for meat and for dairy or wool is indicated at the sites in the sample. Contrasting practices are evident at Nicopolis ad Istrum and at Dichin, two neighbouring sites in central Bulgaria, while in Dobrogea there is a focus on young individuals, as was also the case for cattle in this region in the early Byzantine period. Overall, the data suggest site-specific, rather than region-specific, approaches to husbandry practice in the Balkan provinces. To the north of the Danube, young individuals are generally more abundant than adults, though, once again, considerable variation in practice is evident, and the sample size is small.

Figure 6.20 shows sheep/goat age by site type and period. Of the three late Iron Age sites featuring very young individuals, two are semi-urban, while the mid-Roman and early Byzantine sites at which very young individuals are present are both military, indicating that sheep/goat breeding was not only undertaken by rural communities. In the late Iron Age, there is no clear differentiation in sheep/goat exploitation by site type. In the early Roman period, exploitation practices vary widely across five semi-urban sites. An abundance of young individuals at three of these sites demonstrates a focus on exploitation for meat, while a very high proportion of adults at a fourth site raises the possibility that these animals were husbanded in the extramural area for dairy or wool production; the import of live animals for the extraction of milk, wool or mutton cannot be ruled out, however. In the mid-Roman period, the abundance of young sheep/goat is higher on average at urban and military sites than at rural sites, indicating a greater focus on exploitation for meat at the former site types, and for dairy or wool at the latter. Late Roman site type data are too limited to draw conclusions regarding site-type-based variation.

In the early Byzantine period, the data suggest a clear change in sheep/goat age distribution by site type relative to the mid-Roman period, though the sample size is fairly small and more data would be required to draw clear conclusions. The period sees a slight increase in the abundance of young individuals at urban and military sites, but a much clearer increase in the proportion of this age group at rural sites, where young sheep/goat now outnumber adults. The data therefore suggest that the early Byzantine period saw an increase in the exploitation of sheep/goat for meat at rural sites in particular. Conversely, a higher proportion of the cattle population was observed to have been kept into adulthood in the early Byzantine period than

in previous periods — a change that indicates an increase in dairy or arable production. In this context, an increase in the abundance of young sheep/goat could be interpreted as evidence for a shift in the focus of meat production from cattle to sheep/goat. As adult cattle appear to have been increasingly favoured over adult sheep/goat, the increased abundance of cattle in this period more likely results from an increase in arable than in dairy production, since both taxa could be exploited for the latter.

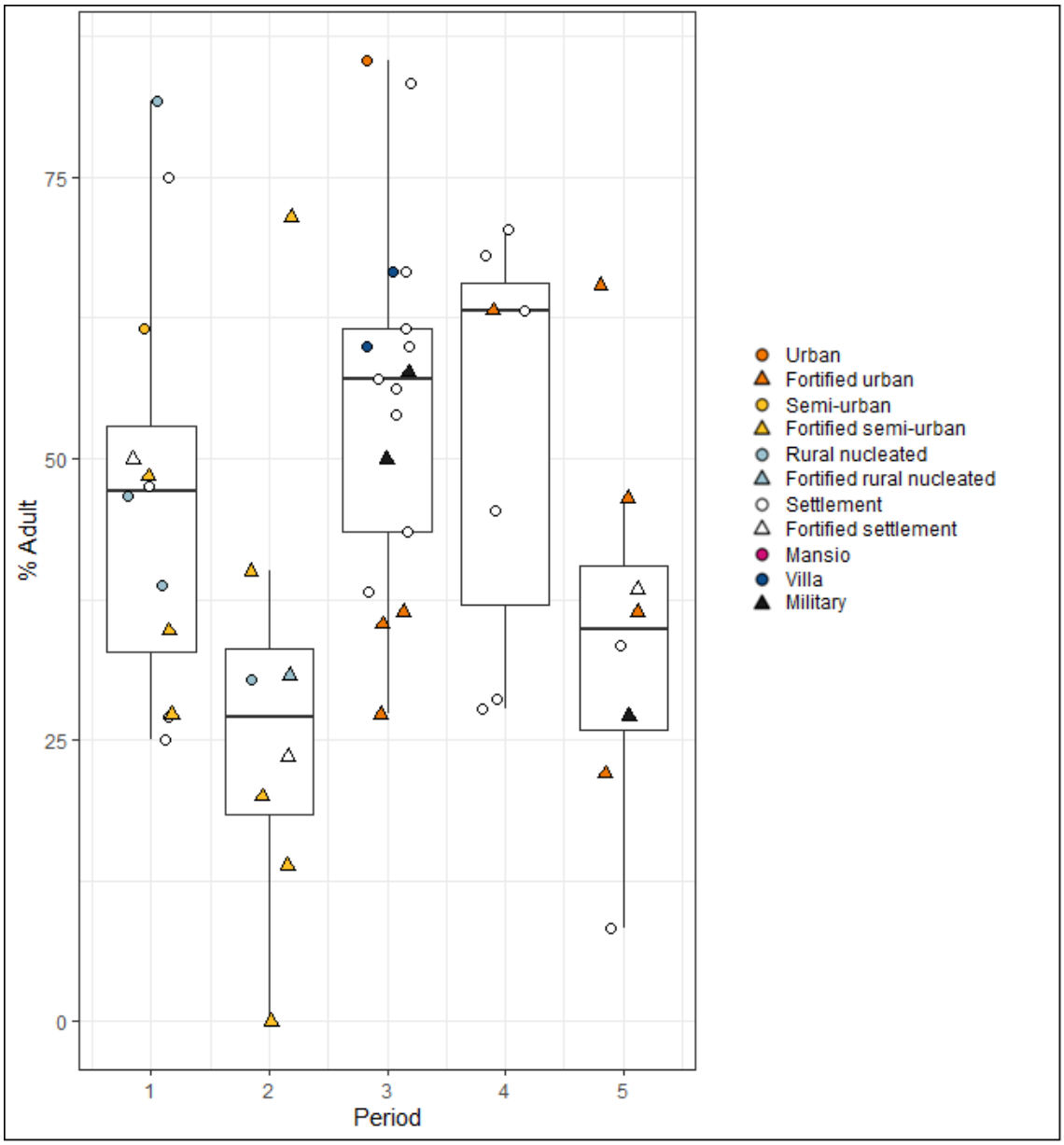


Figure 6.20: Sheep/goat age by site type and period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine. Minimum sample size = 5 specimens.

6.6.4 Pigs

Figure 6.21, A to E, shows pig age distribution by period. While young individuals outnumber adults in every period, some spatial and temporal variation in age distribution is evident. In the late Iron Age, young individuals comprise more than 60% of the pig remains on all but one site — Yassa-Tepe (Yambol Province, Bulgaria), in central Bulgaria (Ribarov and Boev 1990). Young individuals comprise only 40% of this assemblage, suggesting that the majority of pigs were culled beyond prime age. At three sites to the north of the Danube, very young pigs were recovered, indicating the breeding of pigs onsite, or perhaps the import for consumption of suckling pig. At one of the three sites — Vlădiceasca (Ilfov County) — very young pigs comprise 21% of the remains (Ionescu 1976), strongly indicating the presence of a breeding population. In the early Roman period, the proportion of young pigs remains high. There is little evidence for spatial variation in pig exploitation across the fairly small sample of sites, though the abundance of adults appears to be slightly higher in Transylvania than elsewhere in the study region. No early Roman data were available for the Balkan provinces, preventing analysis of temporal change through the first two periods in this region.

In the mid-Roman period, young pigs predominate once again, though adults comprise a relatively high proportion of the pig remains at several sites. At Porolissum, in Roman-occupied Dacia, for example, adults comprise 79% of the remains (Ghiurco *et al*. 1992; Gudea 2003; Damian *et al*. 2008), indicating the consumption of a large proportion of the pigs at the site beyond prime age. Very young individuals were recovered from two sites. At the Dacian urban settlement at Romula-Reșca, the presence of a very young individual could indicate either intramural pig breeding or the consumption of suckling pig by the urban community. At the villa at Horia, in Dobrogea, 14% of the pig remains comprise a very young individual, while the remaining 86% comprise young pigs. The data indicate a focus on the consumption of pigs at prime age, suggesting that the youngest individuals recovered from the site may also more likely represent consumption waste rather than evidence for onsite pig breeding. The sample size is too small to enable clear conclusions to be drawn either way, however.

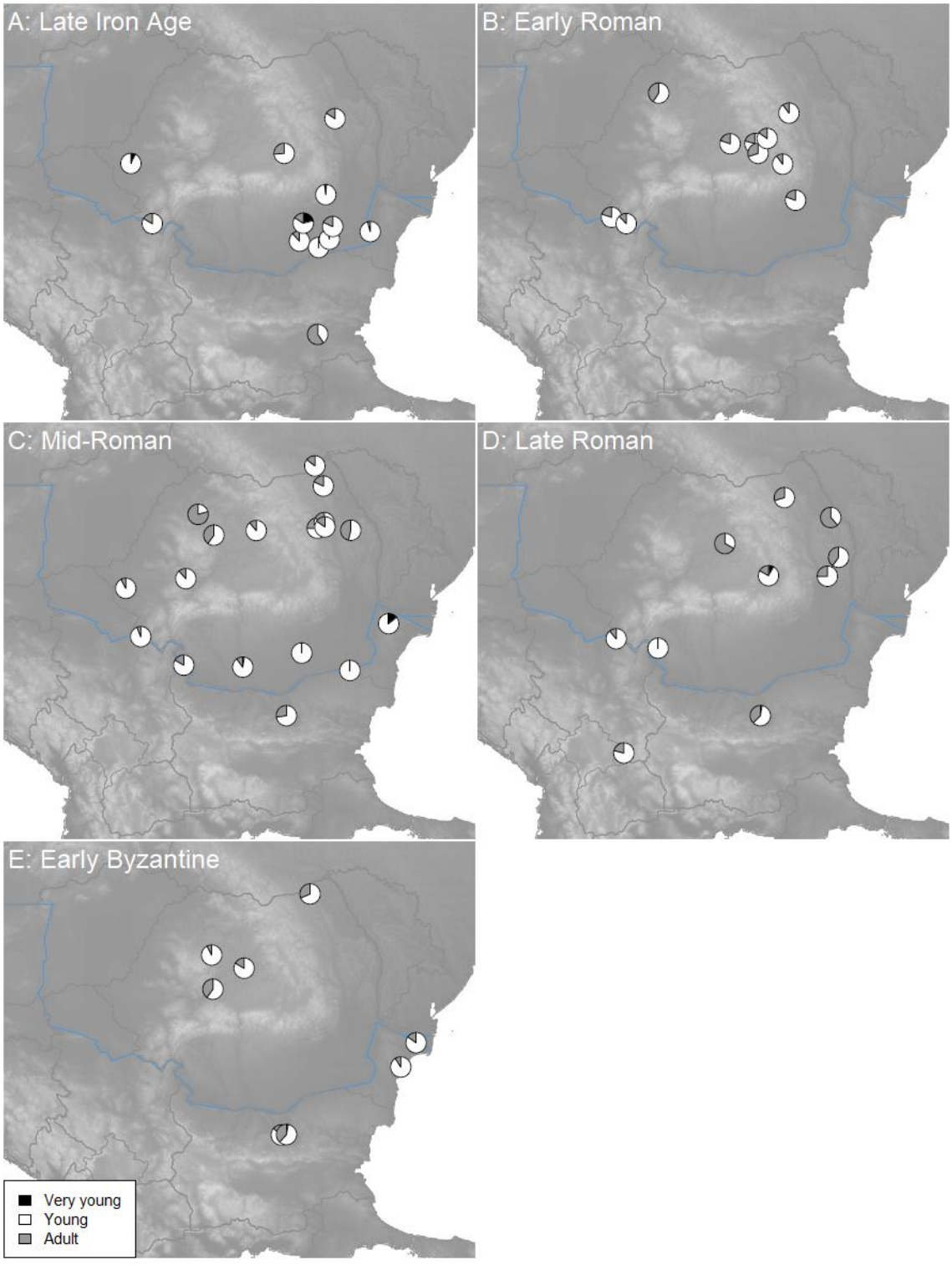


Figure 6.21: Pig age by period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine. Minimum sample size = 5 specimens.

In the late Roman period, there is a clear decrease in the abundance of young pigs. While in the first three periods, young individuals comprised on average 83%, 78% and 80% respectively of the pig remains, by the late Roman period young individuals comprise only 68% on average. A decrease in young pigs is not seen uniformly across the study region,

however, but occurs only in the eastern half of the region. In Transylvania, in post-Roman Dacia, the very limited available data show only a slight decrease in the average abundance of young pigs relative to the mid-Roman period, indicating little change in pig husbandry during and after the end of the Roman occupation in this region, though more data would be necessary to draw reliable conclusions. Beyond the Empire in Moldavia, the proportion of adults increases from 23% on average in the mid-Roman period to 39% in the late Roman period, indicating an increase over time in the consumption of pigs beyond prime age, or perhaps an increase in the export elsewhere of young individuals bred within the region.

In the early Byzantine period, the abundance of young pigs increases again, and this age group comprises a similar proportion of the pig remains as was observed in the first three periods. The total number of sites for which age data were available in this period is fairly small, however, so any conclusions drawn are fairly tentative. In Dacia, there is an increase in the abundance of young individuals from 66% to 79% of the pig remains, indicating an increase in the culling and consumption of pigs of prime age. In the Balkan provinces, young pigs are more abundant in Dobrogea than in central Bulgaria, as was also the case in the mid-Roman period. The data thus suggest that the Roman occupation had relatively little impact on pig husbandry to the south of the Danube.

Figure 6.22 shows pig age by site type and period. As discussed above, the ‘non-adult’ pig population includes very young individuals, which are present on urban, semi-urban, military and rural sites. While the import of suckling pig to consumer sites cannot be ruled out, the presence of foetal or neonatal pigs on at least one urban, one semi-urban, one military and one rural site across the study period suggests that pig breeding likely took place on a range of site types. The proportion of young versus adult pigs on rural sites versus other site types varies somewhat over time. In both the late Iron Age and the late Roman period, young pigs are more abundant on urban, semi-urban and military sites than on rural sites, suggesting the exploitation of more individuals of prime meat age on the former site types than the latter. In the remaining three periods, young pigs are more abundant on rural sites than on other site types. There is no clear correlation between changes in the abundance of pigs relative to other livestock and changes in the abundance of individuals of prime age relative to adults, suggesting that pig culling and consumption strategies were influenced by other factors than those stimulating changes in livestock relative abundance.

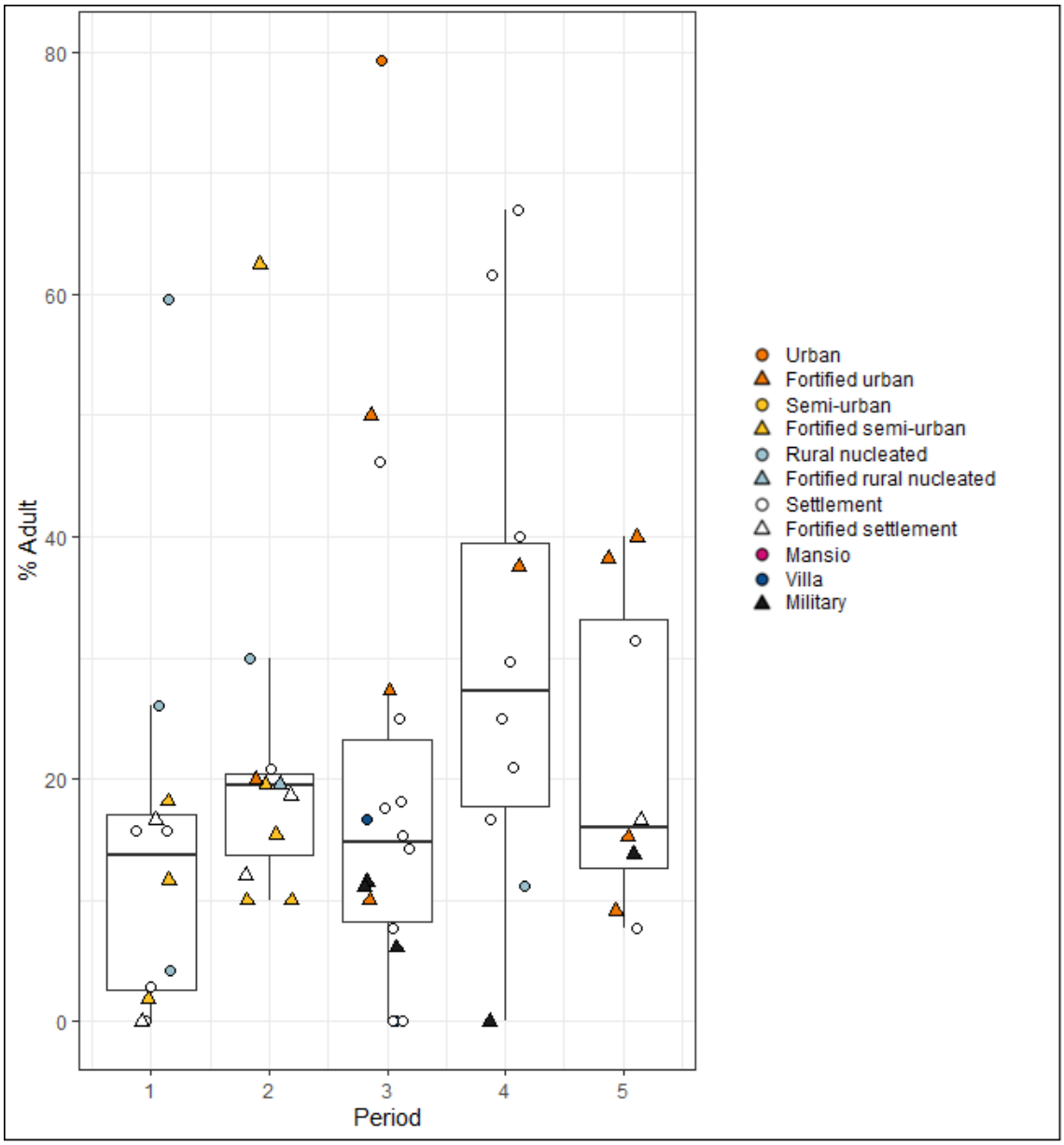


Figure 6.22: Pig age by site type and period. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine. Minimum sample size = 5 specimens.

6.6.5 Summary

Age data for all three livestock taxa reveal a degree of variation in approaches to culling and consumption across the study region and the study period. In certain cases, sufficient data are available to enable the interpretation of observed patterns in one taxon with respect to changes in the exploitation of another. This is the case for the early Byzantine increase in the exploitation of adult cattle and young sheep/goat, concurrent with an increase in cattle abundance, which suggests a shift in meat consumption from beef to a greater focus on lamb, and an increased reliance on adult cattle for traction. In some cases, patterns in age

distribution show clear contrasts with patterns in livestock relative abundance. This is seen in the lack of change in cattle age distribution from the early Roman to the mid-Roman period, despite a clear increase in the relative abundance of this taxon. This divergence suggests that the increased cattle focus under Roman rule occurred not as a result of a clear change in the ways in which this taxon was utilised, but instead by the intensification and expansion of existing management strategies. Overall, while the age dataset provides useful insights into livestock management strategies for certain regions in certain periods, in many cases sample size is too small to draw any clear conclusions.

6.7 Livestock morphology

6.7.1 Introduction

This section will present the analysis of the livestock metrical data. For each taxon, spatial and temporal variation are first considered for the study region as a whole, and statistical testing used to identify any significant changes in size between periods and regions. Size variation by site type is then considered for each region. The section begins with the analysis of the cattle data, followed by sheep/goat, and then pigs.

6.7.2 Cattle

Cattle size by period and region

Figure 6.23, A to C, shows LSI values for cattle bone widths. In the late Iron Age, the Dacian sample has the highest median LSI value. The data indicate that cattle in Dacia and in the area beyond the Empire were considerably larger than those to the south of the Danube in this period, though the sample for the Balkan provinces is likely too small to be representative. In the early Roman period, an increase in cattle size during the earliest Roman occupation of the Balkan provinces brings the median for this region closer to those observed in the other two regions, though the largest individuals recorded in the Balkan provinces in this period are still smaller than those seen in both of the other two regions. Thus while the early Roman period sees the appearance of larger cattle in the Balkan provinces than had previously been present, the largest animals continue to be found to the north of the Danube, outside the area of Roman control.

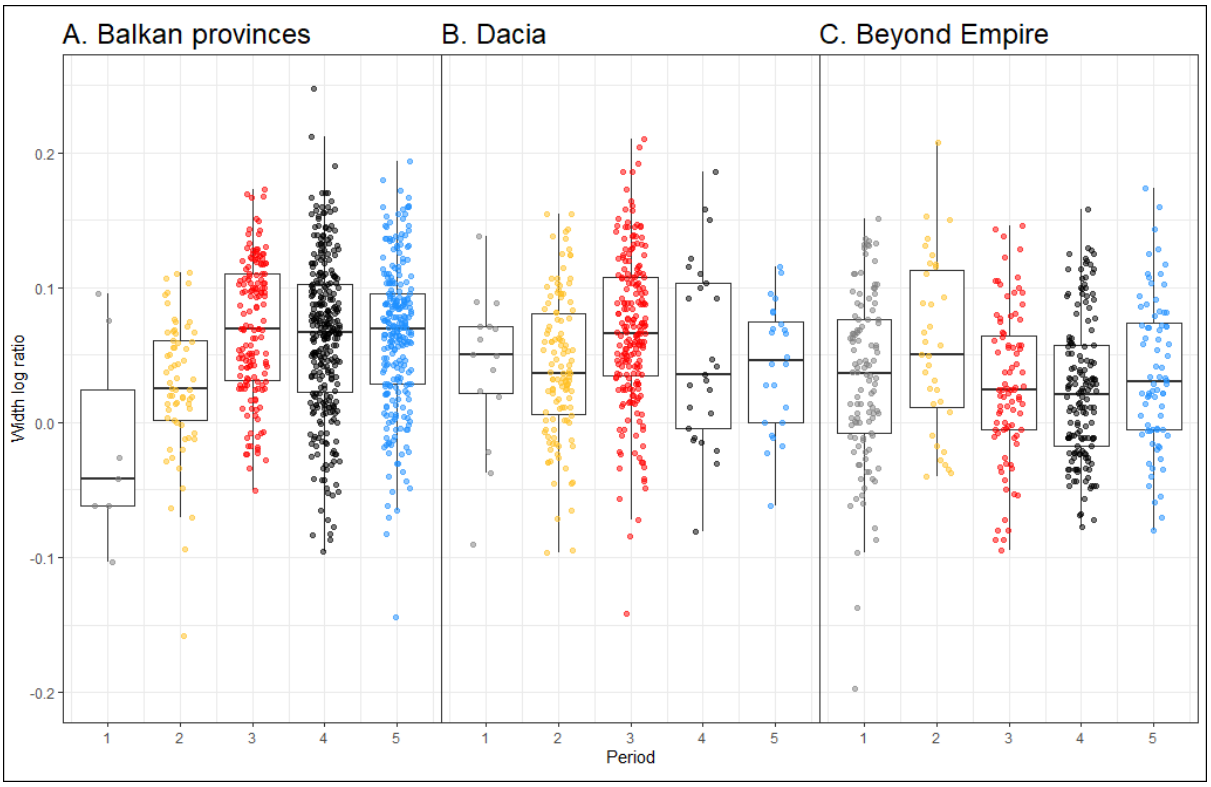


Figure 6.23: LSI values for cattle bone widths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

In the mid-Roman period, the clear increase in the median LSI values in the Balkan provinces and Dacia reverses the pattern seen previously — larger cattle are now present in Roman-occupied than non-Roman-occupied regions, with the largest individuals seen in the Dacian sample. This is a pattern that persists for the remainder of the study period. In the late Roman Balkan provinces, there is no change in cattle size, with the median remaining high. In Dacia, meanwhile, the withdrawal of Rome coincides with a decline in median cattle size. Large individuals do not completely disappear from the sample, however, suggesting that changes in cattle size instituted under Roman continued to have an impact in the region beyond the period of direct occupation. There is little change beyond the Empire in the late Roman period — cattle of a range of sizes, from small to fairly large, continue to characterise the population. The trends observed from the mid-Roman to the late Roman period continue into the early Byzantine period. Cattle remain largest on average in the Balkan provinces. In Dacia, more cattle at the upper end of the size range disappear from the sample, and beyond the Empire, there is once again little change.

A Wilcoxon rank sum test was used to determine whether any of the observed differences in cattle size between periods are statistically significant (Table 6.7), using LSI values for cattle bone widths. The results of the test indicate no statistically significant difference in cattle size between the late Iron Age and the early Roman period, but a significant difference between each of these two periods and the remaining periods. This result indicates an overall change in the size distribution of the cattle population between the first two periods, on the one hand, and the later three, on the other, for the study region as a whole. The test indicates a significant difference between the mid-Roman cattle population and that of the late Roman period, but not between mid-Roman and early Byzantine populations. The slight increase in average cattle size in all three regions in the early Byzantine period thus appears to bring the sample for this period closer in character to that of the mid-Roman period, following a slight late Roman decline in cattle size.

Table 6.7: Wilcoxon rank sum test for cattle size by period. *p* values in **bold** are statistically significant; *significant ($p \leq 0.05$), **highly significant ($p \leq 0.01$).

Period	Late Iron Age	Early Roman period	Mid-Roman period	Late Roman period	Early Byzantine period
Late Iron Age					
Early Roman period	0.35				
Mid-Roman period	****p<0.001**	****p<0.001**			
Late Roman period	****0.01**	***0.05**	****0.006**		
Early Byzantine period	****p<0.001**	****p<0.001**	0.35	0.08	

A Wilcoxon rank sum test was also used to determine whether any of the differences in cattle size between regions are statistically significant (Table 6.8). The results of the test indicate a statistically significant difference in cattle size between each of the three regions, suggesting that the impact of the Roman occupation on cattle size was proportional to the duration of that occupation. In the Balkan provinces, where multiple large individuals are present in each of the three later periods, the cattle are sufficiently larger overall to be significantly different from the Dacian population, where large individuals are only present in the mid-Roman and late Roman periods. Dacian cattle become sufficiently large during the Roman occupation, meanwhile, that the population in this region for the study period as a whole is statistically distinct in size from the population beyond the Empire.

Table 6.8: Wilcoxon rank sum test for cattle size by region. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Area	Balkan provinces	Dacia	Beyond the Empire
Balkan provinces			
Dacia	****0.007**		
Beyond the Empire	****p<0.001**	****p<0.001**	

Figure 6.24, A to C, shows LSI values for cattle bone depths. The bone depth data largely corroborate the patterns identified in the width data. In the Balkan provinces, there is an increase in the median LSI value in the mid-Roman period, and cattle remain relatively large on average thereafter. In Dacia, the mid-Roman period also sees an increase in size, though, in contrast to the width data, the depth data indicate little size decrease in the late Roman period. The sample size for the late Roman period is very small, however, so the observed distribution may not be a reliable representation of the true distribution of sizes. By the early Byzantine period, however, there is a clear decline in cattle size in Dacia. Beyond the Empire, while cattle appear to be slightly larger on average in the early Roman period than in other periods, the sample is likely to small to be reliable. From the mid-Roman period onwards, the cattle beyond the Empire are smaller on average than those in Roman-occupied regions.

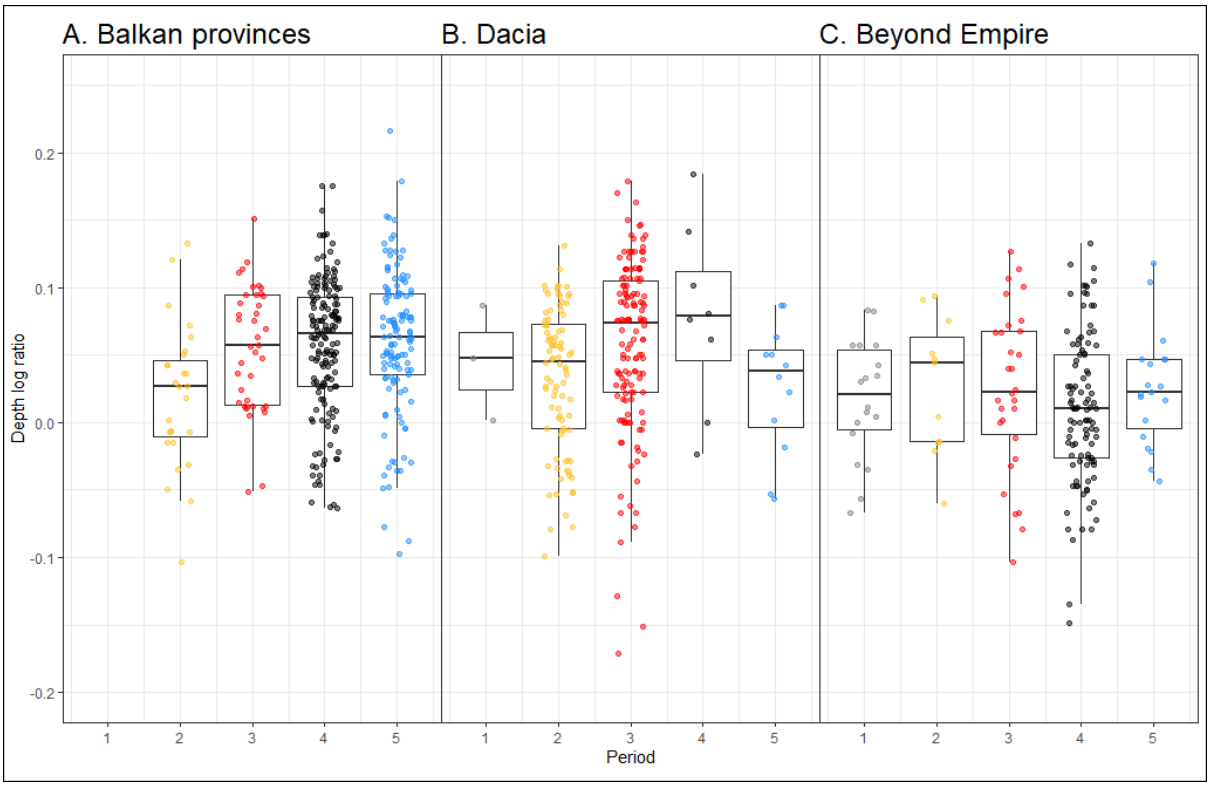


Figure 6.24: LSI values for cattle bone depths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Figure 6.25, A to C, shows LSI values for cattle bone lengths. In the Balkan provinces, there is little change in the median from the early Roman to the mid-Roman period, suggesting that although cattle became generally larger in the latter period, they did not become much taller. The mid-Roman population thus appears to have been characterised by more robust cattle than were present in the early Roman period. In the late Roman period, when there is little change in the width and depth data, the median length value increases. The data indicate the appearance of taller individuals, which would therefore have been less robust than their mid-Roman counterparts, perhaps indicating a higher proportion of castrates in the population. In Dacia, length values more closely track changes in widths and depths, though the cattle appear to be somewhat more robust in the late Roman period than before or after. Beyond the Empire, the clearest difference between the length data and the widths and depths is the much smaller range observed for the former. Thus while cattle range widely in overall size in each period, they differ much less in height — the population in this region therefore likely featured many individuals of a similar stature, but ranging from fairly slender to fairly robust.

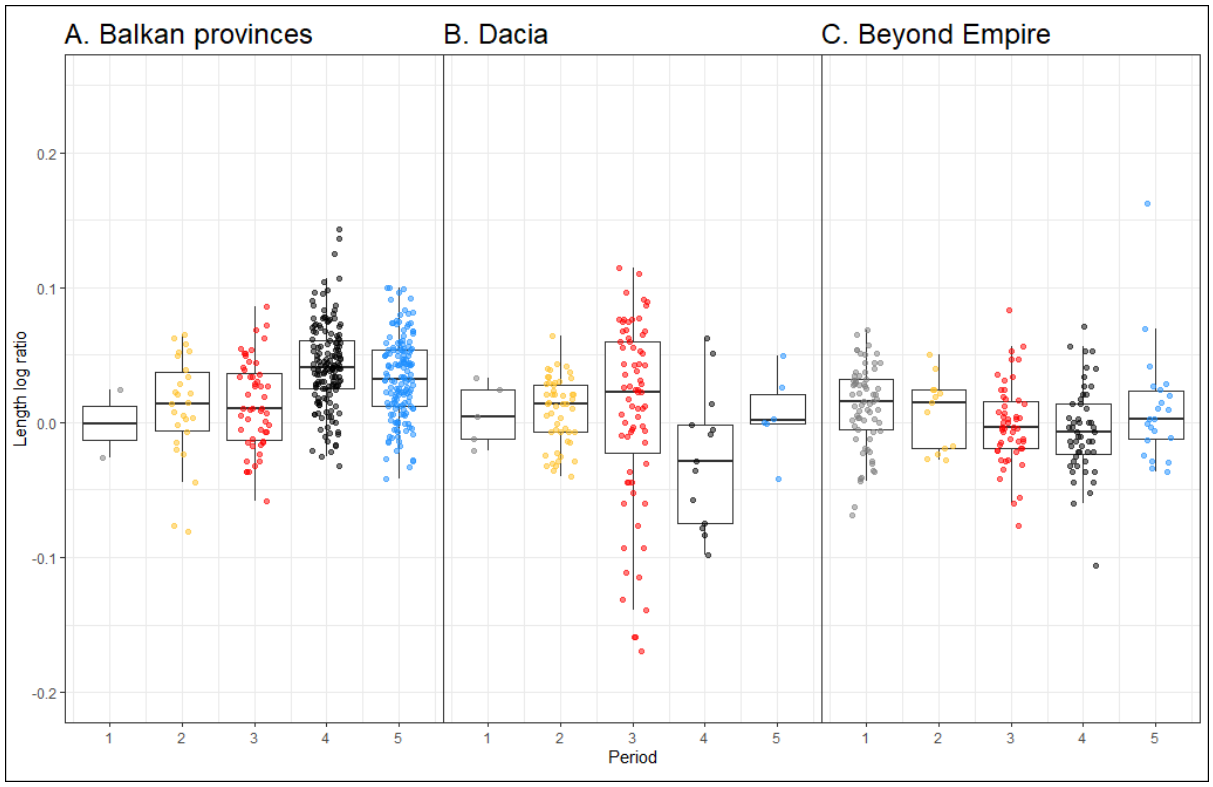


Figure 6.25: LSI values for cattle bone lengths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Cattle size by site type and period in the Balkan provinces

Figure 6.26A shows LSI values for cattle bone widths in the Balkan provinces by site type and period. Width measurements were more numerous than either depths or lengths, so these are used here to evaluate temporal and site-type-based trends in cattle size. Analysis of the data by site type reveals several trends. In the mid-Roman period, slightly more than half of all measurements taken from cattle deposited at urban sites are larger than the median for the period as a whole. The reverse is true for measurements taken from cattle in villa assemblages, which cluster below the median. Points for other rural sites are fairly evenly distributed through the sample. The data thus indicate the preferential exploitation of larger cattle at urban settlements than at villa estates. In the early Byzantine period, while the range of bone widths observed at military sites is fairly wide, values cluster towards the lower end of the range observed for urban and semi-urban sites, suggesting that while cattle of a wide range of sizes were exploited in fairly equal proportions at the latter site types in this period, military communities more often exploited smaller individuals.

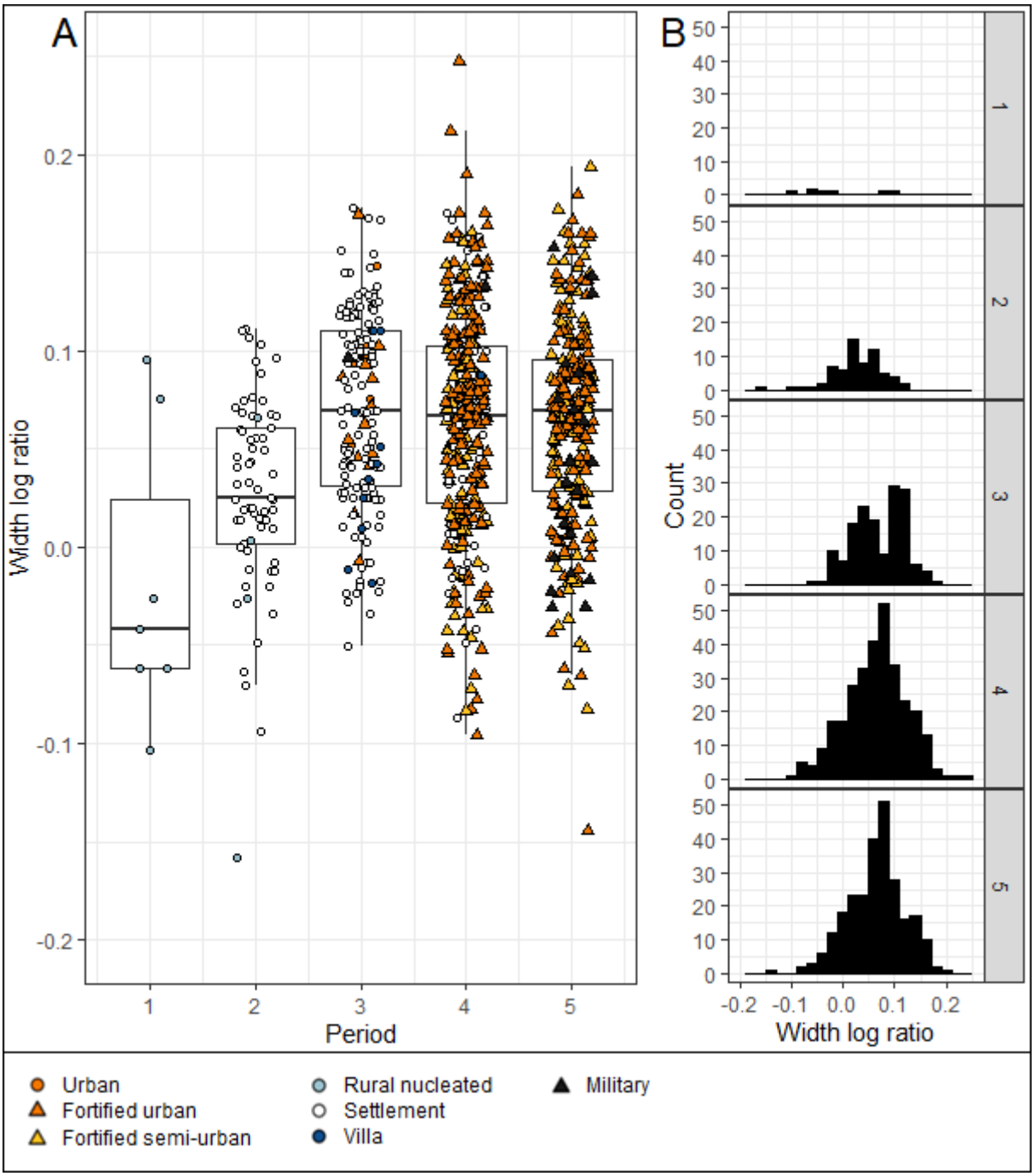


Figure 6.26: LSI values for cattle bone widths in the Balkan provinces. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Figure 6.26B shows the modality of the distribution of LSI values for cattle bone widths in the Balkan provinces by period. Figure 6.26B shows the same data as are shown in Figure 6.26A, but in the form of a histogram to better reveal the modality of the distribution. Only in the mid-Roman period is there a sufficient gap in the distribution to indicate a bimodal population, though there is a hint of the emergence of such a population in the early Roman data. This bimodal distribution could represent a sexually dimorphic population, or could

result from the maintenance of a pre-existing population of smaller cattle alongside a separate population of larger individuals. The appearance of this population of larger cattle could result from the targeted improved feeding of a subset of the cattle in the Balkan provinces, or could instead result from the import and introduction of larger breeding stock to certain parts of the cattle population, both with the aim of meeting demand for increased yields from certain producers and consumers. In the late Roman period, the distribution becomes unimodal, indicating that sufficient interbreeding had taken place by this time that discernible populations of smaller and larger cattle were no longer present. This change could indicate the more widespread improved feeding of cattle, and less variation in approaches to cattle husbandry, or the more widespread use of imported larger individuals or their locally-bred descendants to make a genetic change to the cattle population.

Cattle size by site type and period in Dacia

Figure 6.27A shows LSI values for cattle bone widths in Dacia by site type and period. Variation in cattle size by site type can be seen in two of the five periods. In the mid-Roman period, more than half of all bone widths from villas and other rural sites fall below the median, while the reverse is true for urban and military sites. Metrical data for this period thus indicate the exploitation and deposition of a higher proportion of larger cattle at urban and military sites in Dacia than were available at rural sites. In the early Byzantine period, though the sample is relatively small, the data indicate a change in site-type-based patterns of exploitation, as urban cattle bone widths are on average smaller than their rural equivalents.

Figure 6.27B shows the modality of the distribution of LSI values for cattle bone widths in Dacia by period. In the early Roman period — the only period exhibiting multiple modes in the data — the gaps in the distribution are too small to infer the presence of separate populations of differently-sized cattle. In the mid-Roman period, when cattle size increases under the Roman occupation, there is no indication that this occurred via the emergence of a separate population of larger cattle; rather, the distribution of values suggests a single population of females and males. The data suggest that the production of larger individuals, whether by feeding or by breeding, was sufficiently widespread throughout the cattle population to result in a unimodal distribution of bone widths. In the late Roman period, there is a clear gap in the distribution, which could result from the maintenance of populations of larger cattle in Dacia alongside separate populations of smaller individuals after the Roman

occupation ended — the sample size for this period is too small to draw clear conclusions, however.

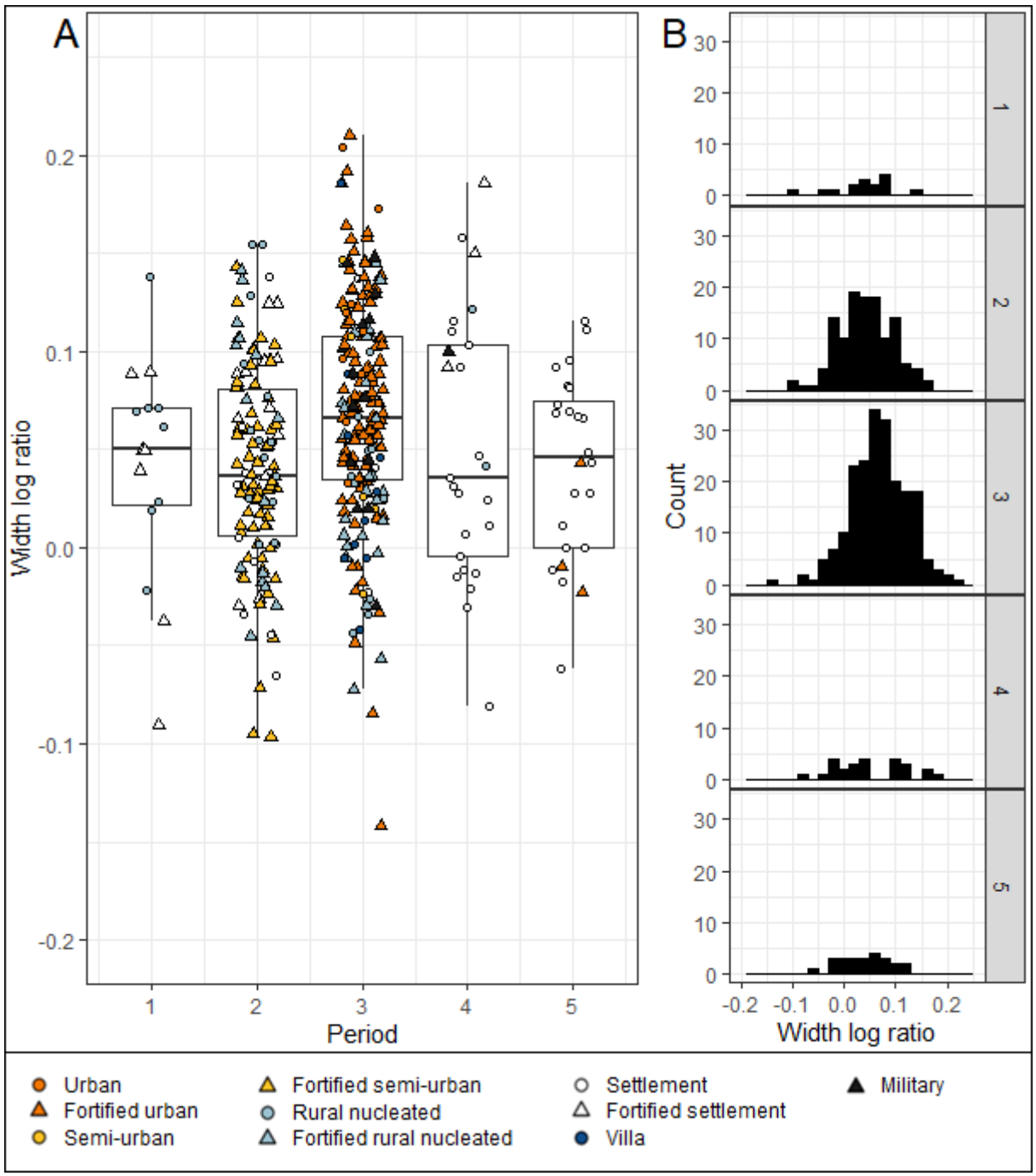


Figure 6.27: LSI values for cattle bone widths in Dacia. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Cattle size by site type and period beyond the Empire

Figure 6.28A shows LSI values for cattle bone widths beyond the Empire by site type and period. Analysis of the late Iron Age data reveals that cattle were on average smaller at semi-urban sites than at rural sites. Measurements were available from too limited a range of site types in the four later periods to enable the analysis of temporal variation in cattle size by site type. Figure 6.28B shows the modality of the distribution of LSI values for cattle bone widths beyond the Empire by period. While there are gaps in the distribution throughout the study period, these are generally too dispersed to identify clear size groups. In the late Roman period, the data indicate the possible presence of small numbers of larger individuals, alongside larger numbers of medium-sized and smaller cattle. This distribution could result from the breeding or import of larger cattle, but could equally be a consequence of the presence in the population of females, males and castrates. In the early Byzantine period, the data indicate a possible bimodal population, though the sample size is too small to draw clear conclusions, and the larger of the two groups lies within the range of the previous two periods, so is perhaps unlikely to result from the establishment of a new feeding or breeding regime.

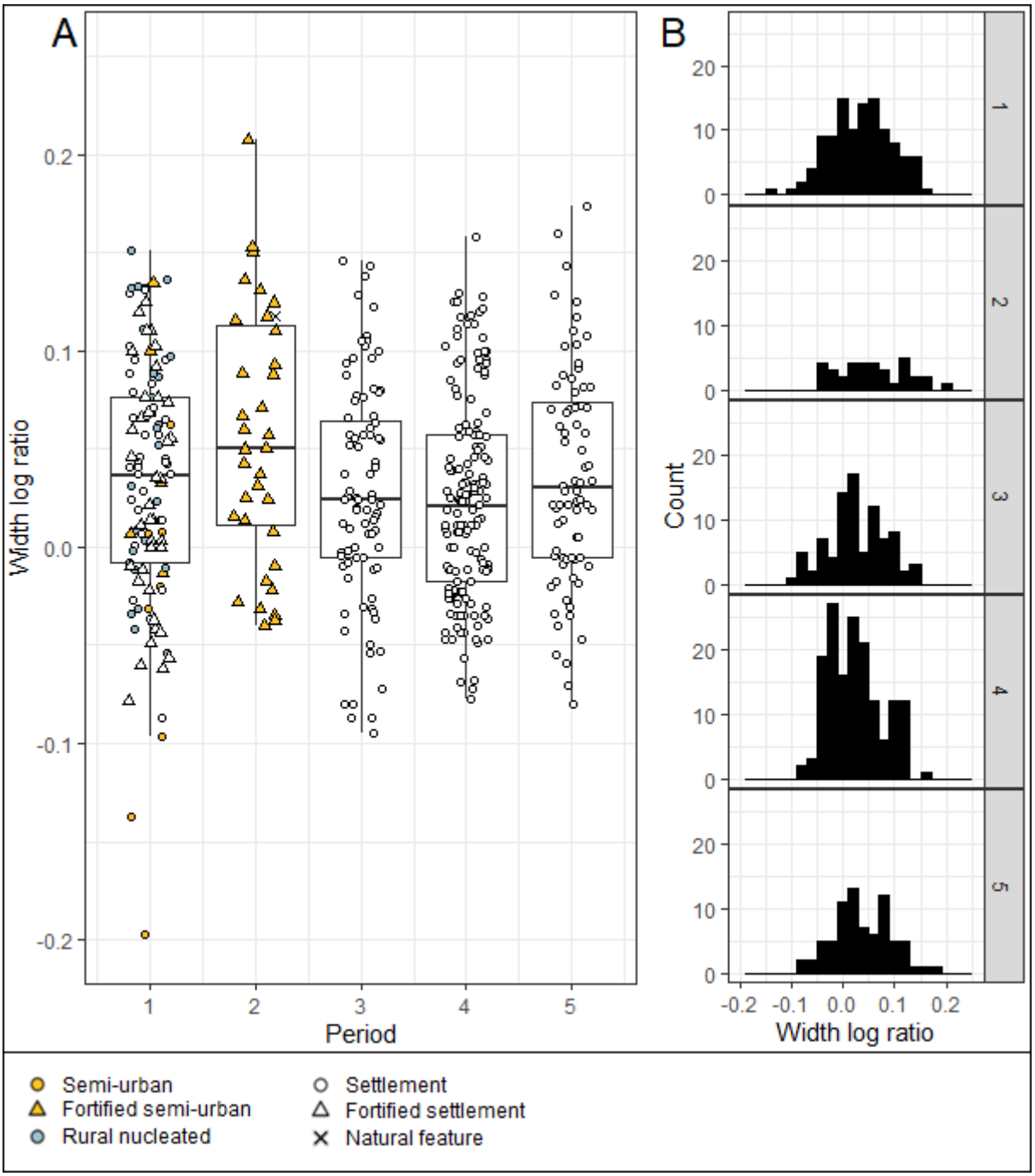


Figure 6.28: LSI values for cattle bone widths beyond the Empire. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

6.7.3 Sheep/goat

Sheep/goat size by period and region

Figure 6.29, A to C, shows LSI values for sheep/goat bone widths. Data for the Balkan provinces are too few in the late Iron Age to compare sheep/goat size in this region with the other two regions. To the north of the Danube, median sheep/goat size is similar in both regions. In the early Roman period, the median LSI value is slightly higher in Dacia than in the Balkan provinces, and slightly higher again beyond the Empire. Sheep/goat are thus slightly smaller in Roman-occupied than in non-Roman-occupied regions in the early Roman period.

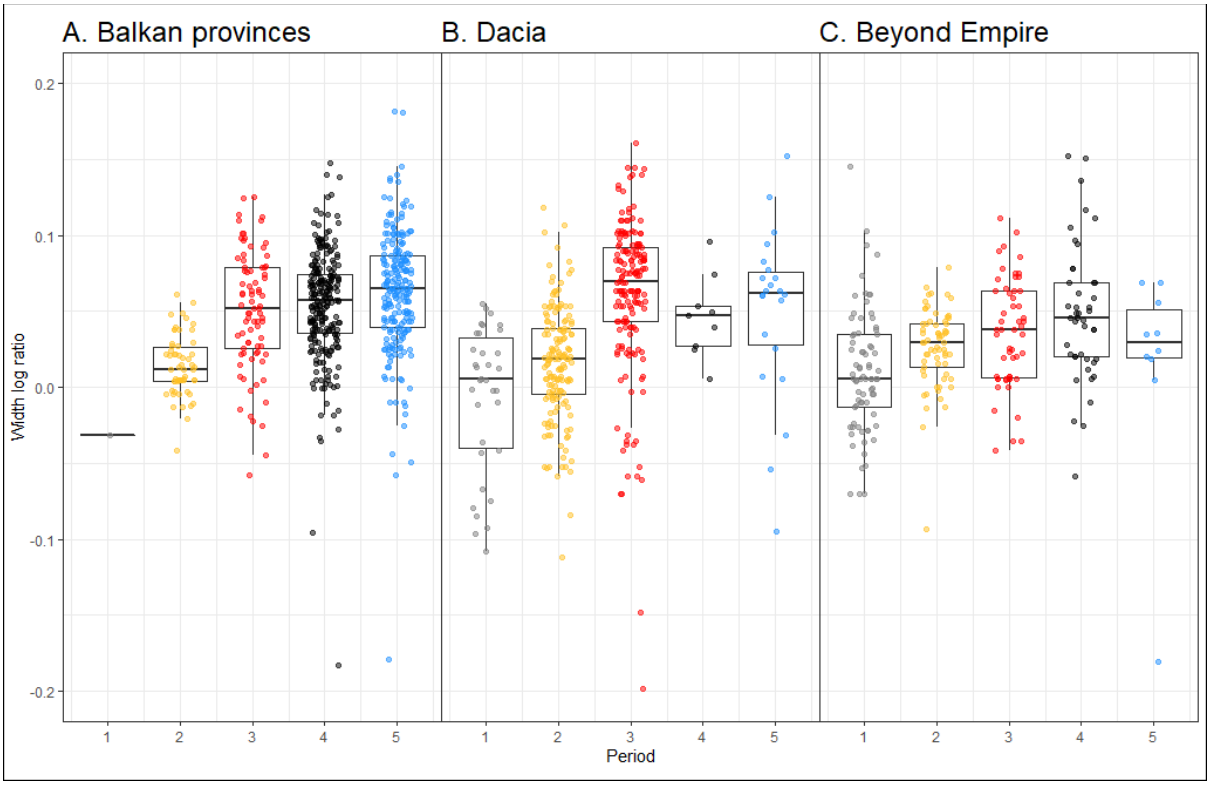


Figure 6.29: LSI values for sheep/goat bone widths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

From the mid-Roman period onwards, sheep/goat are larger on average in Roman-occupied regions than elsewhere, as was also observed in the cattle data. There is a clear increase in the median in both the Balkan provinces and Dacia in the mid-Roman period, with the highest

average seen in the latter region. The data suggest that although in the Balkan provinces larger sheep/goat only emerged several centuries into the Roman occupation, in Dacia a considerable increase in sheep/goat size occurred much more quickly following the conquest. In the late Roman period, a slight increase in the median in the Balkan provinces, and a clear decrease in Dacia, results in a lower average size in the latter region. The Dacian sample is small, however, and may not therefore be representative. Despite repeated small increases in the median LSI value in the area beyond the Empire through the first four periods, sheep/goat here remain smaller on average in the late Roman period than those found in the Balkan provinces. The early Byzantine period sees little change in sheep/goat size in the Balkan provinces, with only a very small increase in the median observed.

A Wilcoxon rank sum test was used to determine whether any of the observed differences in sheep/goat size between periods are statistically significant (Table 6.9), using LSI values for sheep/goat bone widths. The results of the test indicate a statistically significant difference in sheep/goat size between the late Iron Age and the remaining four periods, making clear the magnitude of the size increase in later periods. A statistically significant difference between the early Roman data and the data for all three later periods shows that, while the early Roman sheep/goat population was composed of significantly larger individuals than that of the late Iron Age, these animals remained considerably smaller than those present from the mid-Roman period onwards. The results of the test indicate no significant difference in sheep/goat size between the mid-Roman period and either of the following two periods, but a significant difference between the populations of the two latter periods. This result, along with the distribution of sizes observed in the LSI data, suggests that average sheep/goat size in the mid-Roman period lay somewhere between that of the late Roman and early Byzantine periods, with late Roman sheep/goat slightly smaller and early Byzantine sheep/goat slightly larger than their mid-Roman counterparts.

A Wilcoxon rank sum test was also used to determine whether any of the differences in sheep/goat size between regions are statistically significant (Table 6.10). The results of the test indicate a statistically significant difference in sheep/goat size between each of the three regions, suggesting that, as was also the case for cattle, Roman impact on the size of sheep/goat was influenced by the duration of the occupation in each region.

Table 6.9: Wilcoxon rank sum test for sheep/goat size by period. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Period	Late Iron Age	Early Roman period	Mid-Roman period	Late Roman period	Early Byzantine period
Late Iron Age					
Early Roman period	**0.004				
Mid-Roman period	**p<0.001	**p<0.001			
Late Roman period	**p<0.001	**p<0.001	0.22		
Early Byzantine period	**p<0.001	**p<0.001	0.22	**0.01	

Table 6.10: Wilcoxon rank sum test for sheep/goat size by region. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Area	Balkan provinces	Dacia	Beyond the Empire
Balkan provinces			
Dacia	**p<0.001		
Beyond the Empire	**p<0.001	**0.002	

Figure 6.30, A to C, shows LSI values for sheep/goat bone depths. The available data generally corroborate the patterns observed in the width data. In the Balkan provinces, median sheep/goat size increases steadily from the mid-Roman period onwards. In Dacia, the largest individuals are seen in the mid-Roman period, whereafter the median is lower. Beyond the Empire, there appears to be a slight increase in average size from the late Iron Age through to the late Roman period, as was also observed in the width data.

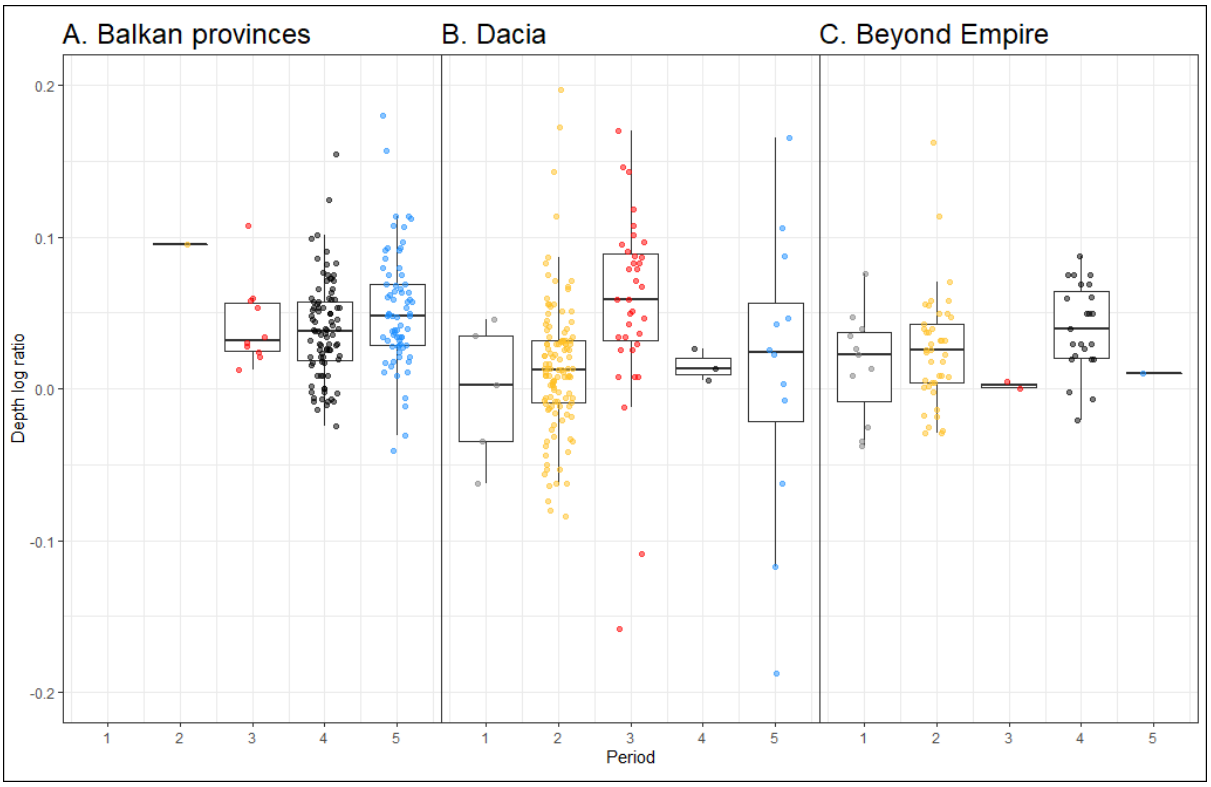


Figure 6.30: LSI values for sheep/goat bone depths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Figure 6.31, A to C, shows LSI values for sheep/goat bone lengths. Once again, the data generally confirm the patterns observed in the width data. The clearest difference is seen in the Balkan provinces in the late Roman and early Byzantine periods. The late Roman period sees a much larger increase in the median LSI length value than was apparent in either the width or depth data, indicating a relatively larger increase in sheep/goat height than in overall size in this period. The late Roman period thus sees the appearance of population of taller, less robust individuals than were previously present, perhaps indicating a larger proportion of castrates in the population. The early Byzantine period sees a small decrease in the median LSI length value in the Balkan provinces, though this remains higher than the mid-Roman median. The data thus indicate the re-emergence of slightly more robust individuals in the early Byzantine period than were present in the late Roman period, likely of a similar level of robustness to the mid-Roman population. The contrasting trajectories of change in the sheep/goat width and depth data, on the one hand, and the length data, on the other, echo the patterns observed in the cattle data, with taller, less robust individuals present in the late Roman period.

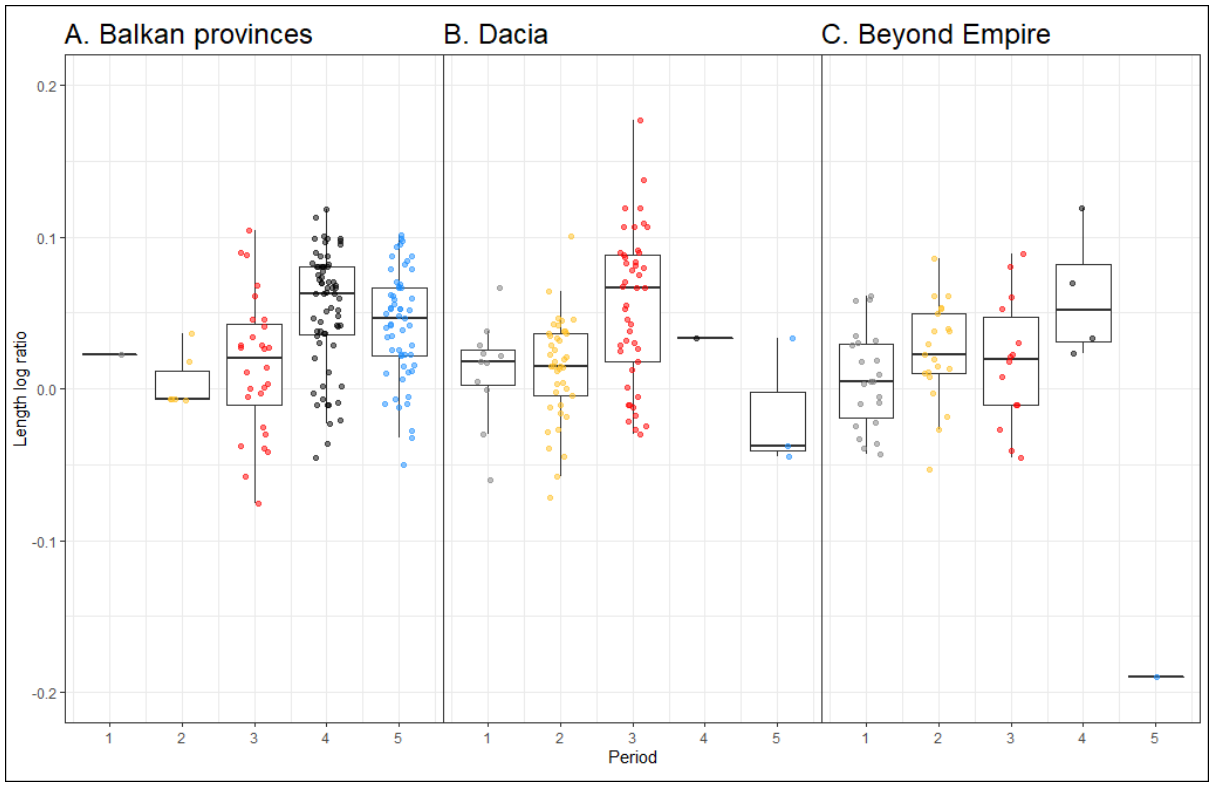


Figure 6.31: LSI values for sheep/goat bone lengths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Sheep/goat size by site type and period in the Balkan provinces

Figure 6.32A shows LSI values for sheep/goat bone widths in the Balkan provinces by site type and period. Analysis of the data by site type reveals several patterns in the size distribution of sheep/goat. In the mid-Roman period, while there is little difference in the range of LSI values at urban and rural sites, slightly more than half of all measurements taken from individuals at urban sites lie above the median, while slightly more measurements from rural sites lie below the median than above. The difference is fairly slight, but suggests that more sheep/goat at the upper end of the size range were exploited at urban than at rural sites. In the late Roman period, sheep/goat are on average slightly larger at urban than at military sites; in the early Byzantine period, this size distinction disappears. Figure 6.32B shows the modality of the distribution of LSI values for sheep/goat bone widths in the Balkan provinces by period. There is no indication of any separation between smaller and larger sheep/goat in any period, suggesting that changes to feeding practice or breeding stock in the periods that saw an increase in average size were implemented throughout the sheep/goat population.

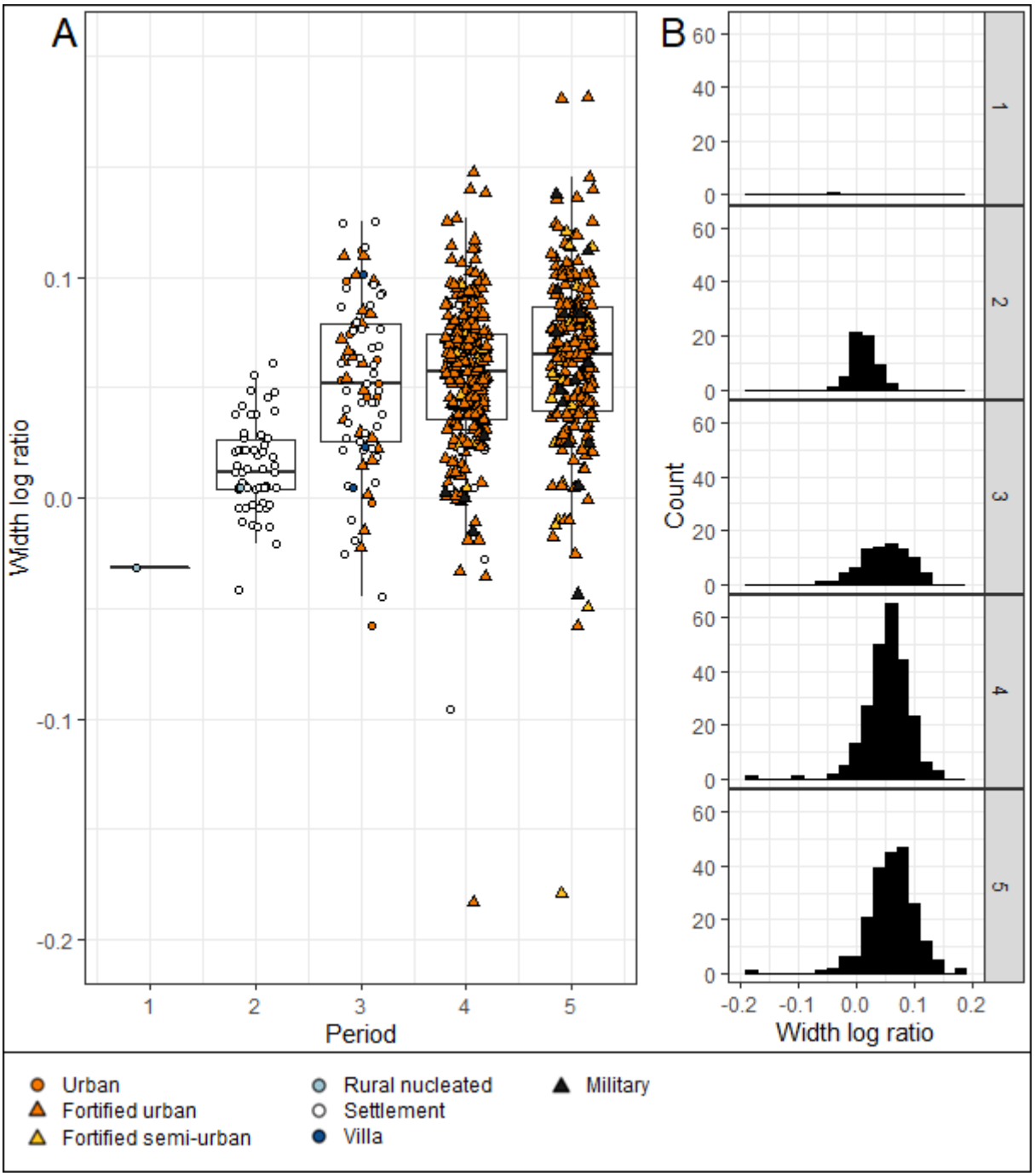


Figure 6.32: LSI values for sheep/goat bone widths in the Balkan provinces. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Sheep/goat size by site type and period in Dacia

Figure 6.33A shows LSI values for sheep/goat bone widths in Dacia by site type and period. There are no clear patterns in sheep/goat size by site type in the first four periods. In the early Byzantine period, the small amount of available data suggests that individuals exploited at

urban sites were on average smaller than those at rural sites, but the sample size for each site type is too small to draw clear conclusions. Figure 6.33B shows the modality of the distribution of LSI values for sheep/goat bone widths in Dacia by period. There is no indication that the emergence of larger sheep/goat in the region occurred via the development or introduction of a separate population of larger individuals. It appears rather that larger individuals were present throughout — and continuous with the remainder of — the sheep/goat population.

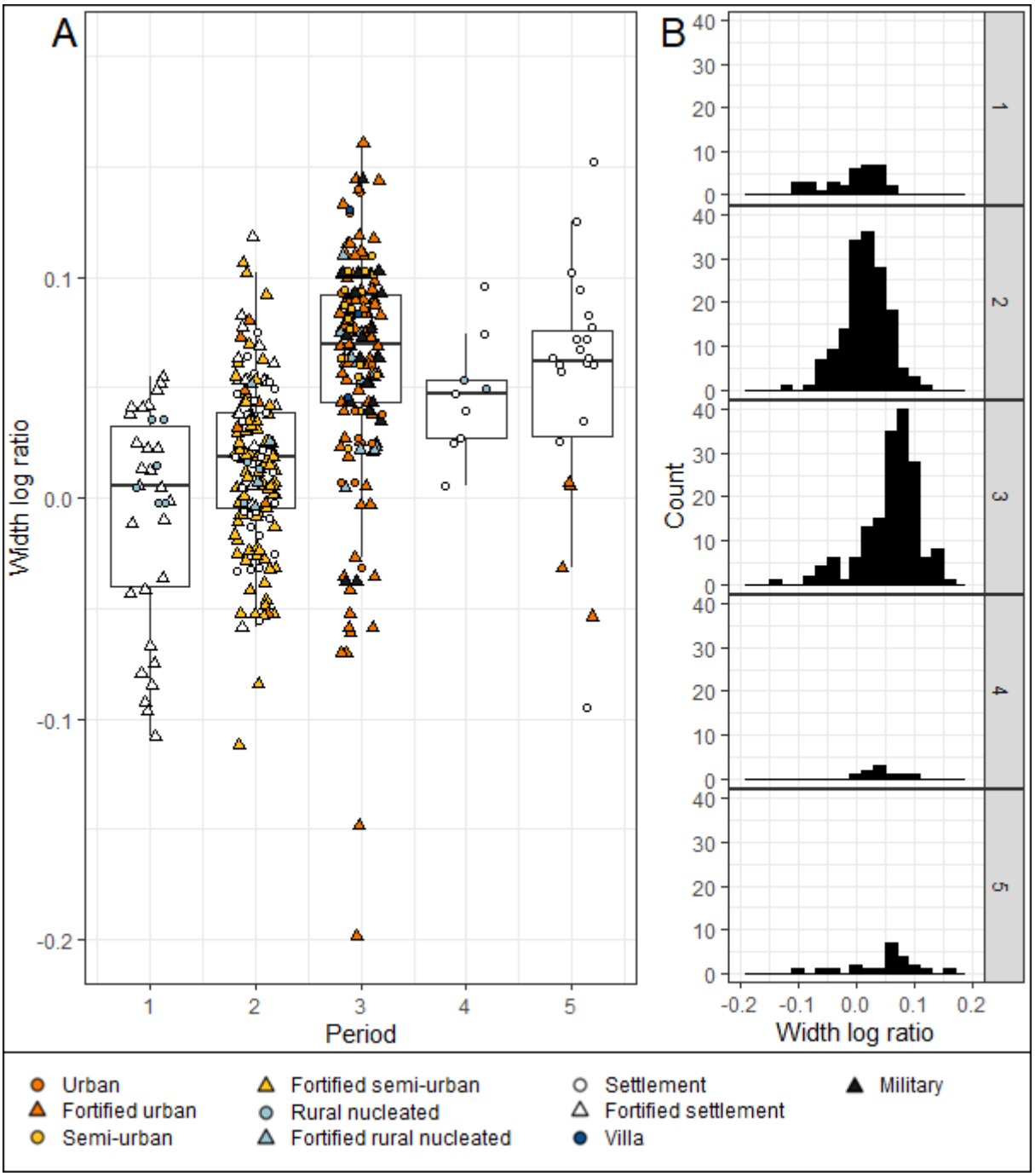


Figure 6.33: LSI values for sheep/goat bone widths in Dacia. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Sheep/goat size by site type and period beyond the Empire

Figure 6.34A shows LSI values for sheep/goat bone widths beyond the Empire by site type and period. Analysis of size distribution by site type in this region is limited by the limited availability of site type data, with many sites categorised only as ‘settlement’, and the limited

range of site types from which metrical data were available. Only the late Iron Age sample reveals any size differentiation by site type — considerably larger sheep/goat are present at rural than at semi-urban sites in this period, with all available width measurements for the latter site type lying on or below the median. Figure 6.34B shows the modality of the distribution of LSI values for sheep/goat bone widths beyond the Empire by period. Overall, there are few clear gaps in the distribution of the data. Only in the mid-Roman period is there any suggestion of more than one peak in the data, but the sample is too small to draw reliable conclusions regarding sex-based or population-based bimodality.

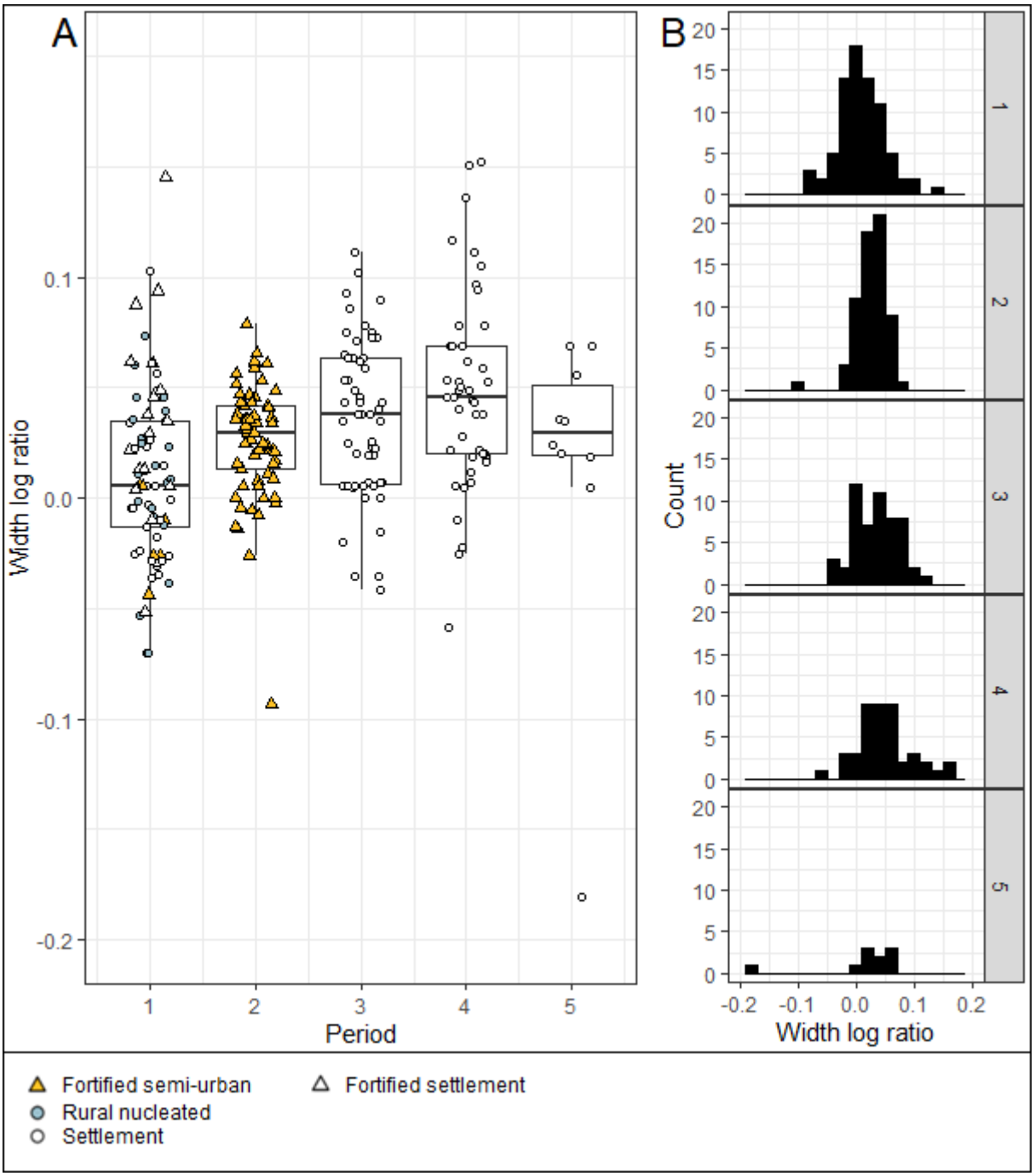


Figure 6.34: LSI values for sheep/goat bone widths beyond the Empire. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

6.7.4 Pigs

Pig size by period and region

Figure 6.35, A to C, shows LSI values for pig bone widths. The late Iron Age data are too limited to draw reliable conclusions regarding interregional size variation. In the early Roman period, the median LSI value is similar in all three regions, indicating little difference in average size in Roman-occupied and non-Roman-occupied regions. In the mid-Roman period, average pig size decreases somewhat in all three regions, and there remains little interregional variation in size, though the sample sizes are once again too small to draw clear conclusions. In the late Roman period, there is an increase in the median LSI value in the Balkan provinces, but a lack of data for Dacia and the area beyond the Empire precludes the analysis of interregional variation in this period. In the early Byzantine period, there is little evidence for any further change in pig size in the Balkan provinces.

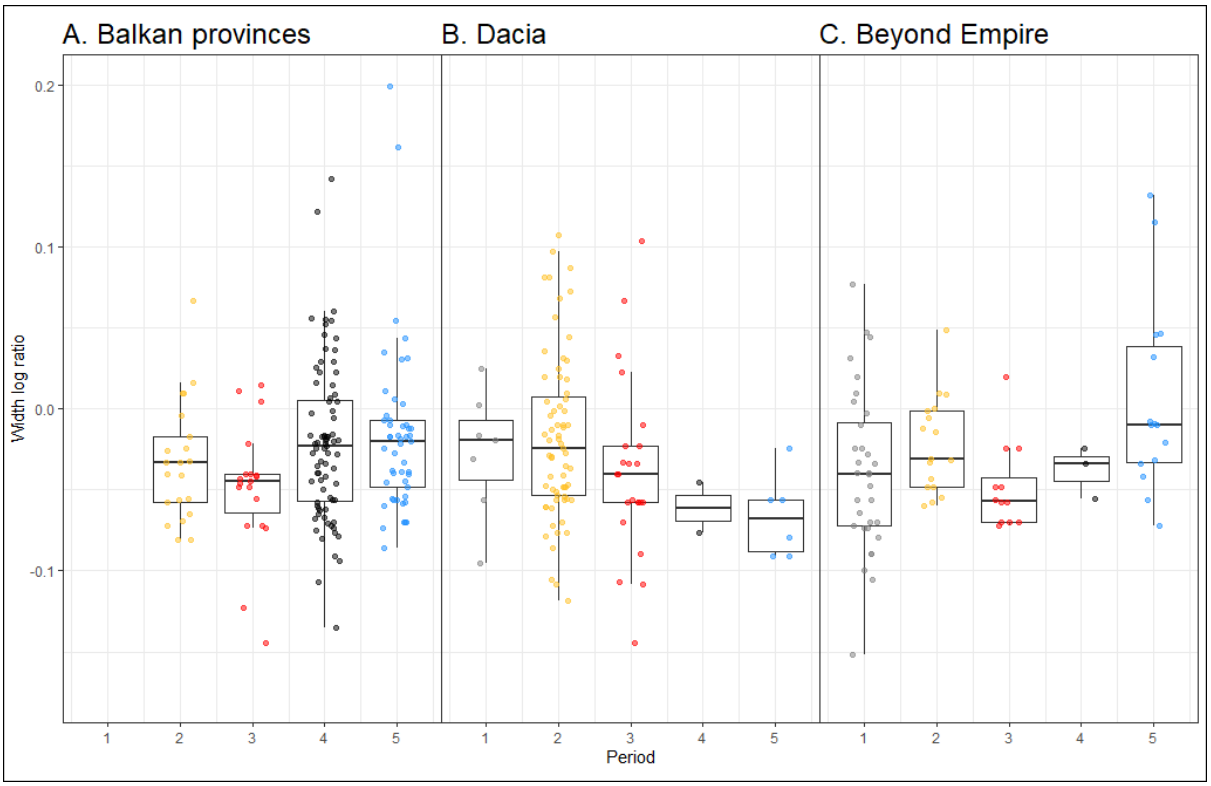


Figure 6.35: LSI values for pig bone widths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

A Wilcoxon rank sum test was used to determine whether any of the observed differences in pig size between periods are statistically significant (Table 6.11), using LSI values for pig bone widths. The results of the test indicate a statistically significant difference in pig size between the mid-Roman period and the early Roman, late Roman and early Byzantine periods. The mid-Roman period, which sees the lowest abundance of pig as a percentage of total livestock NISP, thus also sees the appearance of a population of significantly smaller individuals than are present in both the preceding and the two succeeding periods. The lack of a significant result for the comparison of the late Iron Age sample with the early Roman and mid-Roman data indicates that the size of late Iron Age pigs falls somewhere between the two, with a population composed of individuals smaller overall than early Roman pigs, but larger than those of the mid-Roman period.

Table 6.11: Wilcoxon rank sum test for pig size by period. *p* values in **bold** are statistically significant; *significant ($p \leq 0.05$), **highly significant ($p \leq 0.01$).

Period	Late Iron Age	Early Roman period	Mid-Roman period	Late Roman period	Early Byzantine period
Late Iron Age					
Early Roman period	0.23				
Mid-Roman period	0.56	***0.02**			
Late Roman period	0.26	0.80	***0.02**		
Early Byzantine period	0.21	0.80	****0.01**	0.69	

A Wilcoxon rank sum test was also used to determine whether any of the differences in pig size between regions are statistically significant (Table 6.12). The results of the test indicate no statistically significant difference between any of the three regions, as was also the case when pig abundance was compared between regions. It appears that varying duration of Roman occupation in each region did not lead to significant variation in the extent of reliance on pigs or in the character of the pig population. The data clearly indicate a significant difference in pig abundance and pig size between periods that saw different levels of Roman political control in the study region, however. This result suggests that it was broader temporal change in political, social and economic context across the study region as a whole that had the most significant impact on pig exploitation, with varying trajectories of change in each region of less importance.

Table 6.12: Wilcoxon rank sum test for pig size by region. *p* values in **bold** are statistically significant; *significant (p≤0.05), **highly significant (p≤0.01).

Area	Balkan provinces	Dacia	Beyond the Empire
Balkan provinces			
Dacia	0.75		
Beyond the Empire	0.75	0.75	

Insufficient data were available for the analysis of pig bone depth measurements — only eight depth measurements in total were available, across three periods. Figure 6.36, A to C, shows LSI values for pig bone lengths. The changing distribution of LSI length values over time very closely matches that observed in the width data, with all period-by-period changes in the median values following the same pattern. The data thus indicate little change overall in the robustness of pigs in the periods for which both width and length data were available.

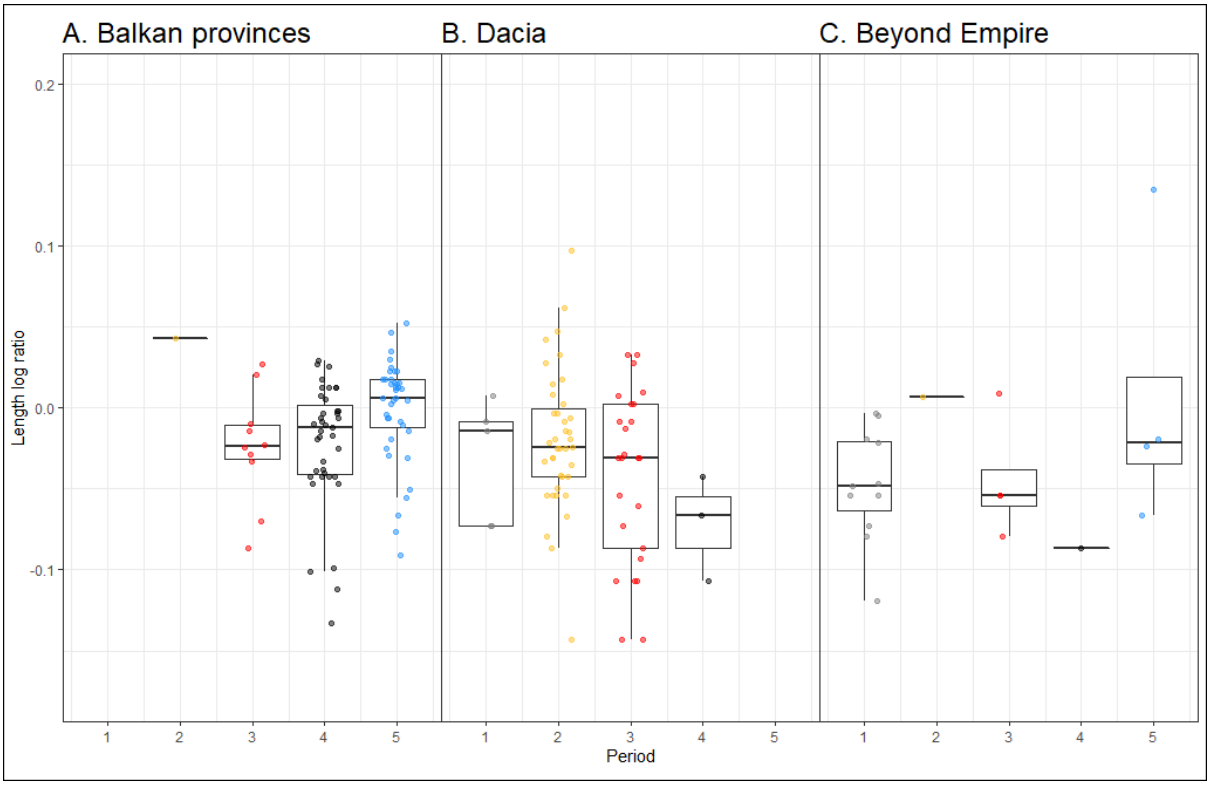


Figure 6.36: LSI values for pig bone lengths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Pig size by site type and period in the Balkan provinces

Figure 6.37A shows LSI values for pig bone widths in the Balkan provinces by site type and period. Pig bone measurements were available from too narrow a range of site types to enable detailed analysis of exploitation by site type, though the mid-Roman data indicate that larger pigs may have been present on urban than on rural sites. Figure 6.37B shows the modality of the distribution of LSI values for pig bone widths in the Balkan provinces by period. The distribution of the data is more-or-less unimodal in each period, indicating that the observed changes in average pig size were not the result of the greater input of resources into a subset of the pig population, but instead resulted from the development of larger individuals continuous with the remainder of the population.

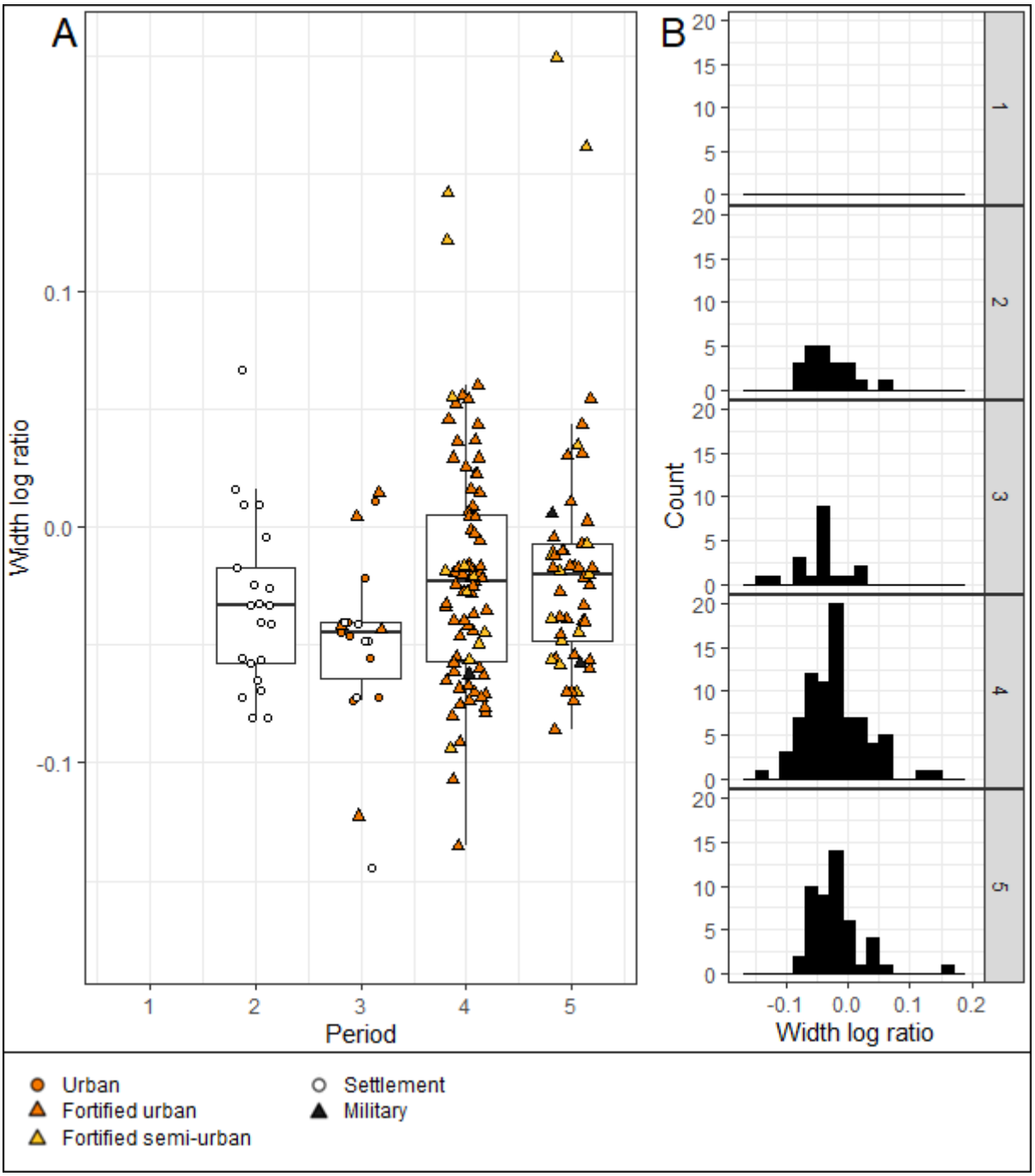


Figure 6.37: LSI values for pig bone widths in the Balkan provinces. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Pig size by site type and period in Dacia

Figure 6.38A shows LSI values for pig bone widths in Dacia by site type and period. The data reveal clear variation in the exploitation of pigs by site type in the early Roman period. A higher proportion of LSI values for semi-urban sites lie below the median than above,

while the reverse is true for rural sites. Whether communities at semi-urban sites raised their own pigs, or imported these animals from elsewhere, the data indicate more limited access to the largest individuals at these sites than was the case for their rural counterparts. In the mid-Roman period, the limited available data suggest there may have been a change in exploitation by site type — more pigs at the upper end of the size range are found at urban and military sites than at rural sites in this period. Figure 6.38B shows the modality of the distribution of LSI values for pig bone widths in Dacia by period. The data provide little evidence for any bimodal population in any period.

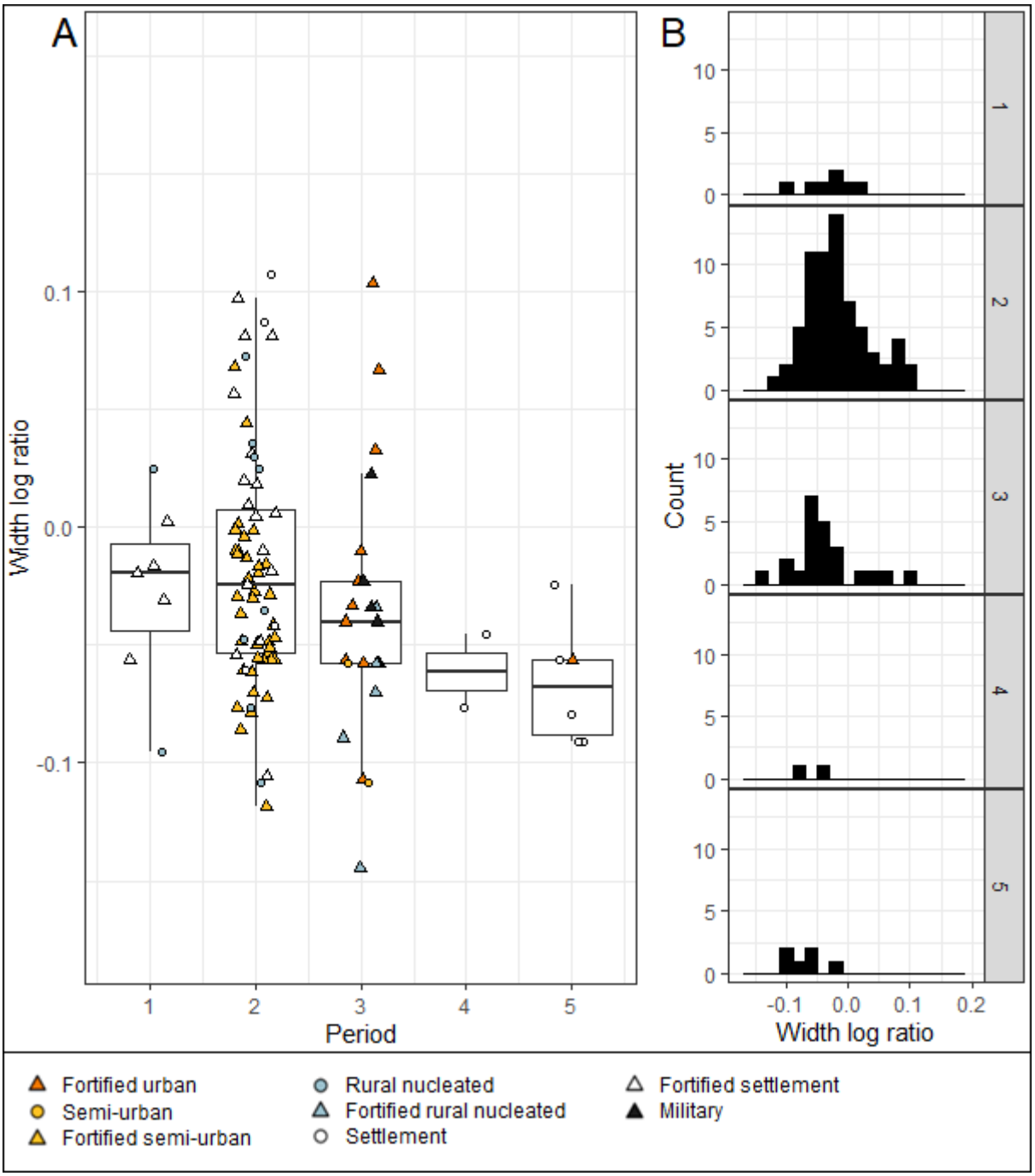


Figure 6.38: LSI values for pig bone widths in Dacia. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Pig size by site type and period beyond the Empire

Figure 6.39A shows LSI values for pig bone widths beyond the Empire by site type and period. Site type data are too limited to identify many trends in size distribution by site type, though the available data suggest that smaller individuals may have been exploited at semi-

urban sites than at rural sites in the late Iron Age. Figure 6.39B shows the modality of the distribution of LSI values for pig bone widths beyond the Empire by period. While there are multiple gaps in the distribution in most periods, the number of available measurements per period is too few to infer the presence of a bimodal or multimodal population in any period.

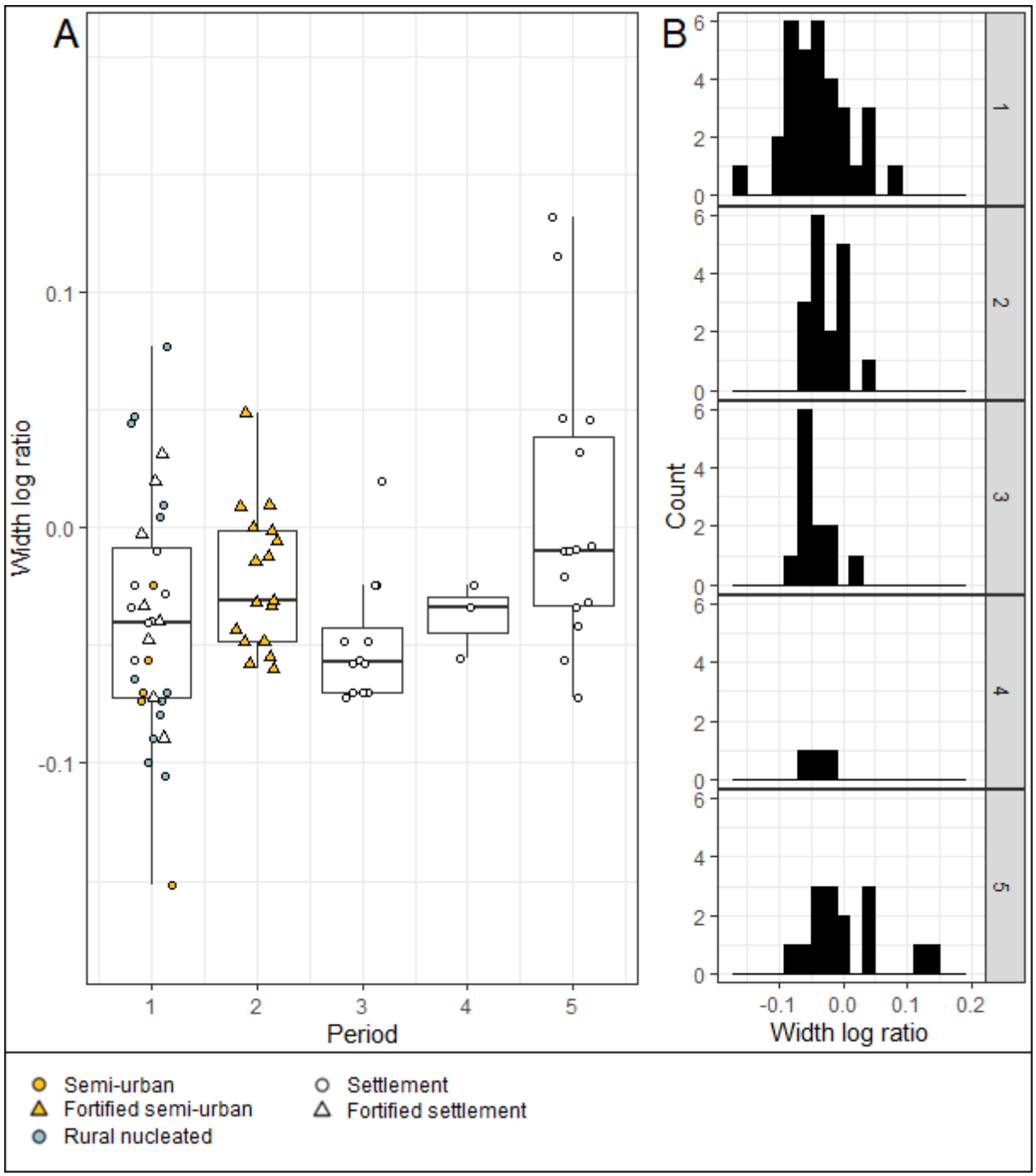


Figure 6.39: LSI values for pig bone widths beyond the Empire. A: site type; B: modality of distribution by period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

6.7.5 Summary

The livestock metrical data reveal contrasting patterns of spatial and temporal variation in cattle and sheep/goat size, on the one hand, and pig size, on the other. The mid-Roman period sees a clear increase in the size of both cattle and sheep/goat in the Balkan provinces and Dacia, concurrent with the emergence of specialised cattle husbandry in both regions. Both changes would have facilitated the optimisation of the yields obtained from animal husbandry. The observed size change could suggest a greater input of resources into the feeding of cattle and sheep/goat to maximise yield per individual, or alternatively — or additionally — could indicate the import of larger breeding stock from elsewhere in the Empire, or the selective breeding of the existing population. There is no evidence for an increase in pig size in the mid-Roman period, though the sample size for this taxon is smaller than those for cattle and sheep/goat, so any conclusions drawn regarding the extent of pig size change must be more tentative.

After the mid-Roman period, the changes instituted in cattle and sheep/goat size appear only to have been maintained in the regions that remained under Roman occupation. Thus in the Balkan provinces, larger cattle and sheep/goat persist into the early Byzantine period, while in Dacia the average size of these taxa decreases somewhat following Roman withdrawal from the province. There is no decline in average pig size in the Balkan provinces in the late Roman and early Byzantine periods — but since the average size of this taxon changes little from the early Roman period onwards, this continuity in later periods does not indicate the persistence of larger livestock in the manner observed in the cattle and sheep/goat data. Overall, then, while the husbandry of cattle and sheep/goat may have been undertaken with the maximisation of yield per individual in mind — at least in regions under Roman occupation — the exploitation of pigs appears to have followed a rather different pattern.

6.8 Summary

Analysis of spatial and temporal variation in livestock relative abundance, age and size reveals clear trends in certain periods and regions, and in the exploitation of certain taxa, but relatively little change in husbandry practice in other cases. There is little evidence for a change in the extent of specialisation or the size of livestock in the early Roman period in the

Balkan provinces. Rather, the data suggest continuity with late Iron Age practices, and therefore relatively change in the organisation of the productive economy during the early occupation. Beyond the Empire, specialised cattle husbandry is seen in both the late Iron Age and the early Roman period, but there is no evidence for the presence of particularly large cattle in the region. Taken together, these data suggest that specialisation in the region is more likely the result of husbandry practice adapted to the local environment, rather than exploitation focused on the maximisation of yield.

A clear increase in cattle exploitation in the Balkan provinces and Dacia in the mid-Roman period provides evidence for the development of a new economic system, based on the production and distribution of cattle resources, and perhaps the utilisation of this taxon in arable production. A north-south gradient in cattle abundance at the height of the Roman occupation suggests that climate and environment may have had a limiting effect on the functioning of the new cattle-based economy in the southernmost part of the study region, however. Evidence for the focused exploitation of cattle in both the Balkan provinces and Dacia indicates that Roman control over production and consumption was probably of equal intensity in both regions in the second and third centuries CE. The longer duration of occupation south of the Danube does not appear to have resulted in any difference in practice here, relative to Dacia. Indeed, the establishment of a province in Dacia in the period that saw the Empire reach the height of its power appears to have led to the more rapid implementation of economic policy in this new province than was the case in the earlier-conquered regions to the south.

A lack of evidence for any major change in cattle age distribution between the early Roman and mid-Roman periods suggests that the range of products for which cattle were exploited did not change considerably in the latter period, indicating that specialisation in cattle husbandry occurred by the intensification and expansion of existing management practices in the mid-Roman period. Livestock size data reveal a clear increase in cattle and sheep/goat size in the mid-Roman period. The increase in cattle size indicates that the optimisation of the yields obtained from animal husbandry was undertaken not only by the establishment of more specialised husbandry practices, but also by the maximisation of yield per individual. The increase in sheep/goat size demonstrates that despite the much greater focus on the husbandry of cattle in the mid-Roman period, the lower abundance of sheep/goat need not be taken as evidence for a lesser investment in the maximisation of yields from this taxon.

Increased disruption in southeast Europe and a decline in Roman political influence from the fourth century CE does not appear to have resulted in the immediate disappearance of the cattle-based economic system, or in a decline in Roman control over resource procurement for urban populations. Resource availability at urban settlements appears to have changed very little in the late Roman period, though there is a decrease in cattle abundance at rural sites in the Balkan provinces, and a small decline in cattle abundance in Dacia, following the withdrawal of Rome from this province in the late third century CE.

It is only in the early Byzantine period that livestock relative abundance changes considerably relative to earlier periods, with patterns of exploitation across the study region demonstrating much greater interregional and intersite variation. This evidence for increasing economic localisation and regionalisation shows that declining Roman political control, and growing political fragmentation of the study region, resulted in a clear decline in Roman economic influence within the Empire's remaining territories to the south of the Danube, and increasing divergence from Roman patterns in post-Roman Dacia to the north. Despite clear changes in livestock relative abundance, the early Byzantine period sees little change in livestock size in the Balkan provinces. The persistence of larger livestock in this region in a period of declining political and economic stability could indicate that increased livestock size in the mid-Roman period was achieved at least in part by the import or selective breeding of larger individuals, rather than solely by an increased input of resources into feeding. Declining stability in the early Byzantine period would arguably have led to decreasing ability to maintain improved feeding regimes, resulting in a decrease in livestock size. Instability would likely have had less immediate impact on livestock size had the earlier size increase been achieved via a genetic change in the population, however.

7 Hunting and hippophagy

7.1 Introduction

This chapter presents the analysis of hunted taxa and horses. It begins by discussing and evaluating spatial and temporal patterns in the exploitation of large game, and then considers hunting and husbandry patterns, with a focus on sites that exhibit particularly high proportions of game. Large game relative abundance is then analysed by taxon, with spatial, temporal and site-type-based variation considered. The chapter then presents the analysis of red deer morphology. Finally, it discusses horse relative abundance and morphology, and considers the extent of evidence for hippophagy

7.2 Large game relative abundance by period

Figure 7.1 shows relative abundance of domestic mammals, large game and small game by period. Due to the potential impact of recovery bias on the relative abundance of small taxa within the assemblages included in the study, small game are included in the figure but are not analysed further in this thesis. The remains of domestic mammals constitute the majority of the assemblage on all sites in each of the five periods, demonstrating the economic importance of husbandry and the extent of reliance on resources provided by animals raised and controlled by the human population. Overall, the data indicate relatively little use of wild animal resources, though there is evidence for greater reliance on large game on a proportion of sites in every period. Across the study period as a whole, relatively little regional patterning is discernible in the distribution of these sites — rather, a greater reliance on wild resources appears to be predominantly a site-specific practice. One possible exception may be the Iron Gates, where a large game NISP greater than 20% is seen on at least one site in each of the first four periods. Data for this region were not available for the early Byzantine period, so it is not possible to determine whether this trend continues later than the fifth century CE.

Table 7.1 shows large game relative abundance by period. Shading is used to highlight cells on the basis of the proportion of total sites for each period that exhibit large game (LG) percentages within four categories: LG<10%; 10%≤LG<20%; 20%≤LG<30%; and LG≥30%. Darker shading indicates a higher proportion of total sites for each period within each

category, with increasingly darker shading used for 1-10% of sites; 11-20% of sites; 21-30% of sites; and 31% of sites and above.

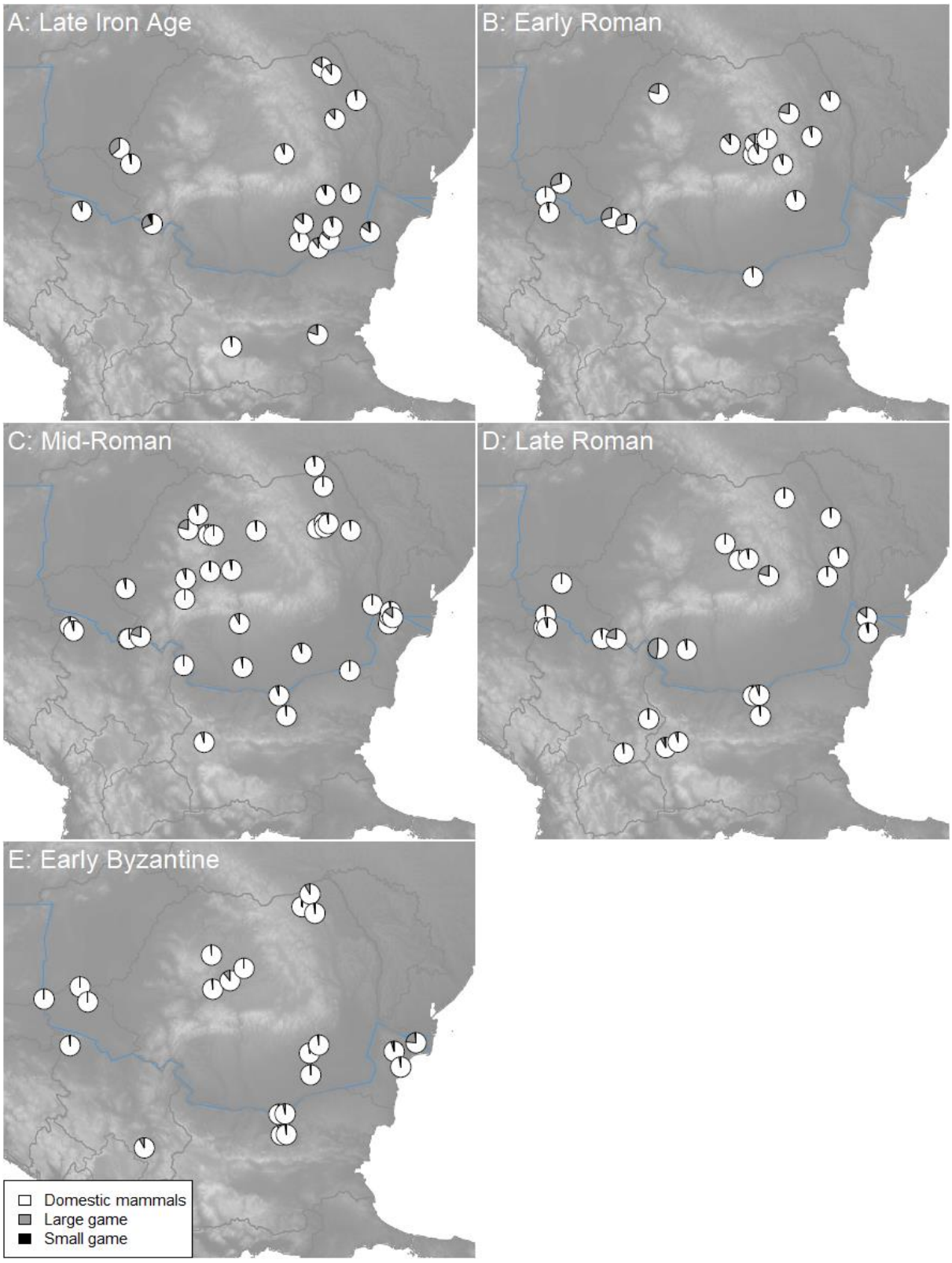


Figure 7.1: Relative abundance by period of domestic mammals, large game and small game. A: late Iron Age; B: early Roman; C: mid-Roman; D: late Roman; E: early Byzantine.

Table 7.1: Abundance of large game (LG) by period.

Period	Total sites	% sites with LG<10%	% sites with 10%≤LG<20%	% sites with 20%≤LG<30%	% sites with LG≥30%
Late Iron Age	20	50	40	5	5
Early Roman	18	56	17	28	0
Mid-Roman	36	92	2.8	5.6	0
Late Roman	26	85	3.8	7.7	3.8
Early Byzantine	22	91	4.5	4.5	0

In the late Iron Age, a large game NISP over 10% is seen on half of all sites. These sites are distributed across multiple climatic and environmental zones, suggesting that reliance on large game did not simply represent specialised exploitation in marginal environments less suited to husbandry. Particularly high proportions of large game are found on unfortified and fortified, and urban and rural, sites, suggesting that site type is also likely not a factor in large game abundance. The wide distribution and varied character of the sites on which large game constitute over 10% of the assemblage indicates that although animal exploitation in the study region focused on products obtained via livestock husbandry, the supplementation of these resources by the regular exploitation of wild taxa was a typical and widespread practice in the late Iron Age. At two sites, large game constitute more than 20% of the assemblage. At Stenca Liubcovei (Caraș-Severin County, Romania), a fortified Dacian settlement, large game form 24% of the NISP (El Susi 1985). At Pecica 'Șanțul Mare' (Arad County, Romania), the probable location of the Dacian fortress Ziridava, large game constitute 36% of the NISP, the result of the deposition of high proportions of both red deer and wild boar (Haimovici 1978; Nicodemus *et al*. 2015).

In the early Roman period, though slightly fewer sites have a large game NISP over 10% than was the case in the late Iron Age, there is a clear increase in the proportion of sites with a large game NISP over 20%, which is now seen on almost a third of all sites. The highest large game abundance is seen in the Iron Gates and the southern Pannonian Plain — regions that saw, or were in close proximity to, Roman military action in the early Roman period. Greater reliance on more marginal resources due to economic disruption could therefore be posited for these two regions. High large game abundance was also seen at certain late Iron Age sites in the two regions, however, suggesting that a favourable environment for hunting — such as the extensive forested environments of the Pannonian Plain, where large game including wild boar and bear could be found in the Roman period (Reed and Roguljić 2020, 40) — may be a more likely explanation for the observed high incidence of large game at certain sites.

In the mid-Roman period, there is a clear decrease in large game exploitation. Less than a tenth of all sites have a large game NISP over 10%, and only two sites have a large game NISP of 20% or more. At the military camp at Pojejena, large game constitutes 20% of the assemblage, and consists principally of red deer, roe deer and wild boar, with brown bear and aurochs remains also recovered. At Bologa, a fortified rural settlement in Cluj County, Romania, 21% of the assemblage consists of large game, which includes brown bear, European bison, a large amount of red deer remains originating from at least 20 individuals, and a smaller proportion of wild boar (Georoceanu *et al*. 1979). The few mid-Roman sites with a high proportion of large game are distributed across the study region, in several climatic and environmental zones, suggesting site-specific reliance on or preference for the use of wild resources to supplement the products obtained from domestic mammals.

In the late Roman period, the proportion of sites with a large game NISP over 10% increases slightly, and comprises three sites in post-Roman Dacia and one in Roman-occupied Dobrogea. For the first time since the late Iron Age, the sample includes a site at which large game constitute over 30% of the NISP. At Hinova, a rural castrum in the Iron Gates, large game remains comprise 47% of the assemblage, and include red deer and wild boar remains, each representing around 10 or 11 individuals, and a single brown bear bone. At the nearby site Moldova Veche 'Vinograda-Vlașkicrai', a village in Caraș-Severin County, Romania, a relatively high proportion of large game is also seen, comprising 22% of the assemblage (Bozu and El Susi 1987). The high proportion of large game at these two sites demonstrates continuation of the trend observed in the previous three periods in the Iron Gates, suggesting that environmental context may have made the exploitation of wild taxa more profitable relative to livestock here than in other regions. Since in all cases domestic mammals comprise the majority of the assemblage, however, large game were likely exploited only to supplement the resources obtained from domestic taxa.

In the early Byzantine period, the relative abundance of large game declines once again, and the proportion of sites with a large game NISP over 10% returns to mid-Roman levels. Only one site has a large game NISP over 20%. At the fortified urban settlement at Halmyris (Tulcea County, Romania), on the Danube delta, large game comprise 22% of the assemblage, and consist predominantly of red deer and wild boar, with a smaller proportion of roe deer, and single specimens of wolf and possible aurochs (Haimovici 2009). With the exception of the late Iron Age and the early Roman period, for which the sample did not

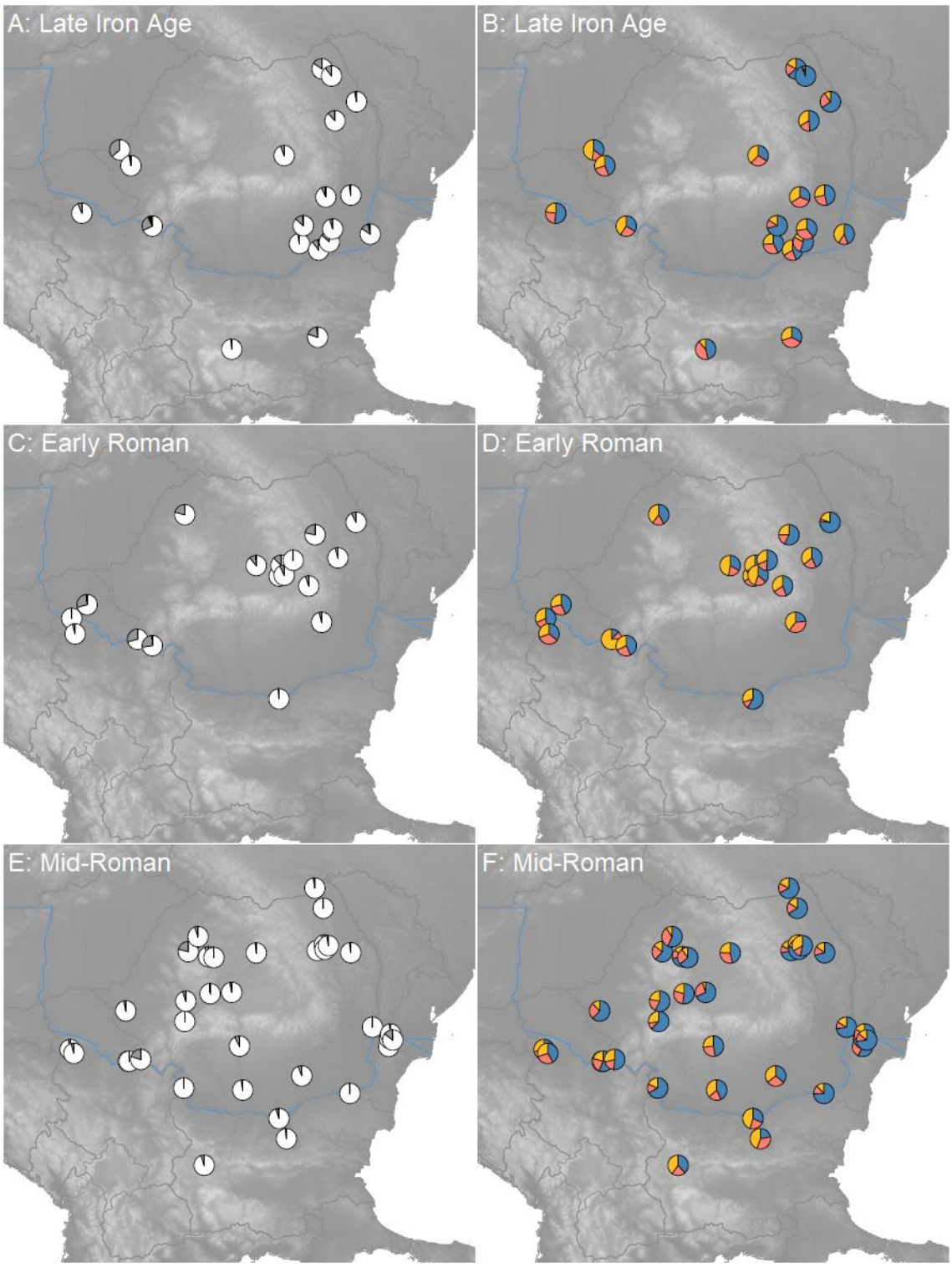
include sites in Dobrogea, at least one site in each period in the Danube delta region has a large game NISP over 10%, suggesting that the environment here may have provided a particular opportunity to exploit wild taxa. Large game abundance in this region is still considerably lower than that of domestic mammals, however. Across the study region as a whole in the early Byzantine period, domestic mammals predominate, and the slight increase in large game exploitation evident in the late Roman period is reversed.

Overall then, while large game exploitation was of greater importance in certain regions and periods than others, domestic mammals were the principal animal resource exploited from the late Iron Age to the early Byzantine period. A relatively high proportion of large game is seen on half of all late Iron Age sites, where these taxa would have supplemented the resources obtained from domestic mammals. In the following period, as Roman political control expanded and provinces were established to the south of the Danube, large game exploitation decreases slightly overall, but appears to have been more heavily relied upon at a larger proportion of sites than was the case in the late Iron Age. When Roman territorial control reached its height during the occupation of Dacia, large game exploitation was at its lowest level. A slight increase in large game is evident in the late Roman period, following Roman withdrawal from Dacia, at which time a large game NISP over 20% is seen on three Dacian sites. In the early Byzantine period, despite declining Roman political control of the study region, large game exploitation decreases once again. While there is thus correlation between increased Roman political control and decreased exploitation of what could be considered more marginal resources, this is not a linear relationship.

7.3 Patterns in hunting and husbandry

This section will discuss patterns in hunting and husbandry, focusing on sites that exhibit particularly high proportions of large game. Figure 7.2 shows relative abundance by period of domestic mammals, large game and small game (A, C, E, G, I), and cattle, sheep/goat and pigs (B, D, F, H, J). In the late Iron Age, husbandry ranges from fairly generalised to focused on cattle, while large game comprise 10% or more of the NISP on half of all sites. At five such sites, pigs comprise a third to a half of the livestock. The high proportion of wild boar and red deer at these sites suggests woodland or forest in the vicinity, an environment that would also have provided suitable forage for domestic pigs (Wealleans 2013, 2076). The high incidence of these three taxa at these sites indicates animal exploitation adapted to the local

environment. In contrast, at Yassa-Tepe, a late Iron Age village where aurochs form the majority of the large game, herbivores comprise 70% of the livestock. This is despite the former's preference for open forest (Wright 2013, 21-22) and the latter's requirement for pasture. Thus while exploitation at many sites was influenced principally by the resources available in the local environment, late Iron Age communities clearly exploited a range of environments.



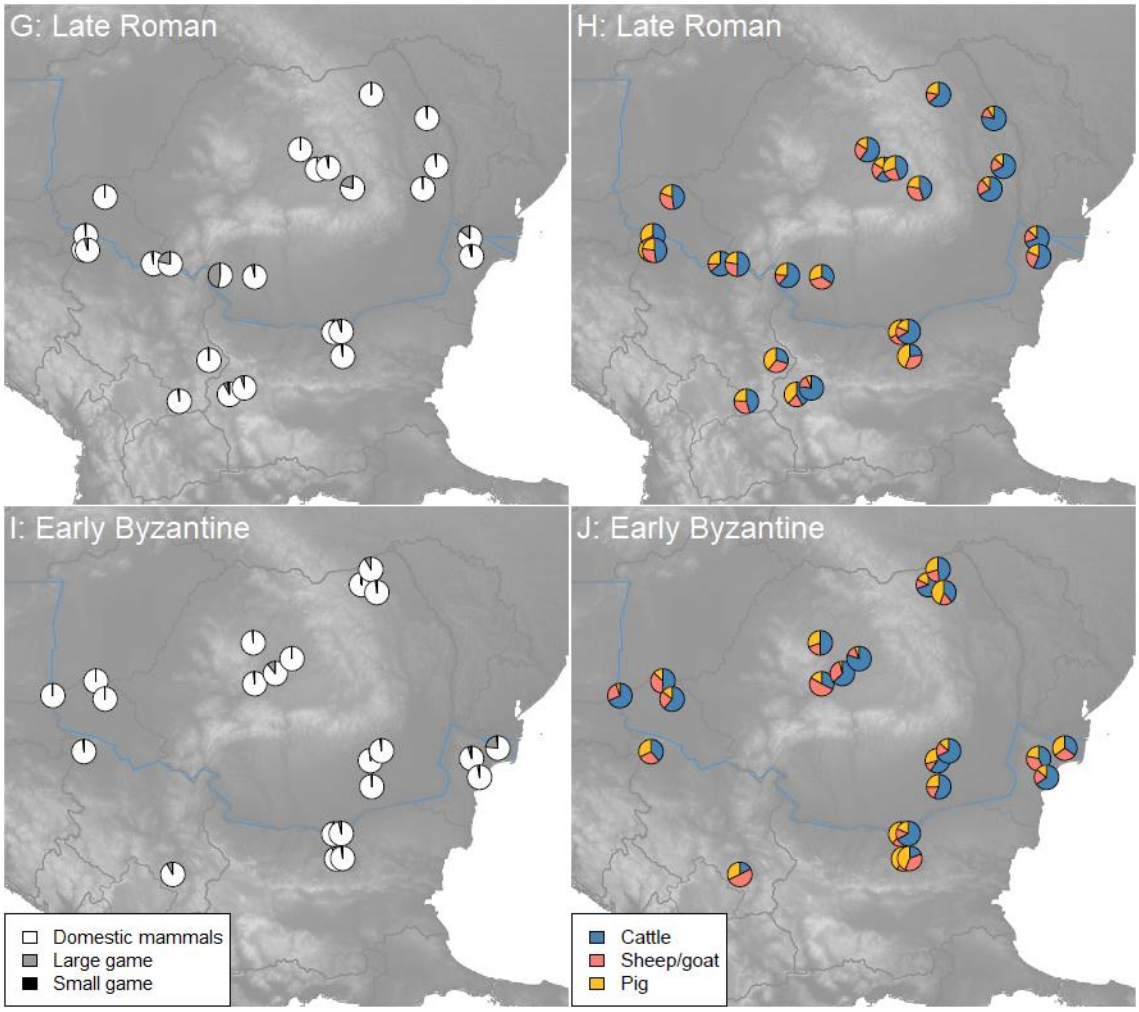


Figure 7.2: Relative abundance by period of domestic mammals, large game and small game (A, C, E, G, I) and cattle, sheep/goat and pigs (B, D, F, H, J). A-B: late Iron Age; C-D: early Roman; E-F: mid-Roman; G-H: late Roman; I-J: early Byzantine.

In the early Roman period this pattern largely continues. Pig abundance increases, in particular in pre-Roman Dacia. This taxon constitutes a third or more of the livestock at five of the eight sites with a large game NISP greater than 10%, with wild boar and red deer forming the majority of the large game remains at these sites. As in the late Iron Age, the high incidence of these taxa together indicates the exploitation of animal resources readily available in the local environment, and husbandry practice adapted to site setting. The data indicate little change overall in the exploitation of either domestic mammals or large game as a result of growing Roman political influence in the south of the study region, though the sample size for this region is relatively small, and more data would be necessary to draw clear conclusions.

In the mid-Roman period, this pattern begins to change. As the Roman occupation reaches its greatest extent, cattle become predominant on the majority of sites, and are the most abundant livestock taxon on the three sites with a large game NISP greater than 10%, suggesting a divergence in the types of environments from which domestic and wild animal resources were obtained. An overall decrease in game exploitation and the development of a more coordinated system of animal resource procurement and consumption indicates a decline in the influence of local environmental context on animal exploitation. In the late Roman period, cattle continue to predominate across much of the study region, including on sites with a large game NISP greater than 10%, though to a lesser extent than was the case in the preceding period. A small decline in cattle abundance in Dacia in this period, concurrent with increased reliance on large game in this former province, indicates renewed reliance on the local environment for the acquisition of animal resources after the Roman withdrawal.

In the early Byzantine period, the pattern begins to change somewhat. The two sites of this period with a large game NISP greater than 10% exhibit contrasting patterns of livestock exploitation. This is also the case for early Byzantine sites in general, irrespective of large game abundance, with husbandry practices becoming increasingly regionalised. Despite this fragmentation, however, the political, social and economic changes that characterised the early Byzantine period appear not to have stimulated increased reliance on wild animal resources. There is no return to the extent of wild resource exploitation seen in the late Iron Age, prior to the establishment of Roman political control in the study region.

7.4 Large game relative abundance by taxon

7.4.1 Introduction

This section will discuss spatial, temporal and site-type-based trends in the relative abundance of the ten large game taxa identified across the studied sites. The section begins with the three most abundant taxa — red deer, wild boar and roe deer — for which patterns in relative abundance are considered in some depth. Seven further large game taxa are then discussed more briefly.

7.4.2 Red deer

The most abundant large game taxon identified across the studied sites is the red deer. Figure 7.3 shows red deer relative abundance by site type and period. There is little evidence for any clear change in red deer abundance between the late Iron Age and the early Roman period, though the median value increases slightly. The mid-Roman period sees a clear decrease in the median and the interquartile range, indicating a decline in red deer exploitation, and less intersite variation in the extent of reliance on the taxon than was observed in the previous two periods. There is then little further change in red deer abundance in either the late Roman period or the early Byzantine period. Overall, the data indicate little change in the extent of red deer exploitation during the earliest period of Roman occupation in the study region, but a clear decline once Roman political and economic control reached its height in the mid-Roman period.

In the late Iron Age and the early Roman period, red deer abundance is considerably higher at rural sites than at urban and semi-urban sites. The data indicate, as might be expected, that rural communities had easier access to environments in which this taxon could be exploited. This pattern continues through the remaining periods, but becomes less pronounced over time. Particularly high proportions of red deer are seen at a range of site types — the taxon comprises more than 10% of the NISP at one urban site, one semi-urban site, two military sites and seven rural sites. While these data confirm the generally greater reliance on red deer at rural sites, they also indicate that higher than average reliance on this taxon was widespread across site types.

Figure 7.4 shows red deer relative abundance by period and region. In the first four periods, red deer abundance is higher on average in Dacia than elsewhere. In the early Byzantine period, however, red deer are slightly more abundant in the Balkan provinces than in post-Roman Dacia or in the area beyond the Empire. Of the 11 sites at which red deer comprise more than 10% of the NISP, 8 lie within Dacia. The suitability of the Dacian environment for red deer may in part account for the greater abundance of the taxon in this region, with the varying extent of red deer exploitation across the three regions perhaps to some extent reflecting the varying availability of the taxon across the study region. Since sample size for certain regions in certain periods is fairly small, however, more data would be necessary to confirm the patterns observed.

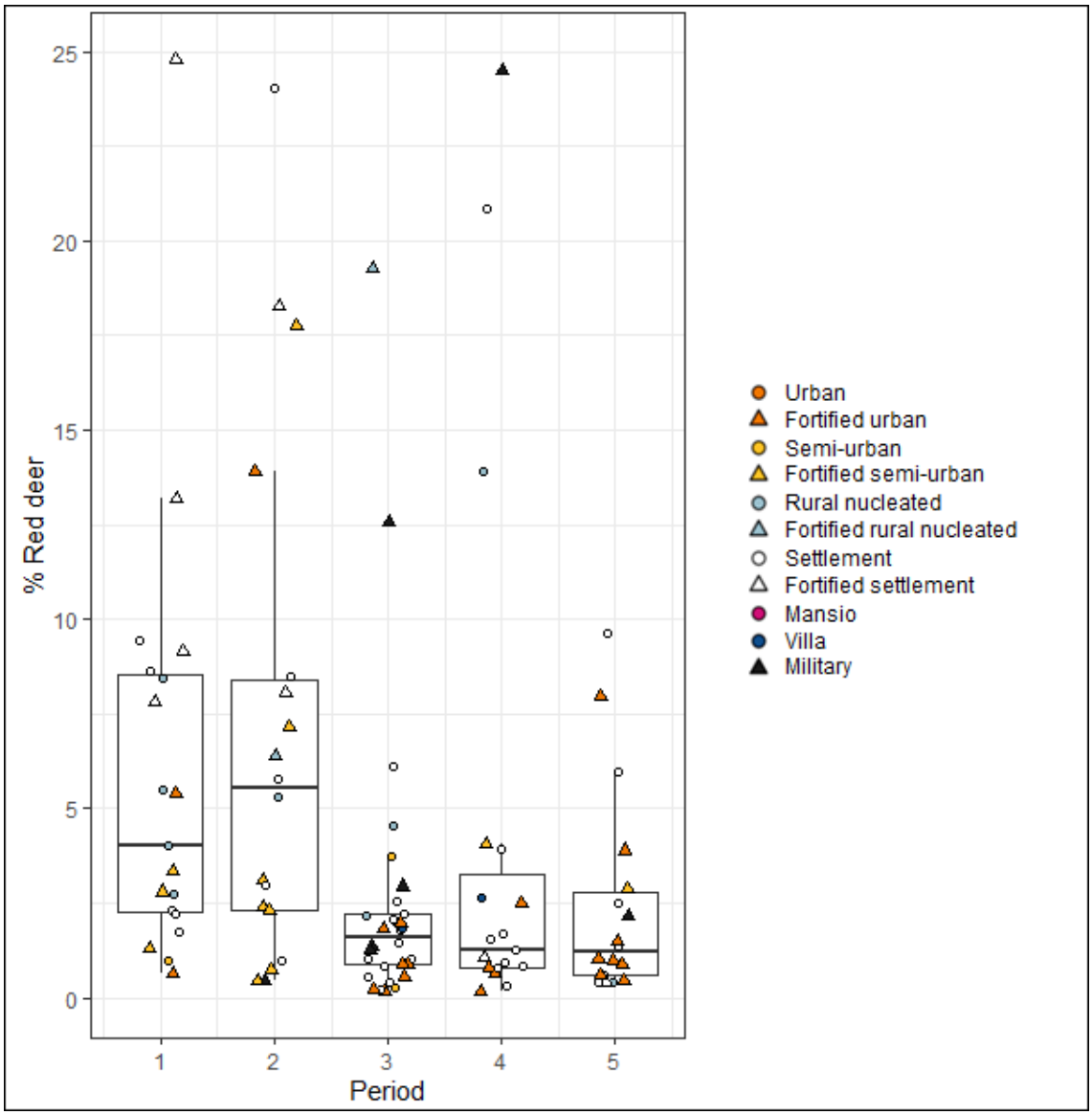


Figure 7.3: Red deer abundance as a percentage of total domestic mammal, large game and small game NISP by site type and period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

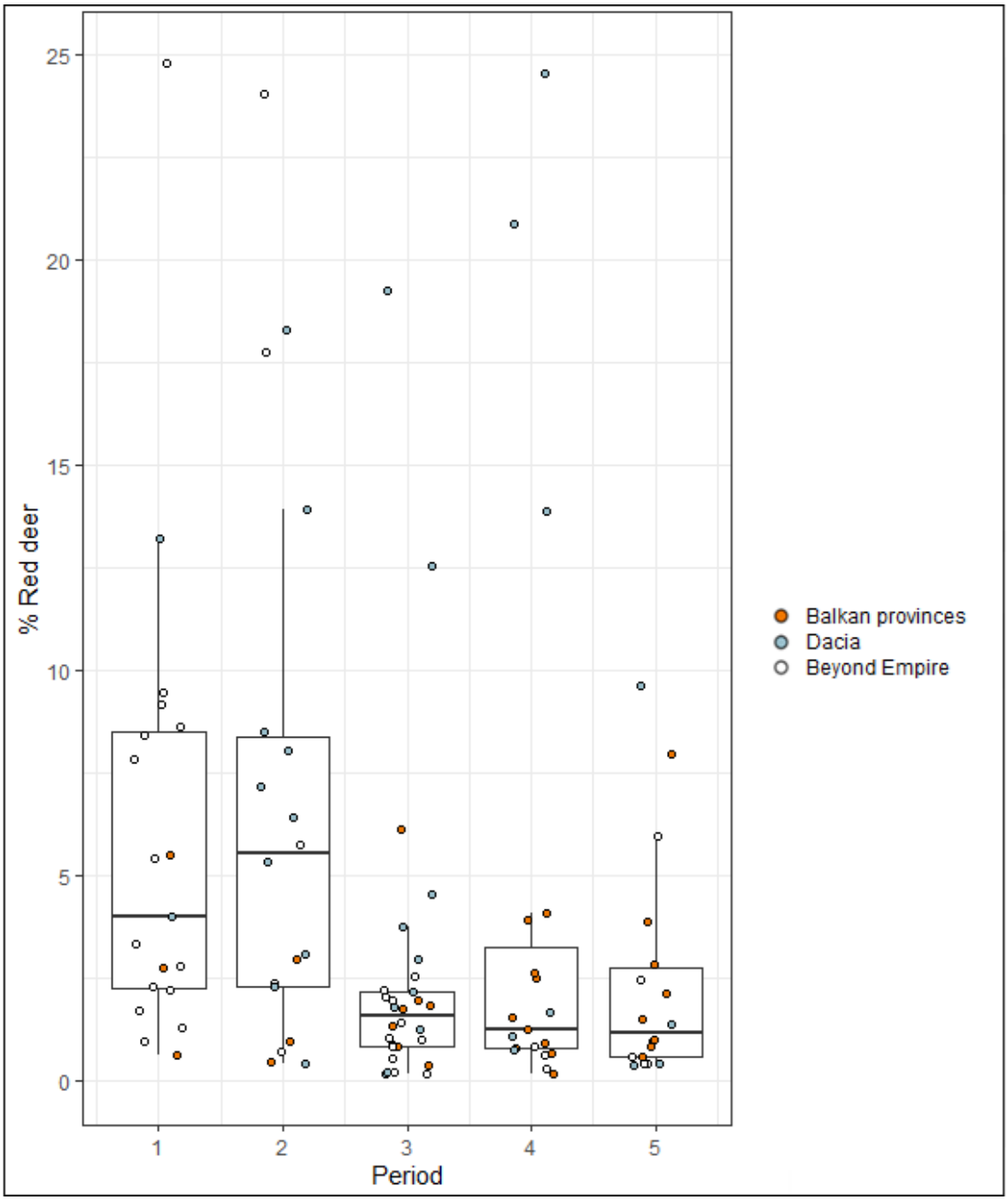


Figure 7.4: Red deer abundance as a percentage of total domestic mammal, large game and small game NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

7.4.3 Wild boar

The second most abundant large game taxon is the wild boar. Figure 7.5 shows wild boar relative abundance by site type and period. From the late Iron Age to the early Roman period, there is little change in the average abundance of wild boar, though the latter period sees an increase in the interquartile range, suggesting greater intersite variation in reliance on this

taxon. The mid-Roman period sees a clear decrease in both the median and the interquartile range, as was also observed for red deer in this period. The data reveal little further change in the extent of wild boar exploitation through the remaining two periods, however, once again echoing the patterns observed in the red deer data.

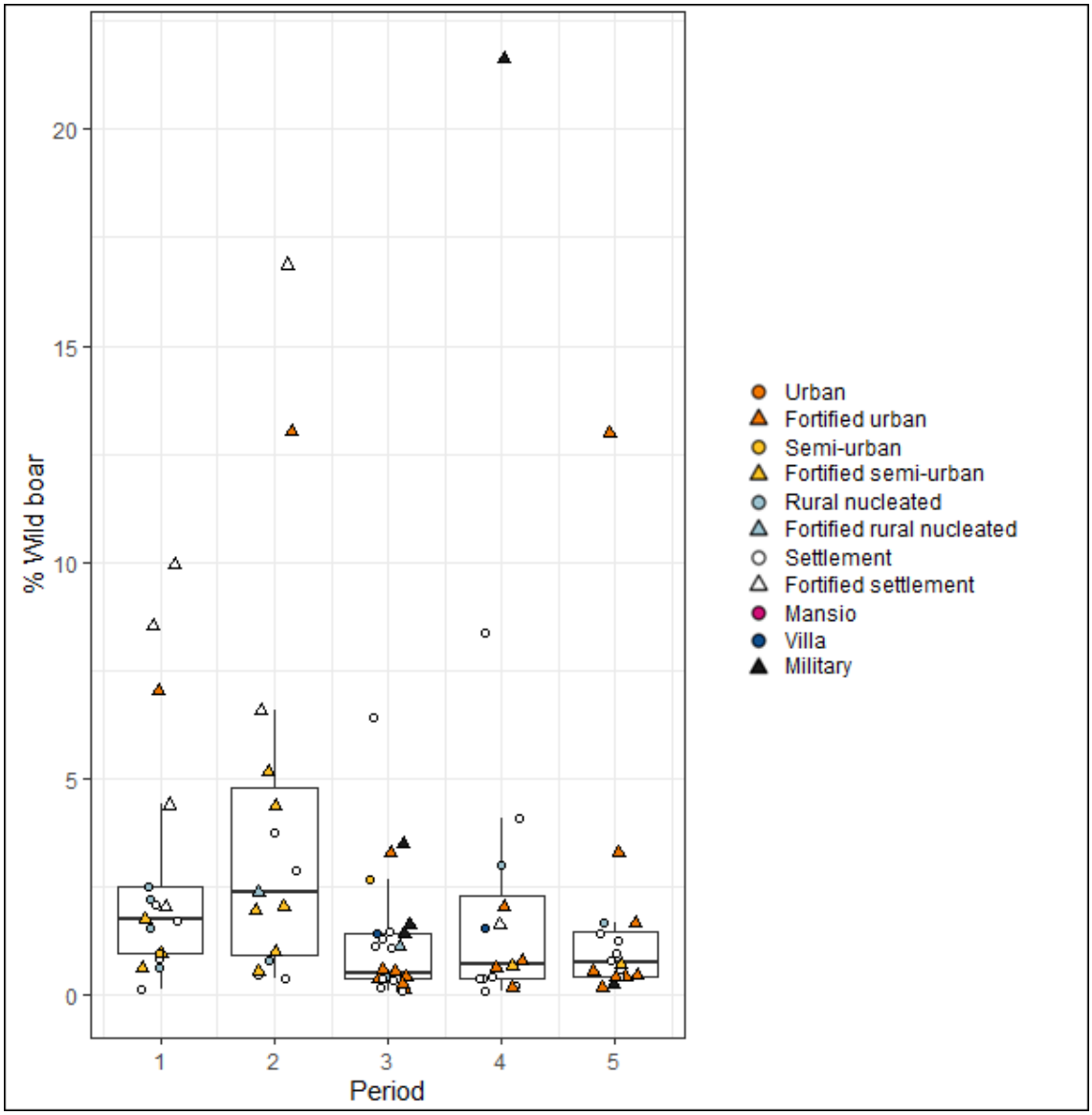


Figure 7.5: Wild boar abundance as a percentage of total domestic mammal, large game and small game NISP by site type and period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

In every period, wild boar abundance is lower at urban and semi-urban sites than at rural sites. Once again, this pattern suggests that rural communities had greater access to populations of large game than their counterparts at urban and semi-urban settlements. Of the five military sites from which wild boar remains were recovered, four lie above the median

value for their respective periods — three dated to the mid-Roman period, and one to the late Roman period. The relative abundance of wild boar at these sites suggests that at least some of the meat consumed by military communities was obtained from wild resources.

Figure 7.6 shows wild boar relative abundance by period and region. As was the case for red deer, wild boar are most abundant in Dacia in the majority of periods, though the sample sizes are once again too small for certain regions in certain periods to draw clear conclusions regarding spatial variation in exploitation. Though fewer sites exhibit a wild boar NISP of more than 10% than was the case for red deer — due in part to the somewhat lower overall abundance of wild boar across the study region — the majority of such sites in the limited available sample lie within Dacia. Like red deer, it is likely that the extent of exploitation of wild boar was influenced to some extent by the varying availability of environments necessary to support populations of the taxon across the study region.

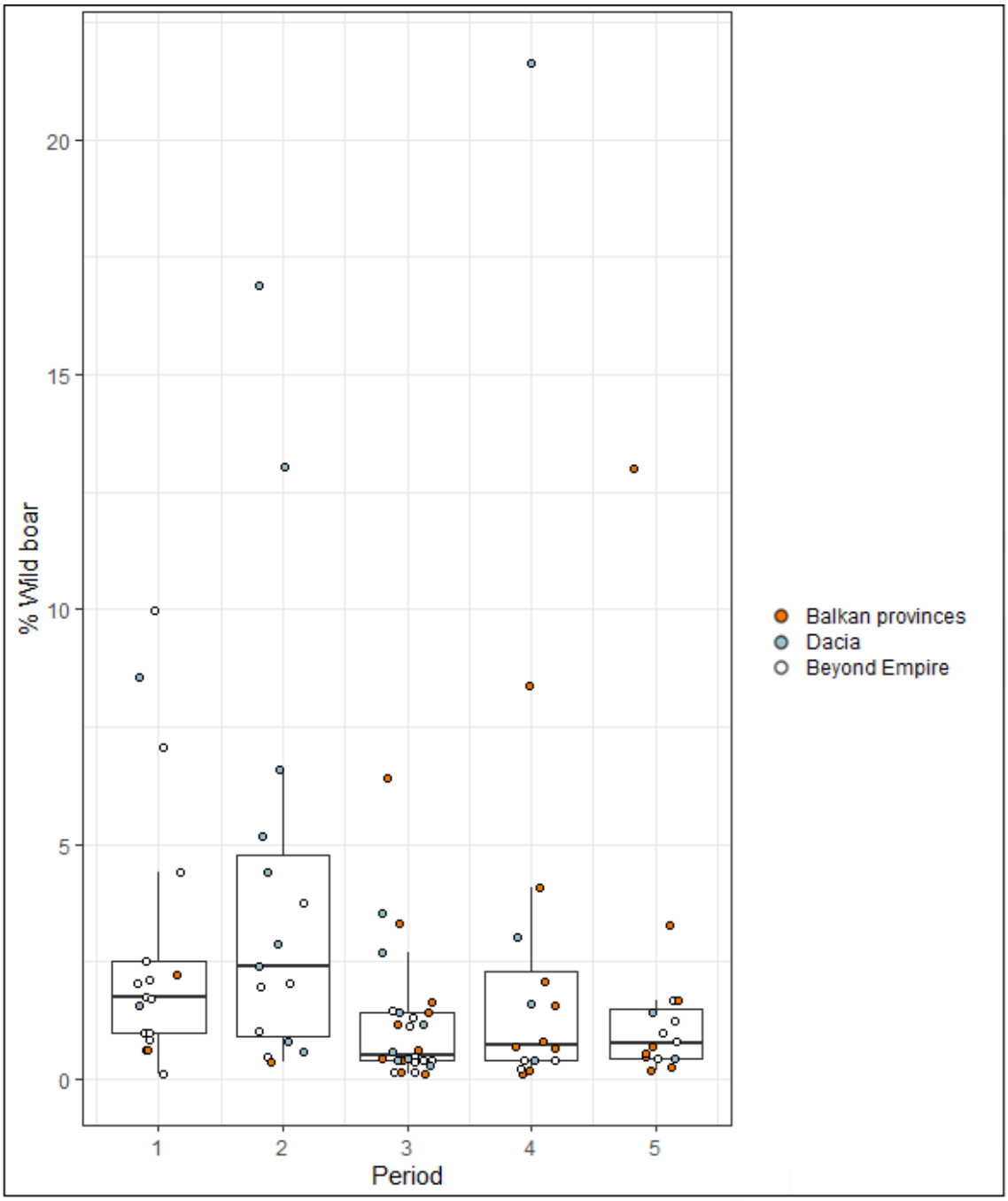


Figure 7.6: Wild boar abundance as a percentage of total domestic mammal, large game and small game NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

7.4.4 Roe deer

Following red deer and wild boar, the next most abundant large game taxon is the roe deer, though the remains of this taxon are present in considerably smaller quantities than either the red deer or the wild boar. Figure 7.7 shows roe deer relative abundance by site type and

period. As was also the case for red deer, there is little change in average roe deer abundance or in the interquartile range from the late Iron Age to the early Roman period. In contrast to the pattern observed in the red deer data, however, while the mid-Roman period sees a small decrease in the median, there is little change in the interquartile range. The data thus indicate a decrease in exploitation of roe deer in the mid-Roman period, but no change in the extent of variation between sites. In the late Roman period, there is little change in the median, but a decrease in the interquartile range is seen, revealing a decline in the extent of variation between sites. In the early Byzantine period, there is little evidence for any further change.

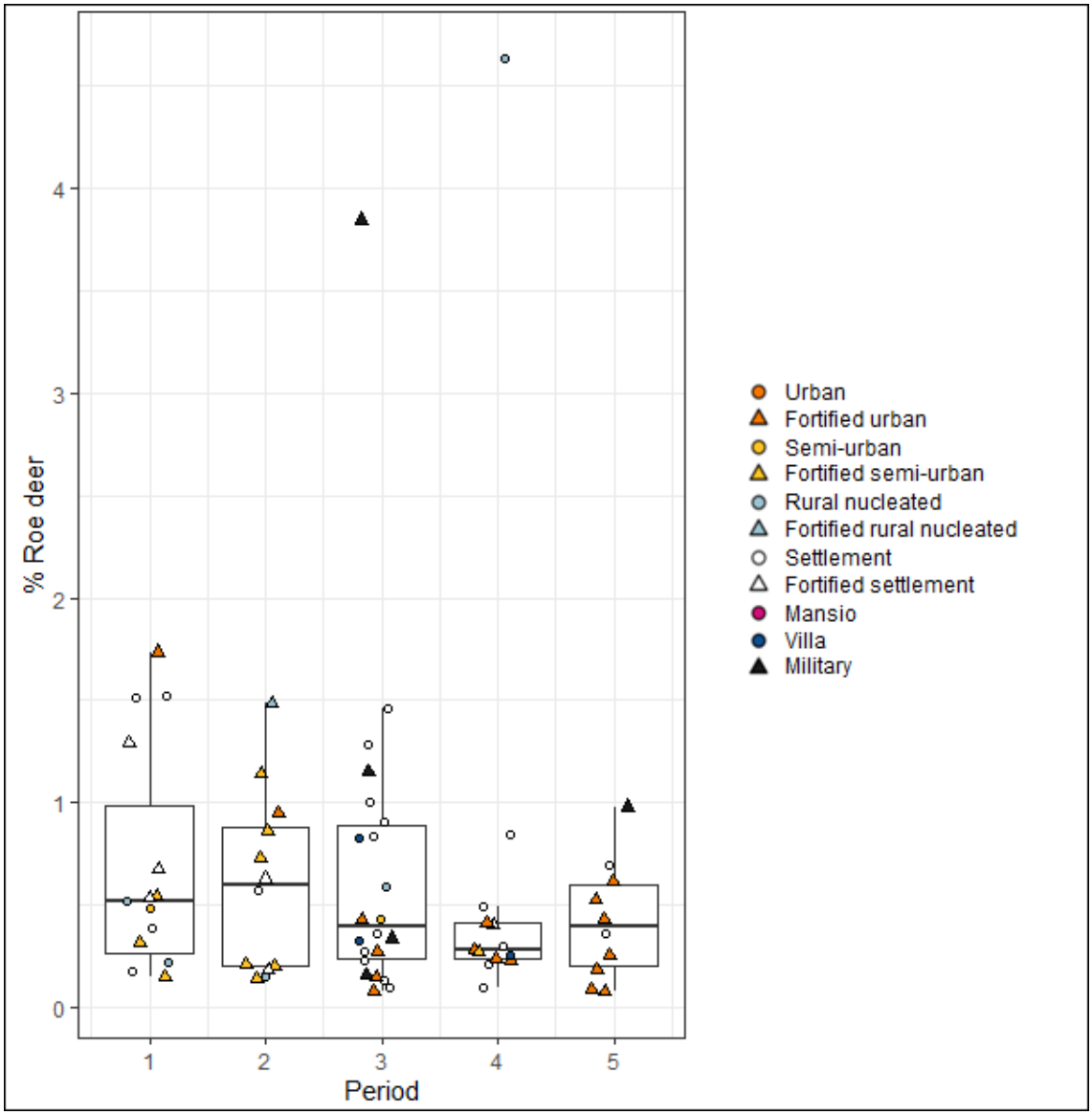


Figure 7.7: Roe deer abundance as a percentage of total domestic mammal, large game and small game NISP by site type and period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Through the majority of the study period, there is a slightly higher proportion of roe deer found at rural than at urban and semi-urban sites, with more sites of the latter types falling below the median than above. In the early Roman period, however, the reverse is true. While site-type-based patterns in roe deer exploitation thus for the most part echo those of red deer, a contrasting pattern of exploitation is seen in the early Roman period. It should be noted, however, that the number of sites of each type is very small for certain periods, so any conclusions drawn regarding site-type-based variation can only be fairly tentative for these periods.

Figure 7.8 shows roe deer relative abundance by period and region. Across the first two periods, the limited available data for the Balkan provinces suggest that roe deer may have been more abundant to the north of the Danube than to the south, though a larger sample for the latter region would be necessary to draw any reliable conclusions regarding spatial variation. In the mid-Roman period, there is no evidence for and interregional variation in roe deer exploitation. In the late Roman and early Byzantine periods, the small sample size for Dacia and the area beyond the Empire preclude spatial analysis of the data.

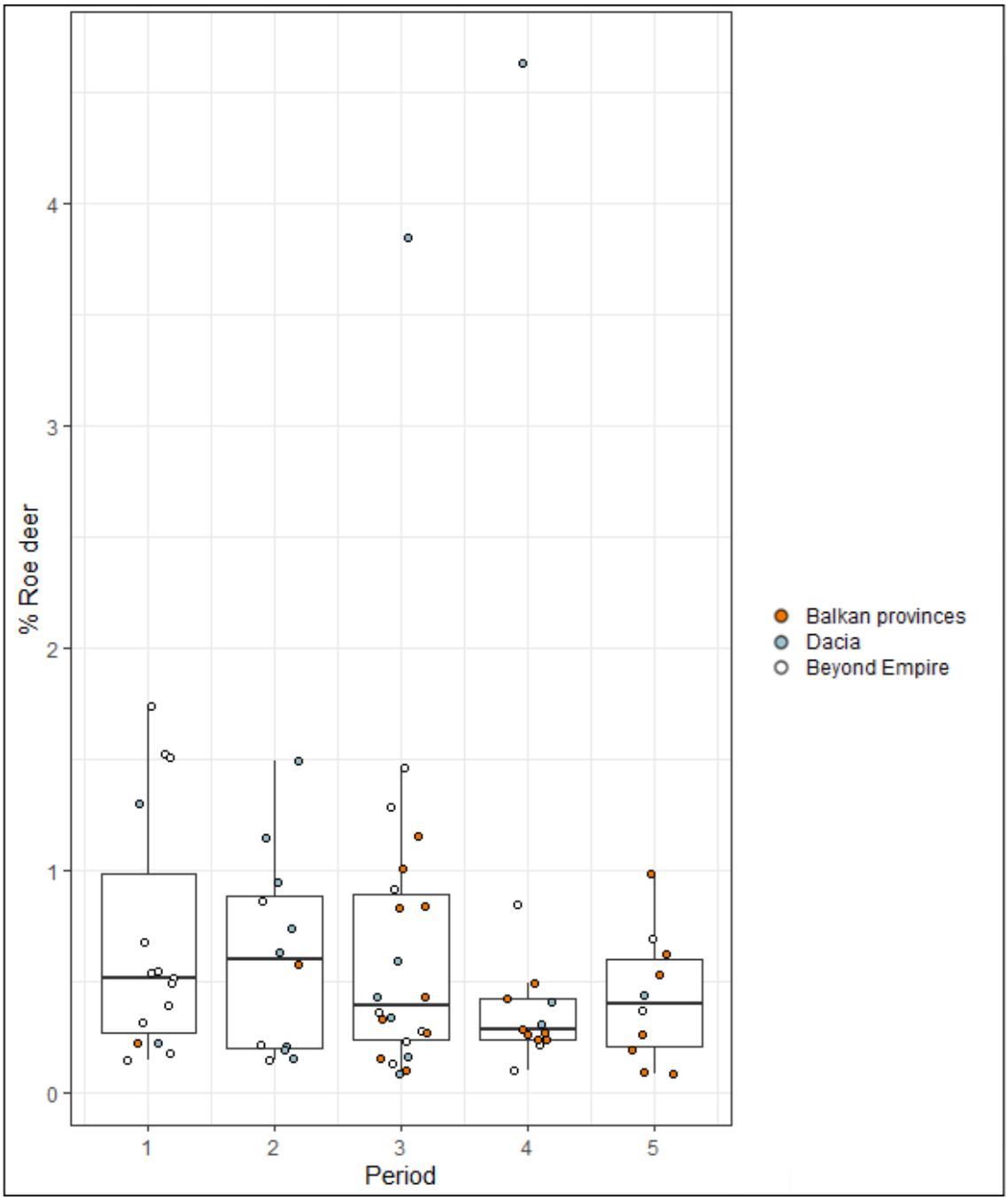


Figure 7.8: Roe deer abundance as a percentage of total domestic mammal, large game and small game NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

7.4.5 Other large game

Following red deer, wild boar, and roe deer, seven further large game taxa were identified across the studied sites, though only three have a total NISP of more than 100. Aurochs remains were recovered from 33 sites, with a total NISP of 343. Aurochs is most abundant in the late Iron Age, with an average contribution to the total domestic mammal, large game and

small game NISP of 1.4%. Its abundance then falls to 0.58% in the early Roman period, and remains below 1% for the remainder of the study period — comprising 0.40% of the NISP in the mid-Roman period, 0.80% in the late Roman period, and reaching a minimum of 0.23% in the early Byzantine period. Aurochs are most abundant in the Balkan provinces and least abundant beyond the Empire. The taxon is present in higher proportions on rural sites, where it comprises 1.2% of the NISP on average, than on urban and semi-urban sites, where it comprises only 0.30% on average. The very low abundance of aurochs overall suggests that its exploitation was limited to occasional supplementation of the diet.

In addition to the four large game taxa discussed thus far, only wolf and brown bear have a total NISP exceeding 100. Wolf remains were recovered in small numbers from all five periods, and in all three regions of the study region. The taxon is present on urban, semi-urban and rural sites, and, while not recovered directly from any military site, is present at the vicus at Stolniceni (Vâlcea County, Romania) (Udrescu 1979). The presence of wolf on these sites most likely results from its exploitation for skin and fur, either as a result of deliberate hunting, or perhaps following its occasional culling to protect livestock — the latter at rural sites in particular. Brown bear remains are also found in small numbers in all five periods, and in all regions of the study region. The taxon is present on urban, semi-urban, rural, and military sites, but numbers fewer than ten remains on all but two sites — the Dacian settlement at Șimleu Silvaniei-Cetate (Sălaj County, Romania) (El Susi 2000), and the urban settlement at Stânceşti, located beyond the Empire in Moldavia. Brown bear exploitation was thus a sporadic practice. These animals may have been deliberately sought out for their skin and fur, or perhaps occasionally culled to protect livestock and settlements.

Four further large game taxa were identified across the studied sites, though each comprises only a very small numbers of remains, with a fairly limited spatial and temporal distribution. Fallow deer were identified at three sites, all within the Balkan provinces. The taxon is most numerous at the late Iron Age village at Yassa-Tepe, in central Bulgaria, where 16 fallow deer bones were found. Five specimens were recovered from late Roman deposits at the urban settlement at Exarch Joseph Street, and two in early Byzantine deposits at the fort at Dichin — both sites also in Bulgaria. The distribution of fallow deer indicates occasional and opportunistic, rather than organised, exploitation. The remains of European bison were recovered from two sites, one dated to the mid-Roman and one to the late Roman period, and both located in Transylvania. The deposition of European bison remains at these two sites,

but not in any other region, likely reflects the suitability of the local landscape for a taxon that favours a forested environment. Three specimens each of golden jackal and Eurasian lynx were identified, the former at a single site in the late Roman Balkan provinces, and the latter across two late Iron Age sites in the east of the study region, beyond the Empire.

7.4.6 Summary

Overall, the analysis of large game relative abundance by taxon reveals that exploitation of large game in the study region focused on three taxa: red deer, wild boar and roe deer. Somewhat contrasting patterns in the relative abundance of these taxa can be observed through the study period. Red deer abundance increases slightly between the late Iron Age and the early Roman period, then decreases considerably in the mid-Roman period, along with intersite variation, with little change evident thereafter. Wild boar follows a similar pattern, though with a lower overall abundance, and with an increase in intersite variation evident between the late Iron Age and the early Roman period. While average roe deer abundance follows a similar pattern to that of red deer, a decline in intersite variation is not apparent until the late Roman period. The data suggest that while large game exploitation decreased considerably overall from the mid-Roman period, this decrease was not uniform across all taxa across all sites, with a degree of variation seen in the patterns of exploitation of the three most common large game taxa. Only very small amounts of the remaining seven large game taxa were identified, suggesting only occasional — and perhaps opportunistic — exploitation.

7.5 Red deer morphology

Figure 7.9, A to C, shows LSI values for red deer bone widths. There is no clear correlation across the dataset as a whole between the patterns observed for red deer and those observed for any livestock taxon. The pattern of change in the red deer width data for the Balkan provinces does somewhat follow that observed in the same region for pig width data, while the pattern observed in the red deer width data for Dacia fairly closely follows the sheep/goat width data for this region. Overall, however, the distribution of red deer widths indicates that different factors likely influenced the size composition of the red deer population than were acting on livestock populations. Figure 7.10, A to C, shows LSI values for red deer bone

lengths. Like the widths, the length data show little similarity overall to the length datasets for any other taxon. Due to the small size of many of the samples, however, more data would be required to draw clear conclusions regarding spatial and temporal variation in red deer size.

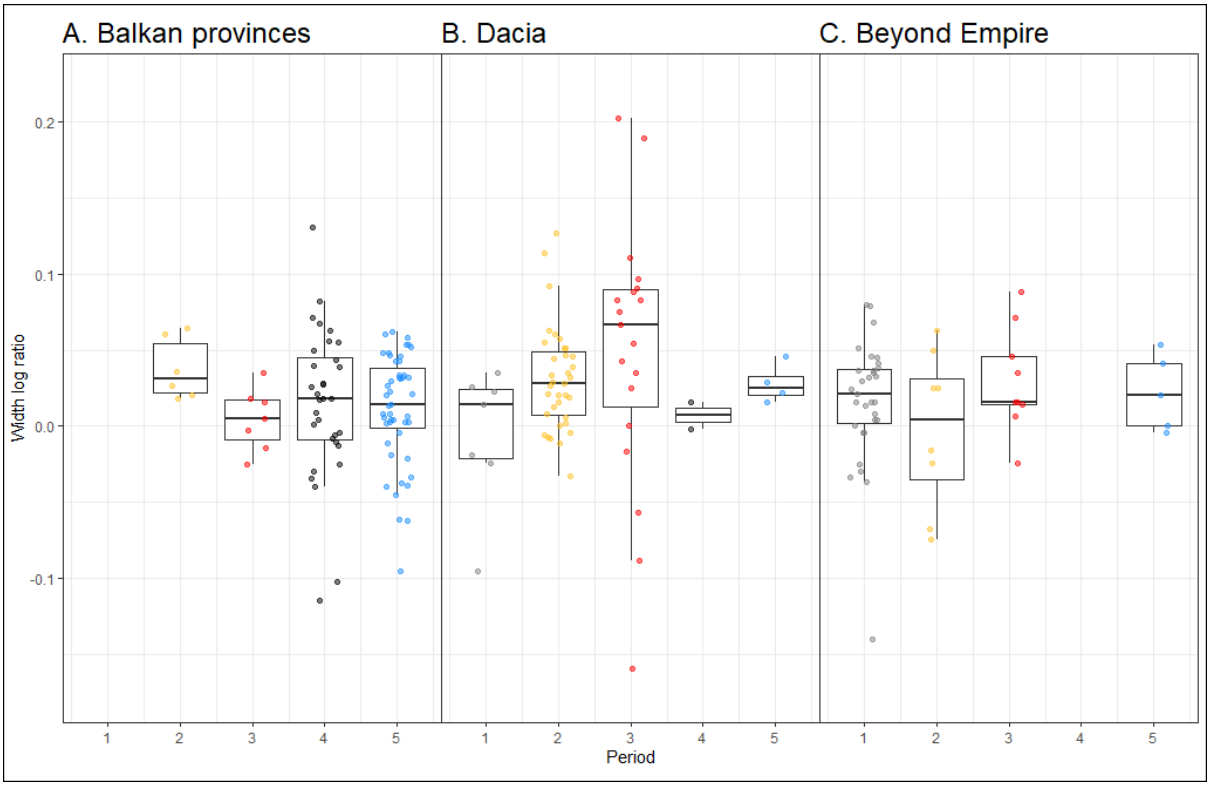


Figure 7.9: LSI values for red deer bone widths. A: Balkan provinces; B: Dacia; C: beyond the Empire.

While it is likely that anthropogenic influence in the form of selective hunting had an impact on the size and sex structure of the deposited 'population' of red deer, climatic and environmental influences would also have been an important factor in the overall size distribution of the populations from which these hunted individuals were obtained. In light of this, the spatial and temporal patterns evident in the red deer width dataset indicate that it was not climatic and environmental factors that were the primary driver of change in livestock size, since the patterns observed for livestock do not closely mirror those observed for red deer — at least not across the study region and the study period as a whole. Spatial and temporal variation in livestock size is thus very likely a consequence of varying Roman influence across the study region and the study period — as was strongly indicated by the close correlation between populations of increased size and periods and regions of Roman occupation.

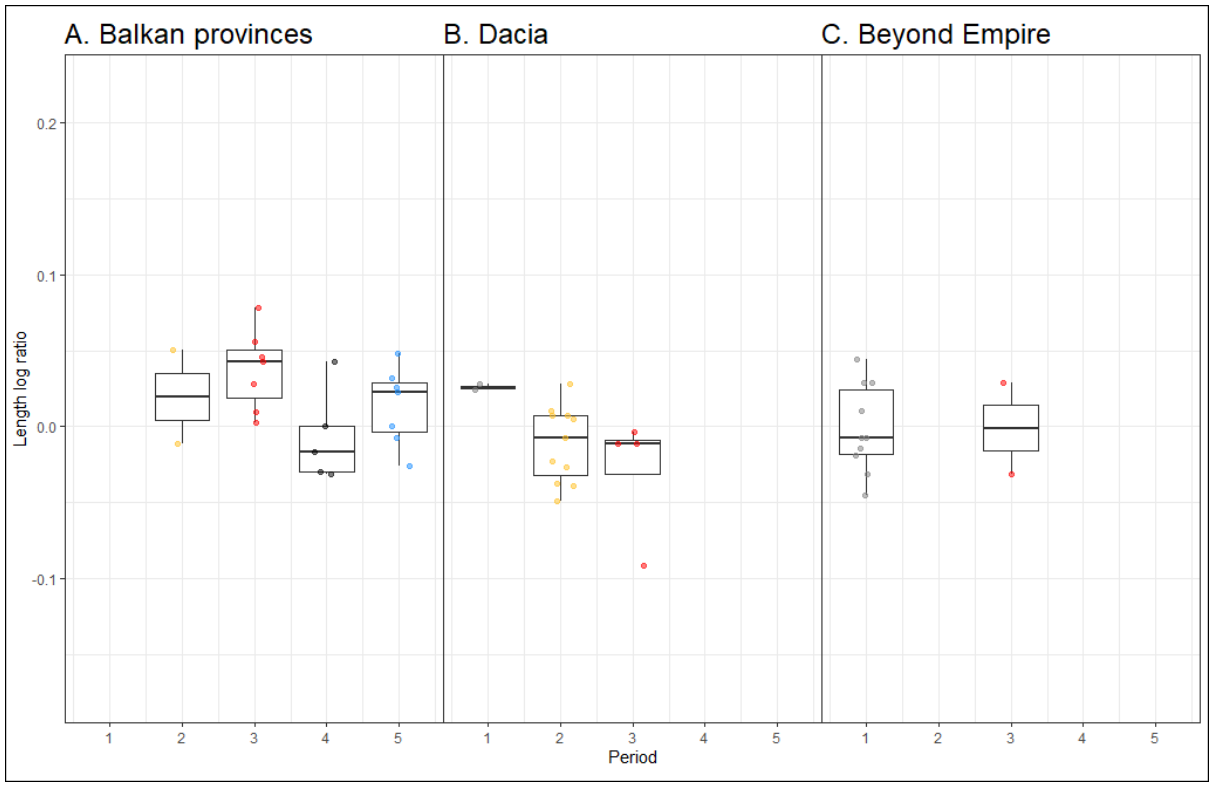


Figure 7.10: LSI values for red deer bone lengths. A: Balkan provinces; B: Dacia; C: beyond the Empire.

7.6 Horses

7.6.1 Relative abundance

Figure 7.11 shows horse relative abundance by site type and period. From the late Iron Age to the early Roman period, there is a decrease in the median value, revealing an overall decline in the exploitation of horses — in the latter period, this taxon comprises less than 10% of the total domestic mammal, large game and small game NISP on every site in the sample. From the early Roman period onwards, there is little further change in the median. Overall, horse abundance is thus uniformly lower from the period of earliest Roman occupation onwards than was the case in the late Iron Age.

Analysis of the data by site type reveals several patterns in the extent of reliance on horses. In the late Iron Age, there is no clear differentiation in horse abundance by site type — it appears that this taxon was of equal importance at rural, semi-urban and urban sites. In the early Roman period, horses are more abundant at semi-urban and urban sites than at rural sites; in the mid-Roman period, the reverse is true. In the late Roman and early Byzantine

periods, horses remain more abundant on rural sites than on either semi-urban or urban sites. Since the key roles of horses — as transport and pack animals — depend upon their regular movement between sites, and between site types, their relative abundance at different site types reflects choices made with regard to their disposal, rather than their abundance and the extent of their exploitation at these site types when alive. This is more the case for horses than for cattle, sheep/goat or pigs, for whom culling for consumption (followed by onsite deposition) is more often the final stage in their primary exploitation, and a key reason for their husbandry. The secondary exploitation of horses for meat is discussed in the following section.

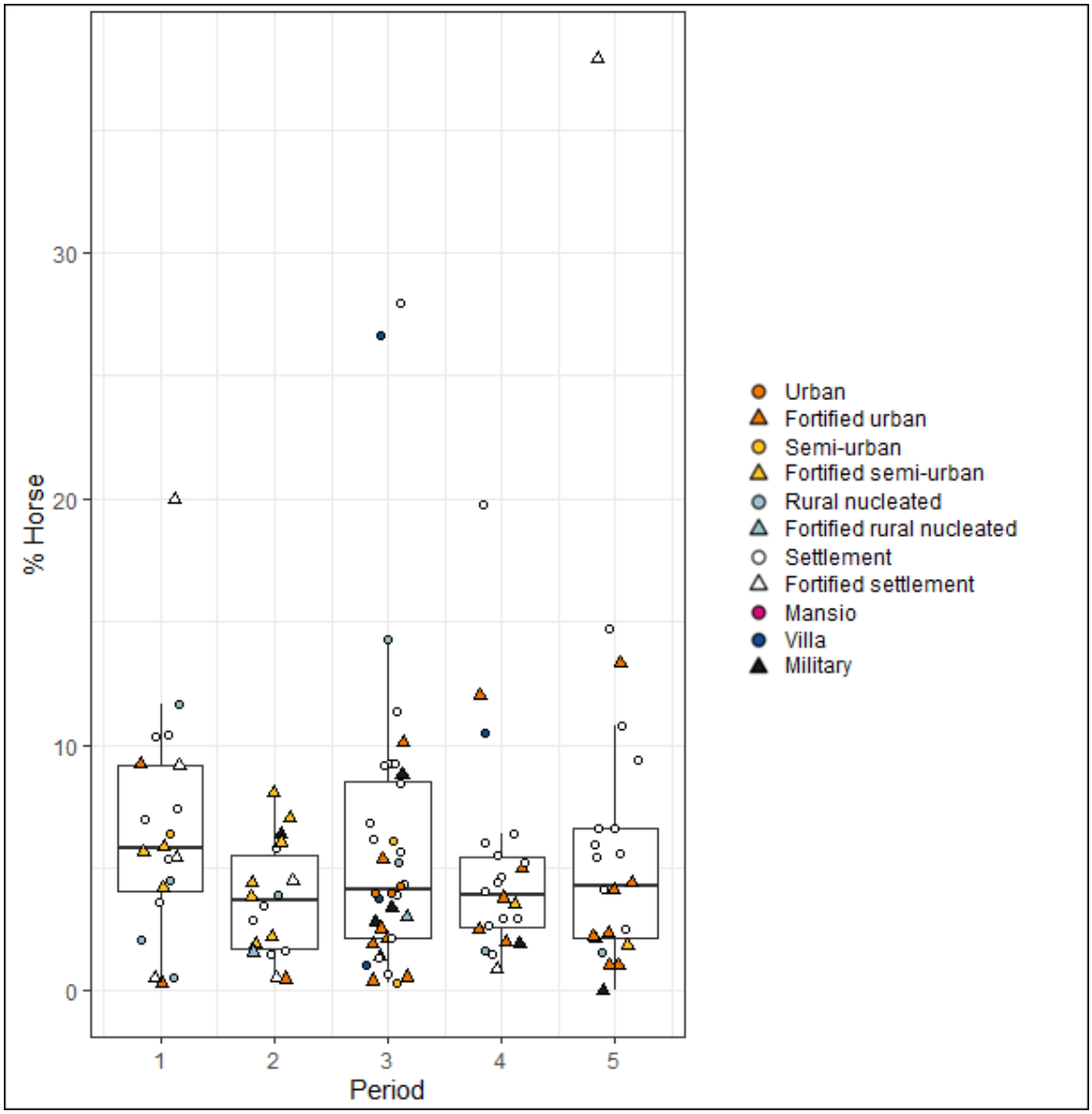


Figure 7.11: Horse abundance as a percentage of total domestic mammal, large game and small game NISP by site type and period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

Figure 7.12 shows horse relative abundance by period and region. The data reveal a progressive slight increase in average horse abundance in the Balkan provinces from the late Iron Age to the late Roman period, after which the abundance of this taxon decreases. In Dacia, the median value is somewhat higher in the late Iron Age, the mid-Roman period, and the early Byzantine period than in the intervening two periods; beyond the Empire, the same pattern of period-by-period change in horse abundance is seen. The highest horse values across the dataset as a whole are seen in Dacia and the area beyond the Empire, at each of which this taxon exceeds 15% of the NISP at more than one site. Overall, average horse abundance is lowest in the Balkan provinces in all periods except the late Roman period, when the median value for Dacia is lower than those for the other two regions.

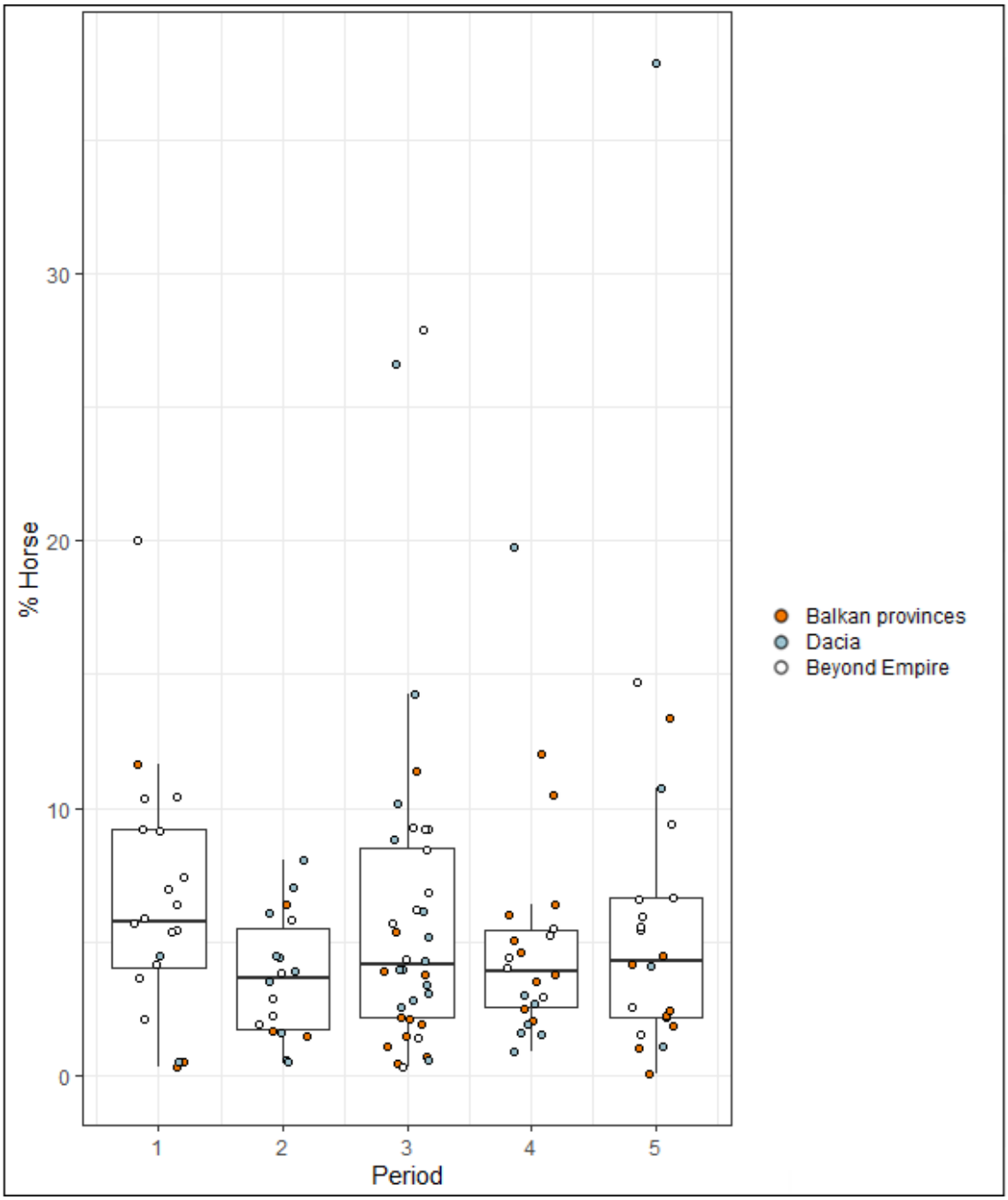


Figure 7.12: Horse abundance as a percentage of total domestic mammal, large game and small game NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

7.6.2 Morphology

Figure 7.13, A to C, shows LSI values for horse bone widths. Spatial and temporal variation in horse size fairly closely follows that observed in the cattle data. The Balkan provinces see an increase in average size from the late Iron Age to the mid-Roman period, whereafter horse size remains relatively high. In Dacia, average size increases during the Roman occupation,

then appears to fall in subsequent periods. Beyond the Empire, average horse size changes relatively little through the study period, but appears to be somewhat lower than in occupied regions from the mid-Roman period onwards. Since many of the sample sizes are fairly small, however, conclusions regarding spatial and temporal variation in horse size can only be fairly tentative.

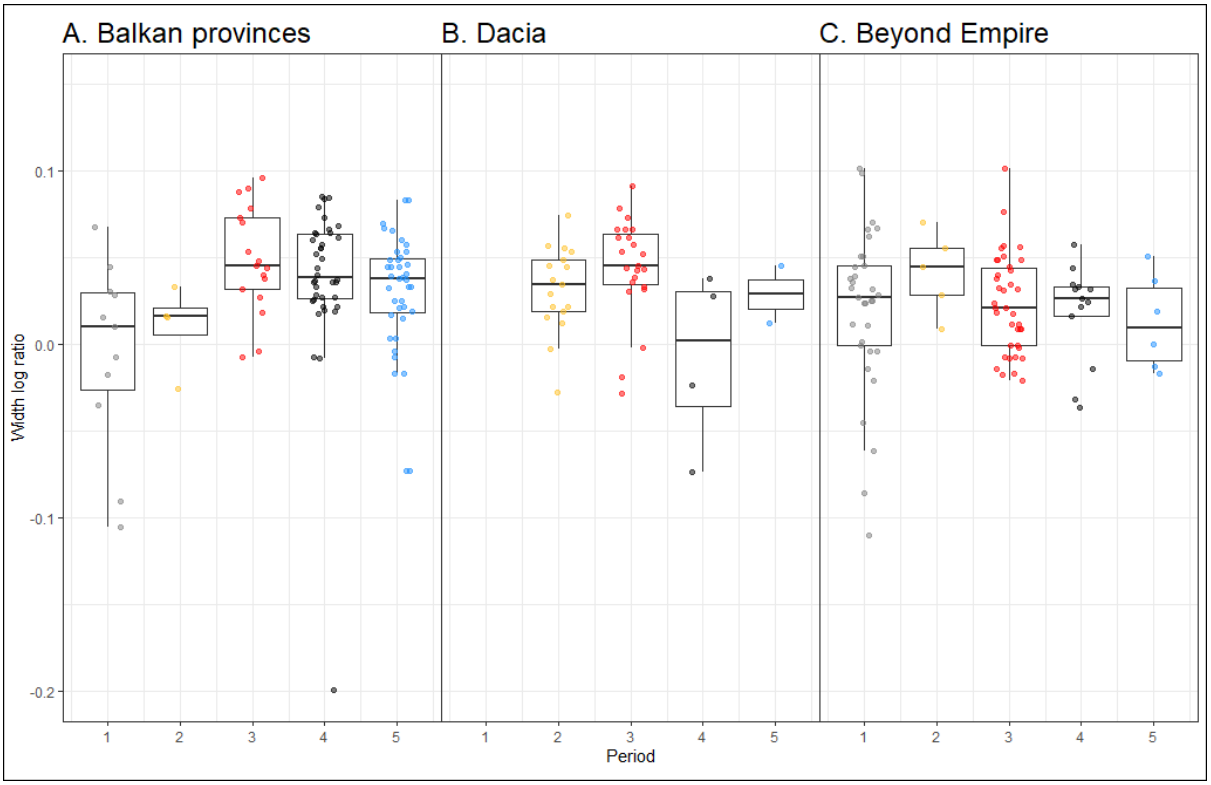


Figure 7.13: LSI values for horse bone widths. A: Balkan provinces; B: Dacia; C: beyond the Empire.

Figure 7.14, A to C, shows LSI values for horse bone depths. The data are too few to provide any real insight into horse size, though they do for the most part corroborate the impression provided by the width data. Figure 7.15, A to C, shows LSI values for horse bone lengths. Once again, the data are too few to enable reliable conclusions to be drawn, but they do largely echo the patterns observed in the widths.

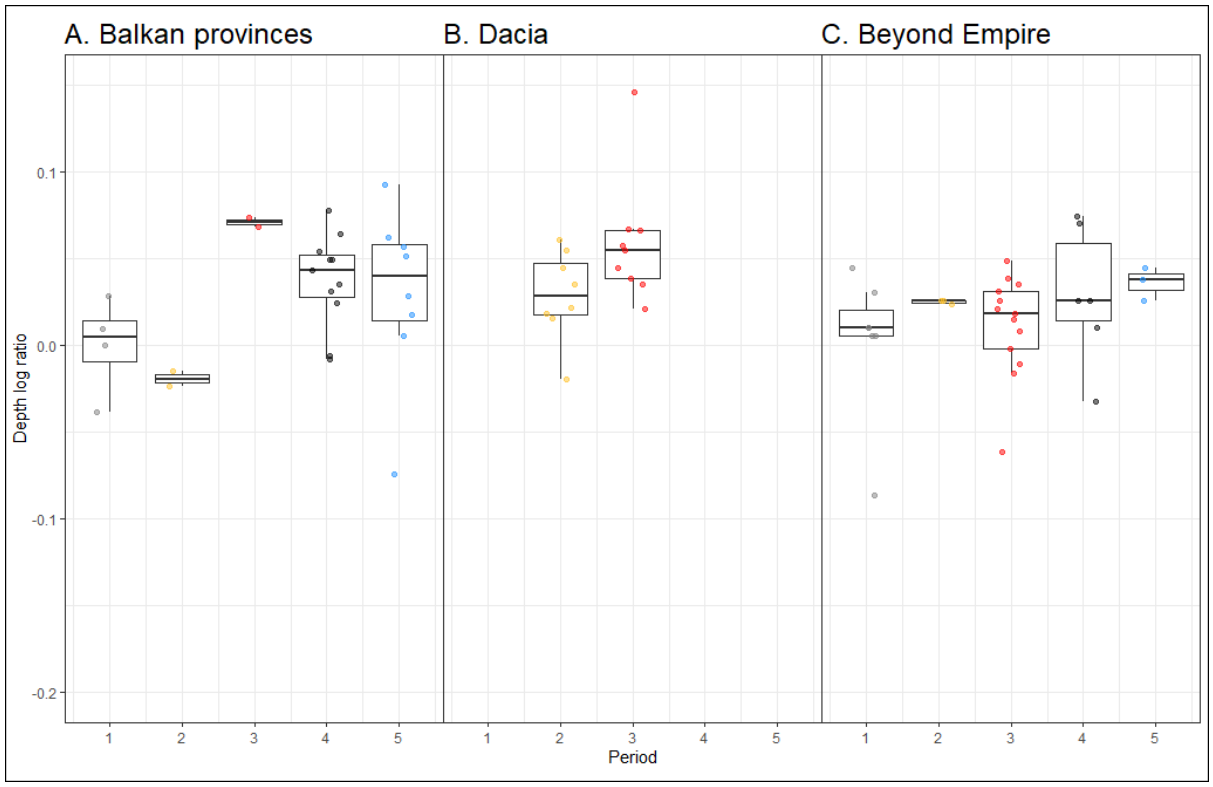


Figure 7.14: LSI values for horse bone depths. A: Balkan provinces; B: Dacia; C: beyond the Empire.

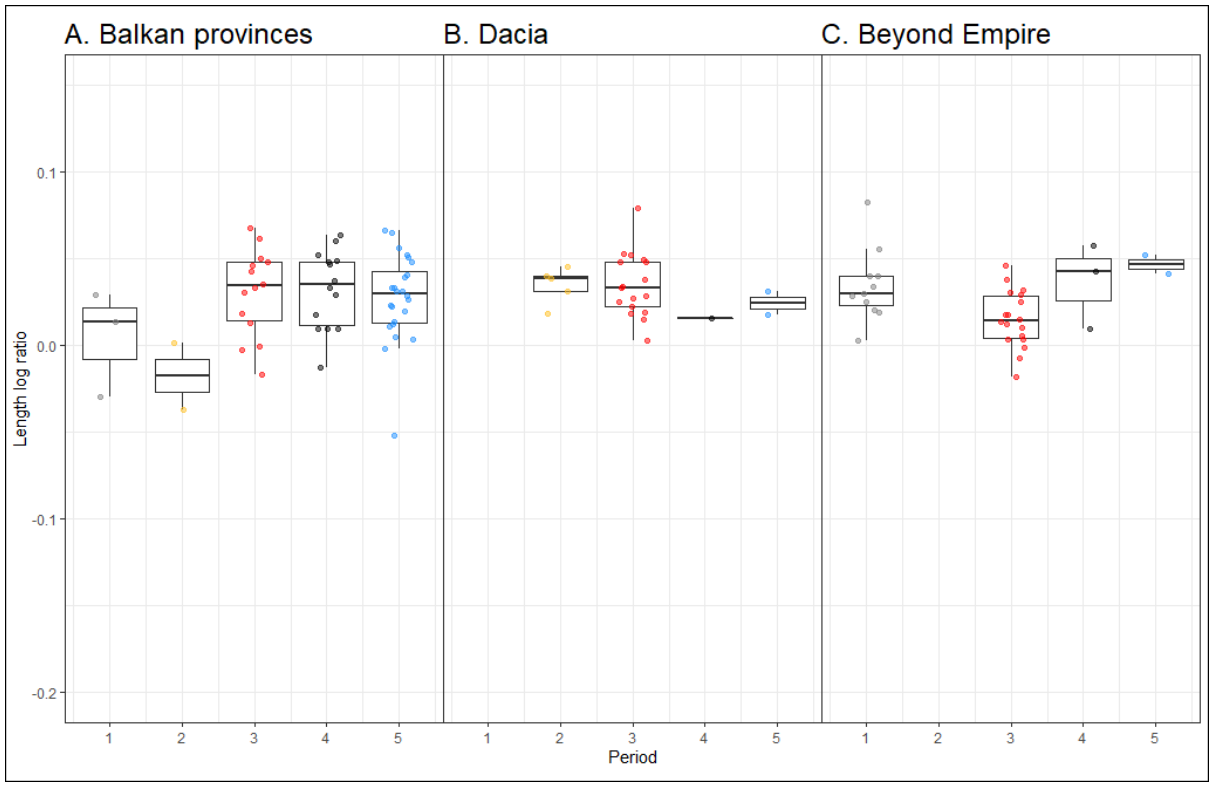


Figure 7.15: LSI values for horse bone lengths. A: Balkan provinces; B: Dacia; C: beyond the Empire.

7.6.3 Hippophagy

Figure 7.16 shows the prevalence of hippophagy by phase, determined by reference to the overall frequency of horsemeat consumption (e.g. occasional, common) noted by the author of each faunal report. While periods of increased disruption might be expected to result in an increase in the consumption of horses due to decreased access to usual meat sources at these times, the horses consumed are unlikely to have been bred specifically for this purpose, so a corresponding increase in horse abundance would not necessarily be expected — though it could be argued that horse culling and subsequent deposition might be expected to increase in such periods, resulting in greater abundance archaeologically. The data indicate, however, that changes in the prevalence of horsemeat consumption do not directly correlate with changes in horse abundance, though both are higher in the late Iron Age than in any other period.

The proportion of all late Iron Age phases with hippophagy positively identified is 56%, falling to 31% in the early Roman period, and falling again to 21% in the mid-Roman period. The prevalence of hippophagy then increases to 29% in the late Roman period, and declines very slightly to 28% in the early Byzantine period. When cases of possible hippophagy are included in the analysis, the figures change slightly to 59%, 41%, 41%, 36% and 42% respectively across the five periods. This latter set of figures indicates no change in the prevalence of hippophagy between the early and mid-Roman periods, and suggests that the practice was least prevalent in the late Roman period. Since it is not certain whether hippophagy did indeed take place in the additional phases included in the latter set of figures, the former set provides a more reliable indication of the true extent of horsemeat consumption, so it is these data that are discussed below.

The consumption of horsemeat is most widespread in the late Iron Age, prior to the earliest Roman occupation, and is observed on the smallest proportion of sites in the mid-Roman period, at the height of Roman territorial and political control. This decline in hippophagy from the late Iron Age to the mid-Roman period suggests increasing Roman economic influence over time, and perhaps more widespread access to meat obtained from sheep/goat, pigs, and particularly cattle, as a new economic system was established, resulting in a decline in the consumption of more marginal resources. Roman-influenced cultural change during the earlier centuries of the occupation may also have influenced the observed decline in

horsemeat consumption. The prevalence of hippophagy increases from the mid-Roman to the late Roman period, suggesting increased reliance on more marginal food sources in the latter period. This is consistent with evidence for changing reliance on large game between the two periods — the proportion of sites on which large game comprise more than 10% of the NISP almost doubles from the mid-Roman to the late Roman period, suggesting diversification of meat acquisition strategies. A slight decrease in cattle abundance and an increase in pigs between the two periods could also indicate disruption to existing food production and supply systems.

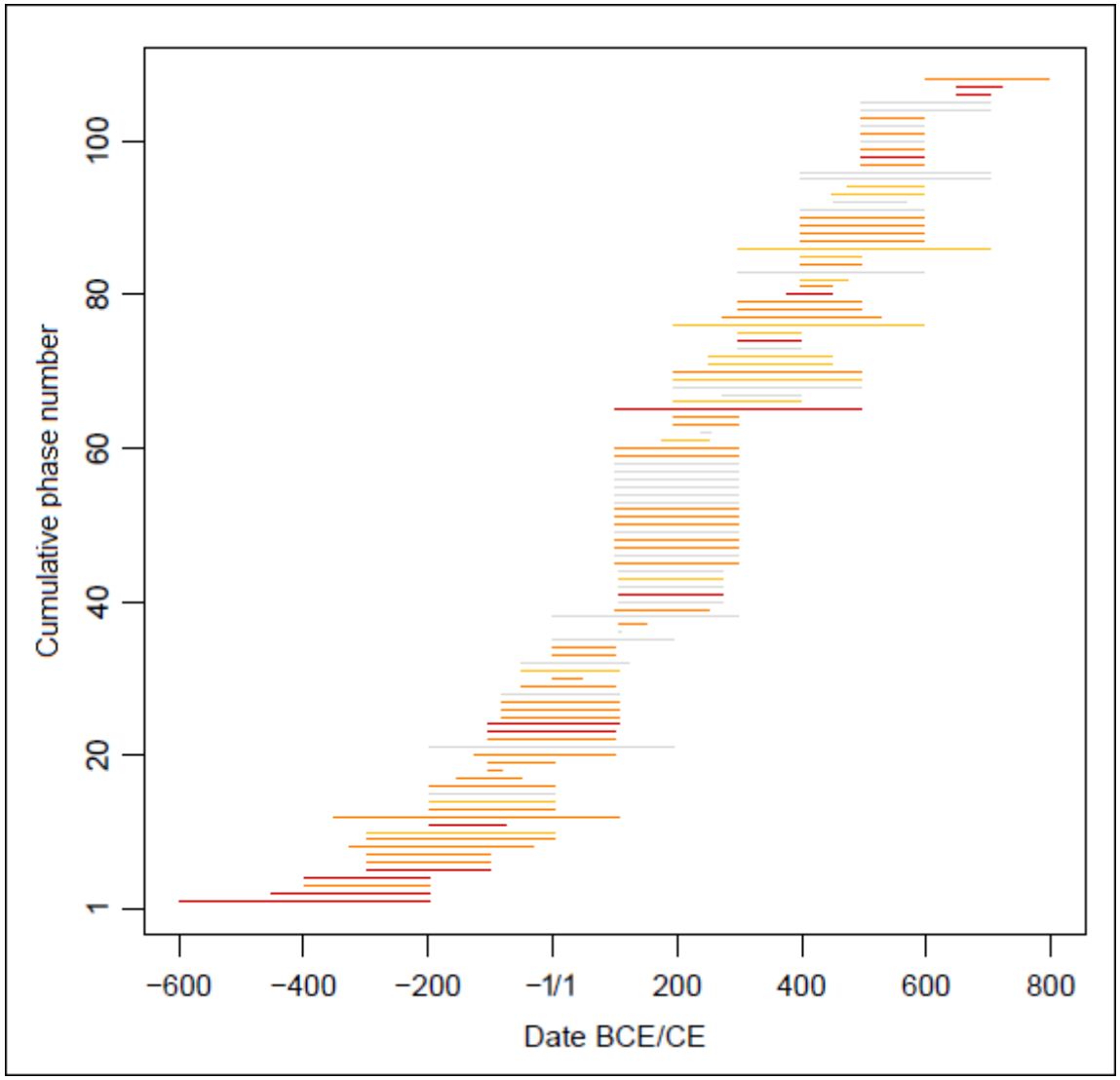
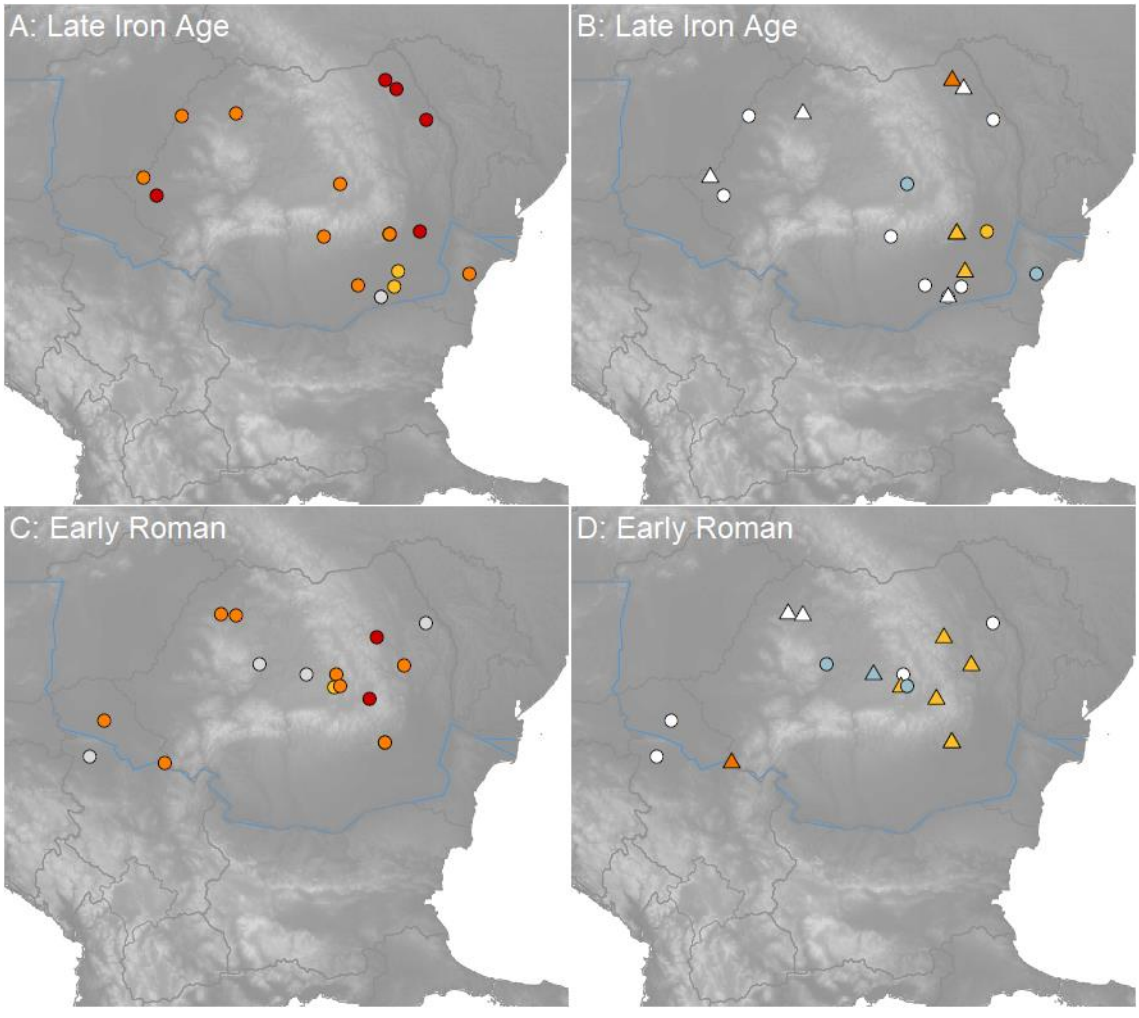


Figure 7.16: Prevalence of hippophagy by phase. Grey: possible hippophagy; yellow: occasional hippophagy; orange: hippophagy present but frequency unspecified; red: hippophagy common.

Figure 7.17 shows the prevalence of hippophagy by site type and period, showing hippophagy frequency (A, C, E, G, I), and site type (B, D, F, H, J), for all sites at which hippophagy has been positively identified, and all those at which hippophagy may have taken place. In the late Iron Age, hippophagy is present on rural and semi-urban sites, and at a single urban site — the Thraco-Getic fortified settlement at Stânceşti. Information regarding the frequency of hippophagy — whether a common or occasional practice — was available for seven late Iron Age sites. Horsemeat consumption was a common practice on at least one urban, one semi-urban, and three rural sites. There is a concentration of sites at which hippophagy was a common practice in the northeast of the study region in Moldavia, indicating either a regionally-specific cultural influence on dietary preference here, or perhaps a regular lack of access to other meat sources, resulting in the exploitation of marginal resources. At two sites in southern Muntenia, hippophagy appears only to have been an occasional practice. Occasional hippophagy is more likely a consequence of sporadic necessity than dietary choice, but may instead result from the occasional supplementation of the diet with horsemeat, once the animals had reached the end of their working lives.



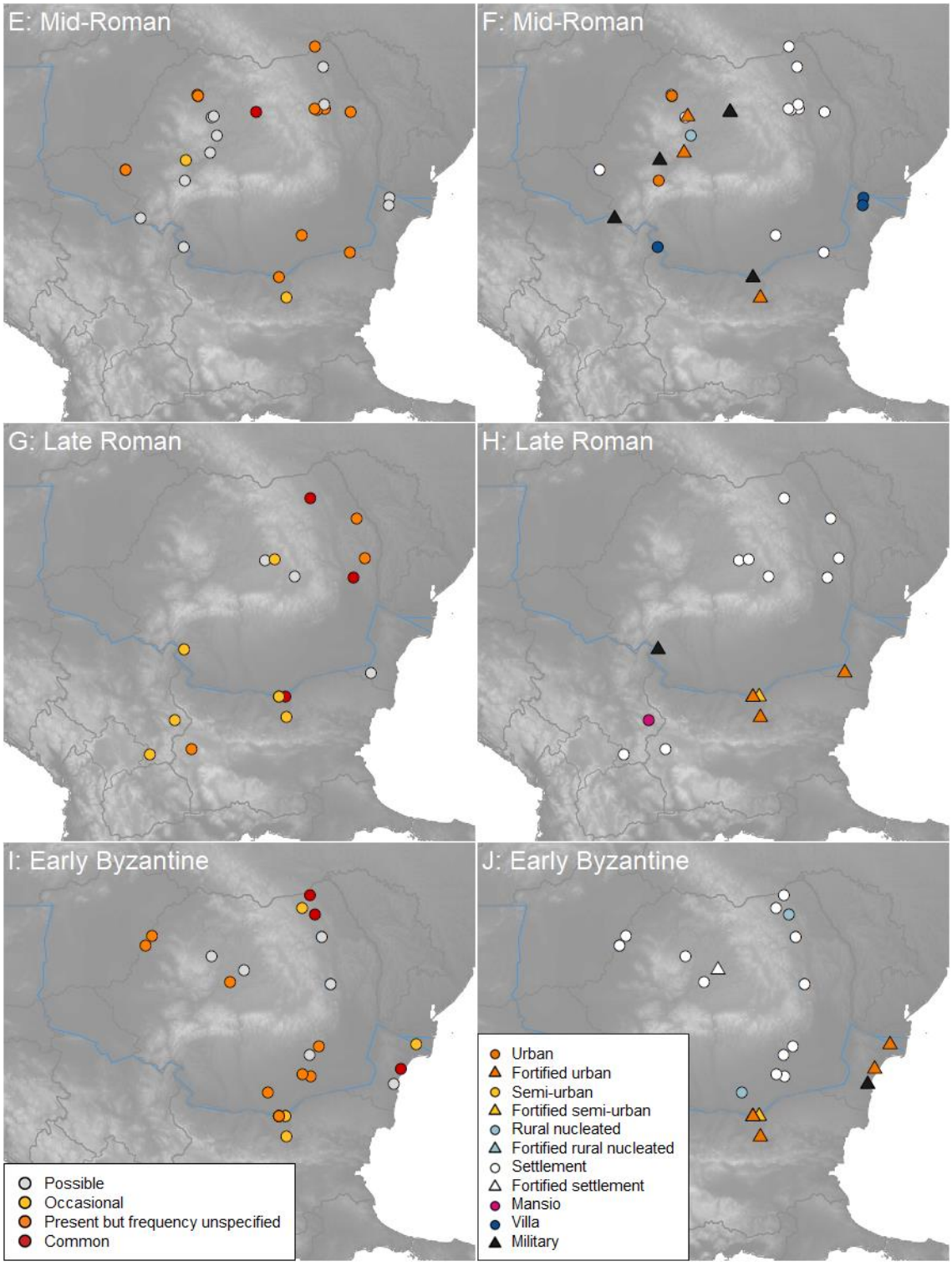


Figure 7.17: Prevalence of hippophagy by site type and period. A, C, E, G, I: hippophagy frequency; B, D, F, H, J: site type. A-B: late Iron Age; C-D: early Roman; E-F: mid-Roman; G-H: late Roman; I-J: early Byzantine.

In the early Roman period, hippophagy is once again present on rural, semi-urban and urban sites, and can be seen at five of the six fortified semi-urban settlements at the southern end of the eastern Carpathians, in the Kingdom of Dacia. Evidence for hippophagy on such a large

proportion of these pre-Roman Dacian semi-urban sites, including on two sites where the practice was observed to be common, indicates a culturally-influenced shared dietary practice. The location of these sites away from the main regions of Roman military activity in this period provides further indication that the consumption of horse was not a response to disruption to usual food production practices.

In the mid-Roman period, the first military sites with evidence for hippophagy appear in the sample. These sites are located in the Balkan provinces and in Roman-occupied Dacia, and include the auxiliary fort at Brâncovenești (Mureș County, Romania) (Kelemen 2015), where hippophagy was common, and the military camp at Micia, where the practice was occasional. Hippophagy at these military sites at the height of the Roman occupation could result from a desire — or a need — to fully utilise resources, leading to the exploitation of horses for meat once they were no longer of use in the cavalry. In addition to military sites, hippophagy is seen on urban and rural sites in the mid-Roman period, and was possibly also practised at three villas — two in Dobrogea and one in Roman Dacia. While hippophagy was evidently widespread in this period, and present across all three regions of the study region, few hippophagy frequency data were available, preventing detailed analysis of variation in the extent of reliance on horses for meat.

In the late Roman period, hippophagy continues to be practised at a range of site types, including at the single *mansio* in the sample, at Pirot-Staro Vašarište, where horsemeat was occasionally consumed. At this site type, the practice may result from the occasional consumption of horses used for much of their lives as work animals for the transport of products around the Roman provinces. As was also the case in the late Iron Age and the early Roman period, in the late Roman period there is a concentration of sites on which hippophagy was a common practice in the northeast of the study region. This is in contrast to the southwest, where hippophagy was only an occasional practice at the majority of sites in the sample. In the early Byzantine period, a degree of regional variation in horsemeat consumption can once again be seen — the practice remaining most common in the northeast — though this pattern is somewhat less clear than in the late Roman period.

Evidence for hippophagy can be seen across all three regions of the study region throughout the study period. While political, social, cultural and economic change may have influenced the frequency of horsemeat consumption on different sites and in different regions, the

Roman presence does not appear to have resulted in the complete disappearance of the practice in occupied regions. While hippophagy is most common beyond the Empire in Moldavia through much of the study period, it is also a common practice on a small number of sites in both the Balkan provinces and Roman-occupied Dacia. Its continued presence in the Balkan provinces and Dacia after the Roman conquest may result from the persistence of pre-existing dietary practices in these regions, or alternatively from the exploitation of marginal resources by various communities on an occasional or regular basis. Hippophagy was identified on multiple sites across the study region for which frequency data were not available — further data from these and other sites would clarify the picture further.

7.7 Summary

Analysis of hunted taxa and horses reveals several spatial and temporal patterns. Large game abundance is highest prior to the earliest Roman occupation in the study region, suggesting food procurement strategies adapted to the local environment — albeit alongside a clear focus on the utilisation of domestic resources — in the late Iron Age. Large game exploitation is lowest in the period that saw the greatest extent of Roman occupation, with a rapid decline observed from the early to the mid-Roman period, indicating that while the early occupation did not stimulate immediate change, the establishment of more widespread control and greater stability resulted in the development of new approaches to resource procurement. The fairly small number of sites exhibiting a high proportion of game are in general well-distributed across the study region — only in the Iron Gates is there consistent evidence to suggest that environmental context may have facilitated — or indeed stimulated — increased reliance on hunting. Overall, the large game and hippophagy data suggest that while certain communities may have exploited these taxa to a greater degree in periods of instability than was otherwise the case, their exploitation was likely also to a certain extent a culturally-determined practice.

8 Dogs

8.1 Introduction

This chapter presents the analysis of dog relative abundance and morphology. It begins by discussing spatial, temporal and site-type-based variation in dog abundance, before considering variation in dog size, stature and slenderness across the study region and study period.

8.2 Relative abundance

Dog remains were recovered from 151 phases, with a total NISP of 2,922. Figure 8.1 shows dog relative abundance by site type and period. Dogs comprise less than 2.5% of the total domestic mammal, large game and small game NISP in all five periods. Abundance is highest in the late Iron Age, declining after the start of the earliest Roman occupation and changing little thereafter. In the early Roman period, dog abundance is somewhat lower at semi-urban sites than at rural sites, while in the mid-Roman and early Byzantine periods abundance is higher overall at urban, semi-urban and military sites than at rural sites. There is little evidence for any site-type-based trends in the late Iron Age or the late Roman period.

Figure 8.2 shows dog relative abundance by period and region. Dogs are most abundant in the Balkan provinces, comprising on average 2.6% of the total domestic mammal, large game and small game NISP in this region. Across the study period as a whole, dogs comprise a higher proportion of the NISP at rural than at urban and semi-urban sites in the Balkan provinces. In Dacia and the area beyond the Empire, average dog abundance is somewhat lower than in the Balkan provinces, at around 2% in both regions. Dogs are most abundant on rural sites beyond the Empire, but in Dacia the pattern is reversed. In both the Balkan provinces and Dacia, the lowest proportion of dog remains was recovered from military sites, indicating more limited utilisation of this taxon by military than by civilian communities.

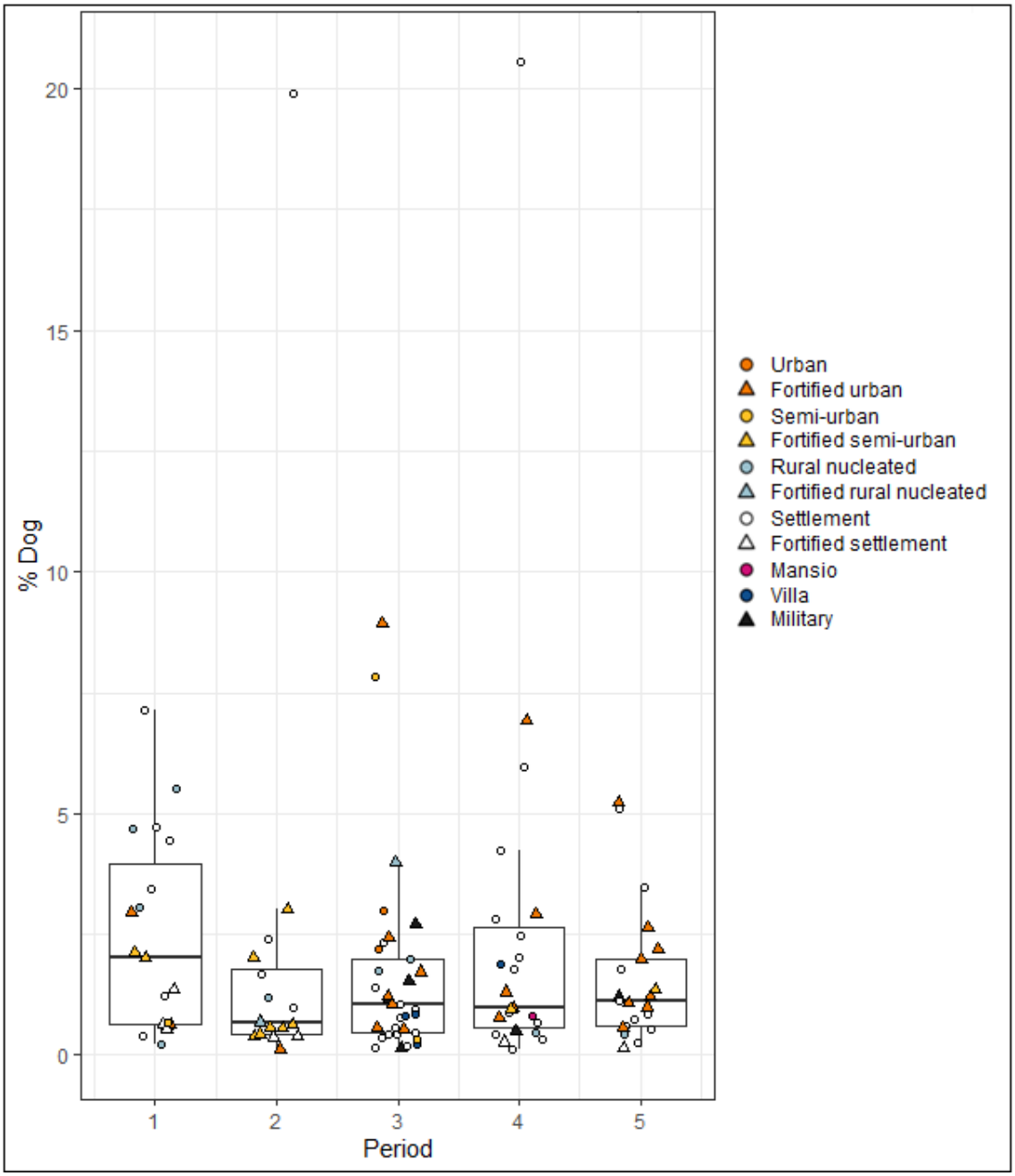


Figure 8.1: Dog abundance as a percentage of total domestic mammal, large game and small game NISP by site type and period. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

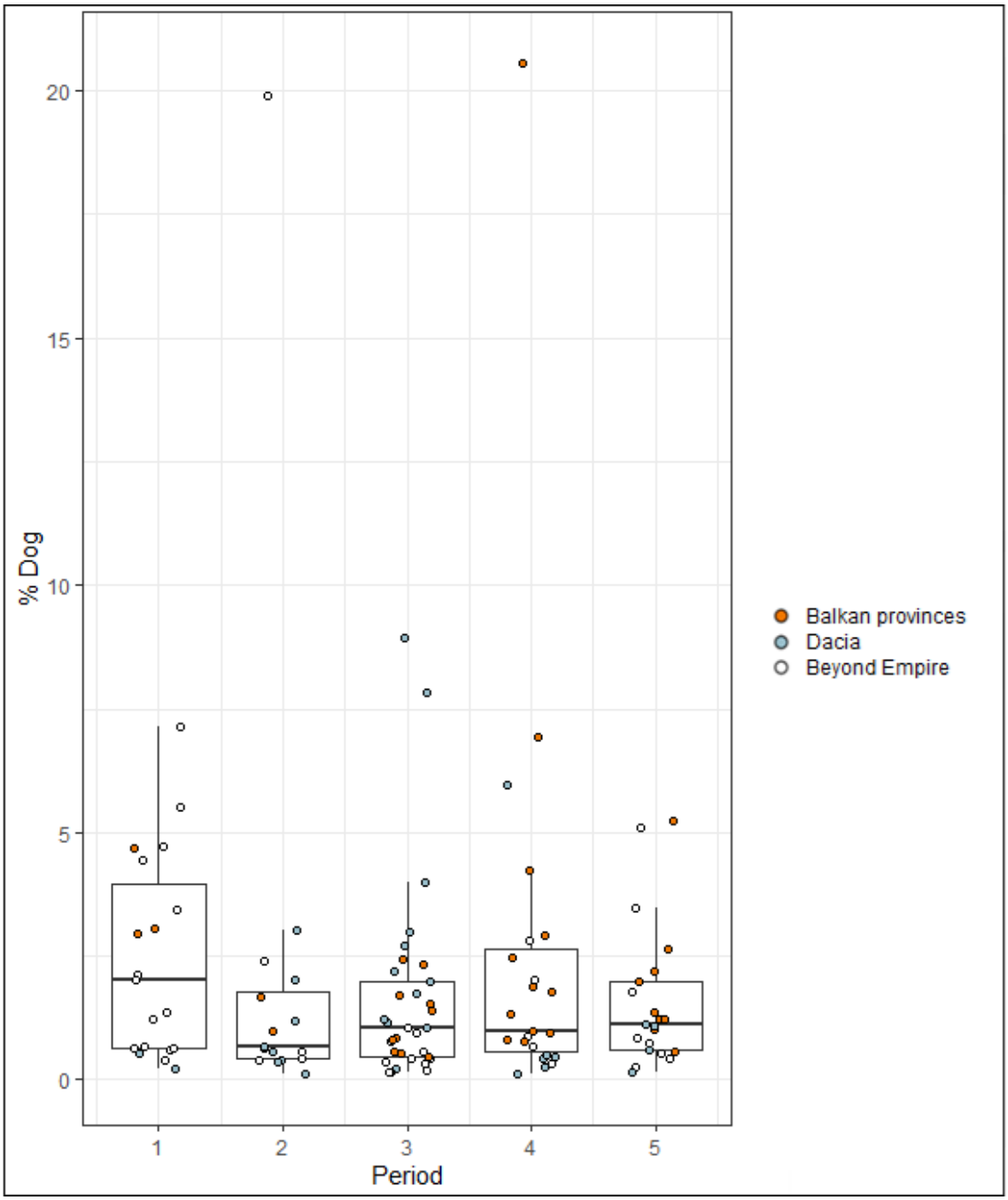


Figure 8.2: Dog abundance as a percentage of total domestic mammal, large game and small game NISP by period and region. 1: late Iron Age; 2: early Roman; 3: mid-Roman; 4: late Roman; 5: early Byzantine.

8.3 Morphology

Figure 8.3, A to C, shows LSI values for dog bone widths. While the data are too limited for the majority of regions and periods to draw clear conclusions, overall they indicate little spatial or temporal variation in average dog size. There is, however, some evidence for the presence of smaller dogs in certain regions and periods. The first appearance of notably

smaller dogs in the dataset is in the mid-Roman period in Dacia. While the data for later periods in Dacia are too limited to determine whether such individuals were present following Roman withdrawal from the province, the late Roman and early Byzantine periods see the appearance of smaller dogs in the Balkan provinces, demonstrating their continued presence in the study region. While there are no particularly small dogs in the limited sample for the area beyond the Empire, several specimens slightly smaller than the average size for the region are present in the late Iron Age and the mid-Roman period. The available data indicate that particularly small dogs were only present in regions under Roman occupation, though more data would be necessary to confirm this.

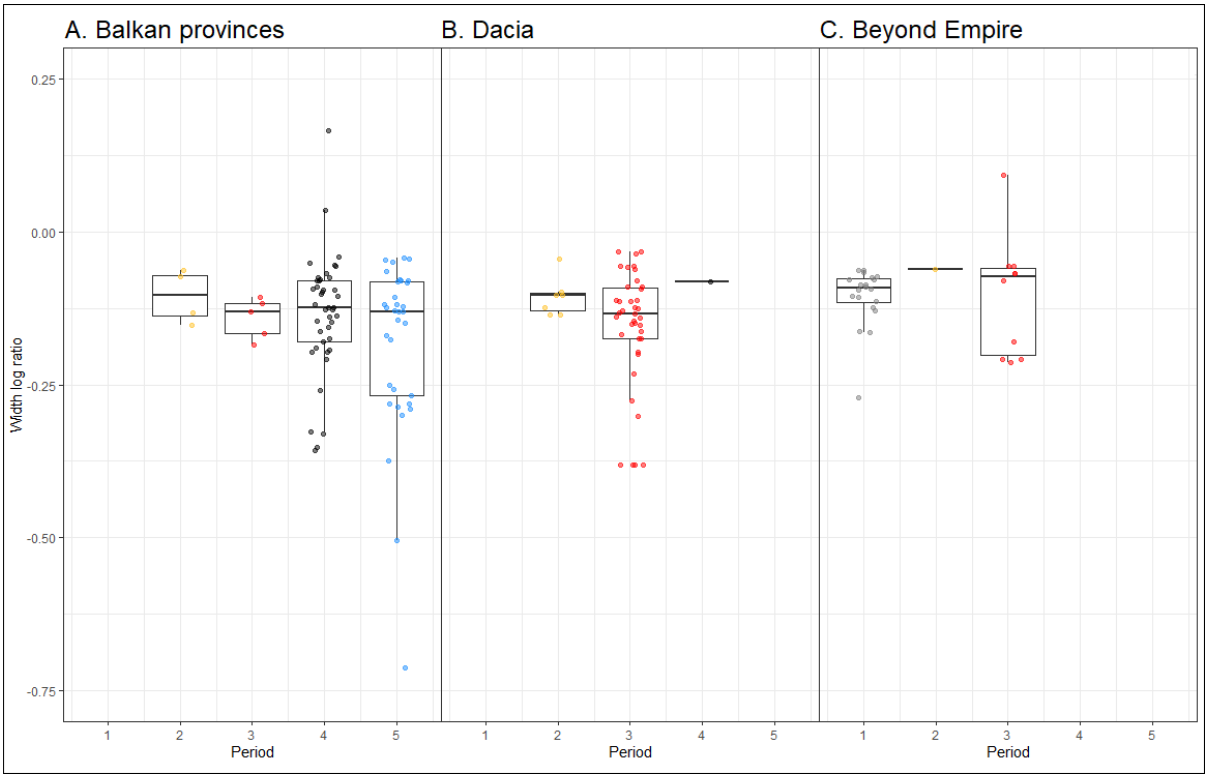


Figure 8.3: LSI values for dog bone widths. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

Site type data are not presented here, due to the small overall sample size and insufficient variation in the types of sites from which dog metrical data were available to enable the analysis of site-type-based size variation. It is worth noting, however, that once smaller dogs appear in the study region, they are present at urban, rural and military sites, and are not limited therefore to civilian sites only. The data could suggest that dogs were also kept as pets

at military sites, but likely also demonstrate the presence of small varieties of dog used in pest control at a range of site types.

Figure 8.4, A to C, shows dog withers height by period. While there is a degree of overlap in the bone specimens represented in this figure and in the LSI width data, the withers height results — which are calculated using length data — include additional specimens not represented in the previous figure. Where dog size categories are discussed, these follow Horard-Herbin *et al*. (2014, 23), and refer to the following withers height ranges: very small < 30 cm, small 30 to 45 cm, medium 45 to 60 cm, and large > 60 cm.

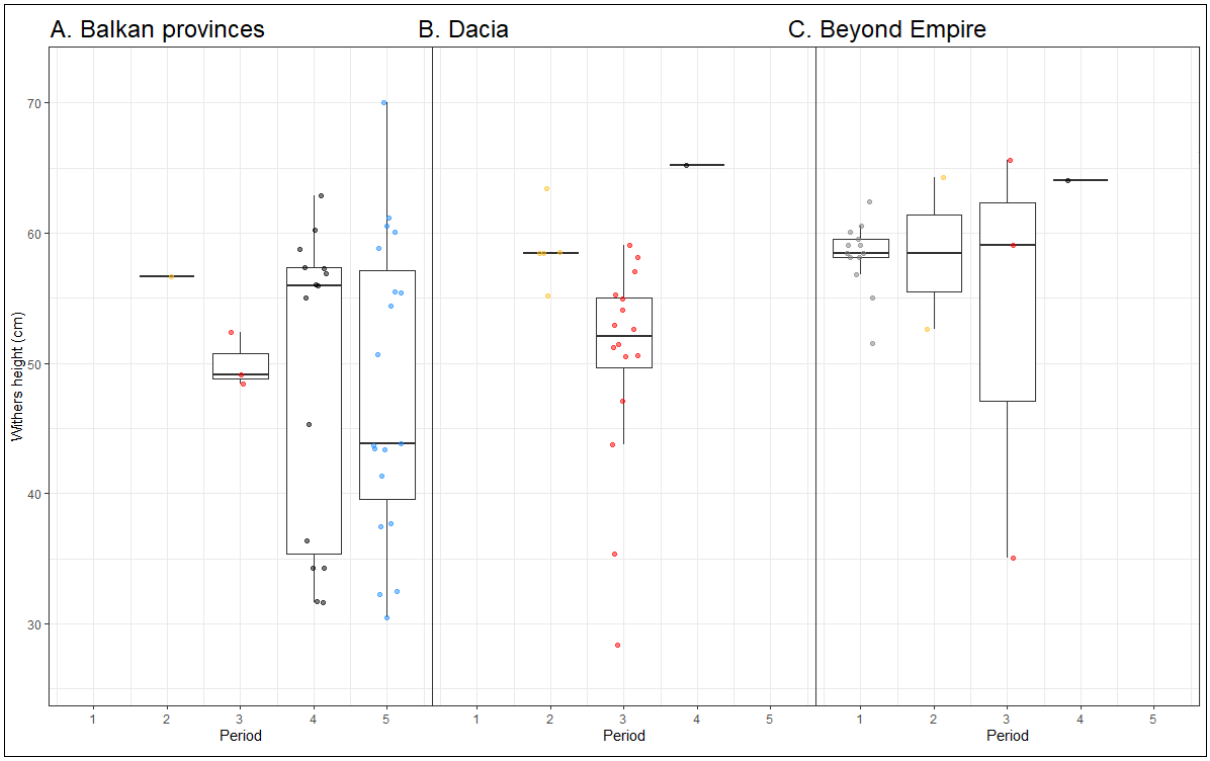


Figure 8.4: Dog withers height by period. A: Balkan provinces; B: Dacia; C: beyond the Empire. Grey: late Iron Age; yellow: early Roman; red: mid-Roman; black: late Roman; blue: early Byzantine.

The withers height data for the most part corroborate the patterns observed in the LSI data, though the sample sizes are once again very small for most regions and periods. In the Balkan provinces, dog size ranges from small to large. In the late Roman period, when small dogs first appear in the sample for this region, the median value falls within the range for medium-sized dogs, indicating that small dogs form a relatively small component of the sample, and may have represented a minority of the population. In the early Byzantine period, however,

the median falls within the range for small dogs, suggesting the presence of a larger component of these individuals. In Dacia, while the majority of the sample is composed of medium-sized dogs, both small and very small dogs are also present. Beyond the Empire, the limited available data reveal the presence of at least one small dog. On the basis of the available sample of LSI and withers height data, the majority of small dogs in the study region were to be found in Roman-occupied regions.

Figure 8.5 shows dog slenderness by period and region, with the slenderness index (SD/GL)*100 plotted against withers height. Slenderness indices are also plotted for a modern poodle and greyhound to provide modern comparators for the archaeological individuals. These are intended to give an impression of the slenderness of the archaeological dogs, but are not intended to indicate any further similarity in appearance between the archaeological dogs and the modern breed. The data reveal few spatial or temporal patterns in dog slenderness. Across the sample of small dogs, a wide range of slenderness indices can be seen, indicating that these individuals ranged from small and relatively slender, to small and fairly robust.

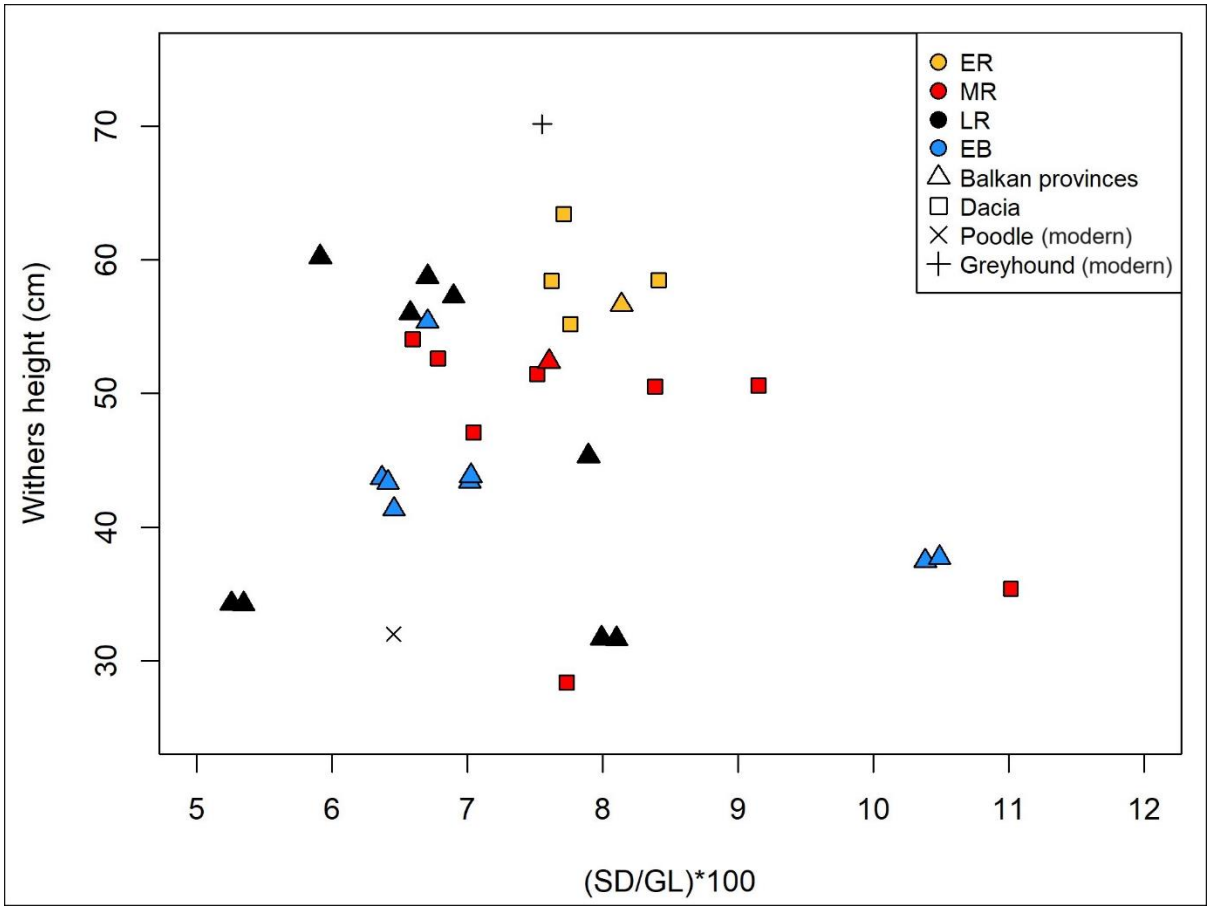


Figure 8.5: Dog slenderness by period and region.

8.4 Summary

Overall, the analysis of dog relative abundance reveals a degree of spatial, temporal and site-type-based variation in the exploitation of this taxon. Dogs appear to have become somewhat less abundant relative to other taxa from the early Roman period onwards. The metrical data reveal several changes in the character of the dog population over time, though larger sample sizes would be necessary to draw any clear conclusions for the majority of regions and periods. The data demonstrate, however, that small and very small dogs were present in the study region, with the majority of individuals in these size categories found in regions under Roman occupation.

9 Discussion

9.1 Introduction

The aim of this research is the exploration of the nature and extent of change in animal exploitation in Roman and late antique southeast Europe, and by inference the evaluation of the timing, pace and extent of wider cultural and economic change across the region. In order to address this aim and the research questions posed, this thesis presents the analysis of spatial and temporal variation in animal husbandry and the productive economy; in the extent of reliance on hunted resources and the consumption of horsemeat — both potential indicators of marginal resource exploitation or cultural change; and in the morphology of dogs and their roles within human societies. Elsewhere in Europe, the Roman period sees an increase in specialisation and livestock size, and the widespread appearance of small dogs, in occupied regions, while declining Roman political influence in later centuries is generally accompanied by decreased specialisation and livestock size. This chapter will discuss the observed changes in husbandry, hunting, hippophagy, and dog size in southeast Europe within the context of the key political, social, cultural and economic changes that characterised the Roman period and late Antiquity in the region.

9.2 The late Iron Age background

In the late Iron Age, prior to the earliest Roman activity in southeast Europe, archaeological evidence reveals wide cultural and economic links between societies in the study region and those in surrounding regions. Connections with and influences from the south are evidenced by the appearance of Greek material culture as far north as Romania in the last few centuries BCE (Glodariu 1976; Tzochev 2015). The presence of La Tène material culture in southeast Europe, along with the distribution as far as central and southern Europe of items produced in the region (Džino 2007), reveals connections between communities in the study region and those to the north and the west. The study region was thus well-connected in the late Iron Age, embedded within wider systems of trade and exchange that focused on the Mediterranean, on the one hand, and central and western Europe, on the other. The development of local coinages, and their distribution across the Balkans, demonstrates the action of more local economic networks (Hammond 1994) within the wider late Iron Age systems.

While southeast Europe was thus well integrated into wider networks that brought coinage, metalwork and food and drink into the region via trade and exchange, meat production and the exploitation of animals for their secondary products appears to have occurred on a smaller, more local scale. Patterns in livestock relative abundance across the majority of the study region in the late Iron Age attest to fairly generalised, mixed-species husbandry, such as might be expected to have been undertaken by communities supporting their needs at a subsistence, rather than a market economy, level. The similar livestock ratios observed at rural and semi-urban sites across much of the study region in this period are consistent with a limited degree of food distribution at a local level, with the products of an unspecialised rural productive economy imported and exploited by semi-urban consumers. Alternatively, however, settlements varying in scale from rural to semi-urban may each have met their own subsistence needs, in the latter case via animal husbandry in the surrounding landscape. In either case, the data suggest that while wider trade networks may have provided a source of — and market for — prestige goods and a range of other types of products, there was little to no market-oriented husbandry for profit in much of southeast Europe.

In the northeast of the study region in Moldavia, however, a different pattern prevails, with livestock relative abundance data revealing a focus on cattle sufficient to infer the specialised husbandry of this taxon. More data from more sites would be necessary to demonstrate that this practice was characteristic of the region as a whole, however, as the dataset collated for this study includes only four late Iron Age sites in Moldavia. Nevertheless, the available data demonstrate that specialised husbandry did occur in the region, and, if typical, would indicate a divergence in patterns of production between Moldavia and the remainder of the study region. Despite evident trade links between southeast Europe and the regions to the north and the west, the absence of specialised husbandry across much of the study region suggests that a market for the export of animal products did not exist on any significant scale in the late Iron Age. Thus the presence of specialised cattle husbandry in Moldavia might best be interpreted as evidence of a cultural preference for this taxon within the context of a favourable local environment.

While husbandry practice was largely unspecialised in terms of the relative focus on each livestock taxon in the late Iron Age, there is evidence for some specialisation in the types of products exploited. In eastern Transylvania and Muntenia — the region comprising the eastern part of the late Iron Age kingdom of Dacia — age data indicate a focus on the

exploitation of young animals, with adults comprising a somewhat smaller proportion of the assemblage. While this pattern is evident across the study region as a whole with regard to pigs, eastern Dacia sees a particular focus on young cattle and sheep/goat in contrast to the higher abundance of adults observed elsewhere. In the case of cattle, the distribution of young individuals by site type reveals a particular focus on the exploitation of cattle for meat at fortified semi-urban sites. If communities at these sites imported animal products, the data would suggest the preferential selection of animals of prime age and thus the import of higher quality meat products, which could be argued to indicate a degree of control over resource acquisition by consumer communities. If, however, semi-urban communities raised their own animals, the data would indicate the specialised exploitation of cattle for meat.

While the late Iron Age data thus reveal several somewhat specialised regional approaches to husbandry practice across the study region, there is little indication of specialised husbandry aimed at surplus production for a market economy. There is possible evidence for external influence on livestock exploitation, following patterns of influence from the south and the northwest observed in other forms of archaeological data. The two most southerly late Iron Age sites exhibit the highest proportions of sheep/goat, echoing the focus on this taxon seen in Hellenistic Greece, while the greater abundance of cattle in the north of the study region shows similarities with practices observed further to the west along the Danube and the Rhine. Overall, however, the clearest theme that emerges from the late Iron Age data is limited regionalised variation within an overall fairly generalised practice. The lack of any clear spatial variation in livestock size and the absence of particularly large livestock in this period are consistent with the lack of evidence in the relative abundance data for the practice of market-oriented husbandry and the generation of profit via surplus production. There is no evidence for either the import of very large individuals into the study region, or the input of resources into size increase via improved feeding regimes.

Greater reliance on both large game exploitation and hippophagy in the late Iron Age than in later periods supports the picture provided by the livestock data. Higher large game abundance in this period suggests that the supplementation of domestic resources with wild taxa was a regular and widespread practice, and indicates food procurement strategies adapted to the resources available in the local environment. The relatively high incidence of hippophagy, meanwhile, could represent a culturally-associated dietary practice. In the absence of an integrated market network via which resource shortages induced by

unfavourable climate or disease might be buffered, however, large game exploitation and hippophagy could provide an alternative buffer by means of a diversified resource base. High large game and hippophagy incidence could thus be interpreted as evidence for the enforced supplementation of domestic resources with more marginal food sources. The greater reliance on hunting and hippophagy observed in the late Iron Age, in combination with widespread evidence for generalised husbandry, thus suggests that food production and resource procurement in this period was undertaken without the buffer provided by a market network via which food produced within the community could be supplemented in times of need.

In contrast to the evidence for wide economic networks and trade connections provided by a range of other forms of archaeological data then, the zooarchaeological evidence suggests that food production and animal resource acquisition was undertaken on a relatively small, community scale in the late Iron Age. While certain food products may have been imported into the study region from further afield, and though market-oriented production of a range of other types of goods is evidenced in the late Iron Age (Archibald 2013; Tzochev 2015), the zooarchaeological data analysed in this study strongly indicate a different approach to the production and consumption of basic commodities. The data suggest that — at least for the majority of communities in southeast Europe — the late Iron Age was a period of predominantly subsistence-level production.

9.3 The early and mid-Roman periods

9.3.1 The early Roman period

The early Roman period saw major political change in southeast Europe, with the earliest establishment of direct Roman control in the mid-second century BCE, and provinces established as far north as the Danube by the end of the first century CE (Gruen 1996; Kos 2013). There is evidence for a change in the settlement system south of the river after the Roman conquest, with many new urban settlements established within the network of pre-Roman foundations (Donev 2019). Economic activity increased in intensity in the newly-established Balkan provinces, with a new Roman road system facilitating trade and exchange, while agricultural production for urban consumers intensified, supplying urban settlements with products including wine and grain (Lozanov 2015; Panaite 2015; 2016; Ilić 2017). Roman influence north of the Danube is evidenced by the distribution of Roman coinage across Dacia, which likely had a social as well as an economic impact on the region

(Lockyear 2004; Stan 2014). The later part of the early Roman period saw increasing disruption across the western part of the study region, however, with a series of Dacian raids into the Balkan provinces and Roman military campaigns into Dacia in the first century CE (Haynes and Hanson 2004; Oltean 2007).

Zooarchaeological data reveal relatively little change in animal husbandry in southeast Europe in the early Roman period. The limited available data for the Balkan provinces suggest continued generalised husbandry practice, though a larger sample of sites would be necessary to draw reliable conclusions for the region. The absence of any urban sites from the sample precludes a consideration of livestock exploitation practices at a site type that increased in frequency in the Balkan provinces during the early Roman occupation. While other forms of archaeological evidence attest to intensified agricultural production and the supply of a wide range of products to urban consumers in the newly-established provinces, the zooarchaeological data, if typical for the region, would suggest that meat production and secondary product exploitation did not undergo any major change in the immediate post-conquest period. While agricultural landscapes underwent reorganisation under the new Roman administration, livestock management within those landscapes appears not have been subject to a similar degree of change. The production of basic commodities in the early Roman Balkan provinces would thus appear to have continued along late Iron Age lines, at a subsistence level.

Livestock metrical data for the late Iron Age are too limited to enable the analysis of the impact of the early Roman occupation on livestock size in the Balkan provinces. The early Roman datasets do not reveal the presence of any particularly large cattle or sheep/goat, however, despite reasonable sample sizes for both taxa. The limited available data therefore suggest continuity between the two periods, though larger samples would be necessary to draw reliable conclusions regarding the true extent of change. Taken together, the livestock relative abundance and metrical data suggest that despite the considerable impact of the Roman occupation on other aspects of life, livestock management and basic provisioning were not a focus of the economic changes instituted in the early centuries of Roman rule. The high incidence of military activity in the Balkan provinces in the early Roman period, and the variable extent of Roman control — with large parts of the region lying outside the Empire for at least part of the period — may have precluded the establishment of an integrated livestock management system. Thus while larger samples would be necessary to draw more

reliable conclusions, the available evidence indicates little change in the productive economy in the early Roman Balkan provinces.

While proximity to the Roman Empire had social and economic benefits for certain sections of Dacian society, for the majority of communities in this region the Roman presence may have had little positive impact. In the early Roman period, the Dacian sample reveals exploitation practices ranging from fairly generalised to focused on pigs. If the generalised husbandry of the very limited late Iron Age sample is typical for the region in that period, the increased reliance on pigs in the early Roman period could suggest disruption to established husbandry practices, with a decline in herbivore husbandry and a greater focus on pigs indicative of an increase in food production within the intramural space. This shift in focus from more generalised husbandry would have resulted in a narrower resource base, more limited opportunity to extract secondary products, and less variety in the diet. Roman military activity would thus have impacted Dacian communities in a manner that extended beyond changes in personal security and political stability, additionally presenting a threat to food security. Due to the limited nature of the late Iron Age sample, however, it is not possible to be certain that a focus on pig exploitation was not a typical practice at a proportion of Dacian sites prior to the early Roman period.

Any disruption as a result of military action appears to have had little impact on communities in the eastern part of the Kingdom of Dacia. Livestock ratios here reveal lower proportions of pigs, while age data reveal a continued focus on the exploitation of young cattle and sheep/goat, suggesting that, in this part of Dacia at least, the early Roman period saw relatively little change in livestock management. Further still from the principal arena of Roman military activity, the data for the area beyond the Empire indicate a continued focus on cattle in the early Roman period, though to a slightly lesser extent that was the case for the late Iron Age. While the sample size for the early Roman period is fairly small, so may not be representative of the region as a whole, the slightly lower cattle abundance observed in the early Roman period is in any case not sufficiently different from that of the late Iron Age to infer any major change in husbandry practice. In both Dacia and the area beyond the Empire, there is little clear evidence for any change in livestock size in the early Roman period.

There is also little change in large game abundance in the early Roman period, indicating continued reliance on wild taxa for meat, and continuity in modes of food acquisition. Large

game abundance is once again highest in the Iron Gates. If military activity did impact access to pasture in this part of Dacia, as is suggested by the focus on pigs in the region, the exploitation of large game would have provided an additional means of replacing more usual food sources. A continued relatively high incidence of large game in the Iron Gates may alternatively — or additionally — have been the result of a favourable environment, with the exploitation of wild taxa more profitable relative to livestock here than in other regions. The lack of change in livestock exploitation in the early Roman period, along with evidence for the continued practice of hippophagy across the study region, demonstrates that a range of late Iron Age practices continued into the early Roman period. The high incidence of large game exploitation in the Iron Gates may thus best be interpreted as a long-term cultural practice within an environment well-suited to wild resource exploitation, given additional importance in the early Roman period as a result of its role in buffering food shortages in times of disruption.

Overall, the lack of change in husbandry practice observed for the early Roman period, in combination with the evidence for continued reliance on large game, suggests that the first centuries of Roman occupation in southeast Europe had relatively little impact on modes of food production and resource acquisition. Despite clear political, cultural and economic changes across the study region in this period, impacting many aspects of life, the zooarchaeological data indicate that food provisioning continued to rely upon long-established systems of production. The clearest change in livestock exploitation in this period — the increase in pig abundance in Dacia — most likely represents a spatially- and temporally-limited response to disruption due to Roman military activity, though a longer-term cultural practice cannot be ruled out. The establishment of Roman control during the early occupation thus appears to have been undertaken without the imposition of major changes to the productive economy or new approaches to food provisioning. There is no evidence for any specialised husbandry or market-oriented production in this early period of Roman rule.

9.3.2 The mid-Roman period

In the mid-Roman period, the Roman occupation extended north of the Danube with the establishment of a province in Dacia. While the extent of demographic change following the conquest is uncertain, there is evidence for a clear change in the Dacian settlement system, in

the road network, and in the intensity of mineral resource extraction under Roman occupation (Ruscu 2004; Oltean 2007; Donev 2019; Fodorean 2019). Manufacture and craftworking increased, demonstrating the economic impact of Roman occupation on the region, while finds of Roman products beyond the Dacian border attest to trade with communities outside the Empire (Opreanu 2011; Popa 2016), demonstrating the spread of Roman economic and cultural influence beyond the region under direct control. The efficiency of the second-century Roman state in establishing control in new territory (Oltean 2007, 1) is demonstrated by the rapid change evident across Dacia. In the Balkan provinces, new urban and commercial settlements were established in this period, and the administration of the region was reorganised (Wilkes 2000; Lozanov 2015). The later part of the period saw the first evidence for a decline in Roman political control over the provinces of southeast Europe, however, as incursions of various groups from outside the Empire resulted in increasing disruption across the region from the third century (Bowman 2005).

The mid-Roman period sees major changes in animal husbandry in southeast Europe, concurrent with the cultural and economic changes attested by other forms of archaeological evidence. Zooarchaeological data reveal a clear change in livestock relative abundance in both the Balkan provinces and Dacia, and the emergence of a cattle-focused economic system across occupied regions. In the Balkan provinces, while certain sites continue to exhibit fairly generalised husbandry practices, more than half of all sites in the mid-Roman sample exhibit a focus on cattle, with highly specialised exploitation of this taxon evident at a quarter of all sites. The data thus reveal the emergence of new approaches to livestock exploitation in this region, with a shift in focus from subsistence farming to specialised arable production or beef consumption — or both — and production aimed at the maximisation of yield. These changes demonstrate that it was not the climatic and environmental characteristics of the Balkan provinces that resulted in the absence of specialised husbandry practice earlier in the Roman occupation. Rather, the emergence of specialised production several centuries after the conquest indicates that it was anthropogenic factors such as political and economic context that constrained the establishment of an integrated system of production and provisioning in the early Roman period.

Although analysis of livestock relative abundance by site type reveals convergent patterns of exploitation at rural and urban sites in the Balkan provinces, the data nevertheless suggest that both site types were integrated into the cattle-focused economic system of the mid-

Roman period. A clear focus on cattle is evident at the majority of rural sites, indicating major changes in the ways in which rural communities practised husbandry relative to the late Iron Age and the early Roman period. While earlier generations most likely met the majority of their needs via the exploitation of resources produced within the immediate vicinity of the settlement, with husbandry undertaken at a subsistence level, in the mid-Roman period many rural communities focused on the husbandry of a single taxon. Access to a market economy would have enabled these communities to focus their production in order to generate a profit, with markets providing an outlet for surplus and a means of generating income when cash payment of taxes was required. The new economic system would also have led to the dependence of these rural communities on the Roman market system, however, necessitating their reliance on external sources to provide the resources no longer produced within the community.

Average cattle abundance is somewhat lower at urban than at rural sites, though several sites of the former type exhibit a focus on cattle. High cattle abundance at such sites could suggest that specialised rural production systems were instituted with the aim of supplying urban consumers with beef, and urban craftworkers with raw materials for leather production. A cattle focus could alternatively — or additionally — suggest that urban markets provided an outlet for cattle products once the animals were no longer useful for work, with urban sites playing a key role in an economic system focused on arable production and the primary exploitation of cattle for traction. Limited available cattle age data for the mid-Roman Balkan provinces reveal a focus on the culling of adult individuals, supporting the latter interpretation. The significant increase in cattle size observed for this period could support either interpretation, with larger cattle capable of providing greater yields in an economic system based on beef production, but also facilitating intensified arable production as a result of their greater power when exploited for traction. In either case, zooarchaeological data for the Balkan provinces indicate the emergence of modes of production that integrated both rural and urban communities into a cattle-focused economic system.

In Dacia, the Roman occupation brought clear changes in livestock exploitation, with a focus on cattle evident across all site types in the mid-Roman period. Unlike in the Balkan provinces, where a new cattle-based economic system only emerged several centuries after the Roman conquest, Dacia saw a rapid reorganisation of production and provisioning following its institution as a province, resulting in high cattle abundance at the majority of

sites during the period of Roman occupation. The capacity of the Roman state to rapidly establish control in new territories by the second century (Oltean 2007, 1) was likely a key factor in the changes observed in Dacian husbandry practice during the occupation. The concurrence of these changes with similar developments in the Balkan provinces suggests, however, that greater stability across southeast Europe as a whole as a result of the Dacian conquest likely also played a role. Political stability would have facilitated the institution of an integrated economic system across the Roman provinces to the north and the south of the Danube in the mid-Roman period.

The impact of the Roman occupation on the productive economy of Dacia is clear, with communities in this region practising considerably different forms of husbandry to those seen in the region prior to the occupation. Evidence for a major change in the composition of the Dacian population after the Roman conquest could indicate that the groups of people practising specialised cattle husbandry during the occupation may not have been the same people that undertook subsistence-level husbandry prior to the conquest, however. Uncertainty regarding the scale of the demographic change renders the extent to which Dacian communities experienced major changes in modes of animal husbandry difficult to ascertain. Where pre-conquest Dacian populations did continue to farm the land during the occupation, however, the Roman conquest brought about not only the imposition of taxation and the reorganisation of settlement patterns, but also considerable changes in the relative abundance of each of the livestock taxa husbanded by those communities. As in the Balkan provinces, age data suggest a focus on the exploitation of adult cattle in Dacia in the mid-Roman period, while metrical data reveal a significant increase in cattle size — both consistent with a focus on arable production in the region during the Roman occupation.

Beyond the Empire in Moldavia, specialised cattle husbandry becomes more prevalent in the mid-Roman period. This practice was not initiated by the Roman presence in southeast Europe, having been undertaken since the late Iron Age, but may nevertheless have become more widespread as a result of the proximity of the region to the cattle-based economy of the mid-Roman Balkan provinces and Dacia. Given the extent of archaeological evidence for cross-border contacts in the mid-Roman period, some level of livestock trade and the import of cattle products from beyond the Empire into Roman-occupied territories — or the reverse — cannot be ruled out. There is no evidence for an increase in cattle size beyond the Empire in this period, however, despite the appearance of significantly larger cattle in occupied

regions. Thus while economic opportunity may have stimulated a degree of cross-border trade of cattle products, and thus some limited integration of the area beyond the Empire into the Roman economic system, changes in livestock management aimed at the maximisation of yield in occupied regions appear not to have inspired any change in the ways in which cattle were managed beyond the Empire.

Large game abundance falls to its lowest level in the mid-Roman period, with less than a tenth of all sites exhibiting large game frequencies of more than 10%. The considerable decline in large game abundance in this period indicates a clear increase in reliance on domestic resources, suggesting that the development of a cattle-focused economic system across occupied regions was accompanied by a sharp decline in the sourcing of food by hunting. In this context, the much higher incidence of large game in earlier periods likely represents at least in part the enforced supplementation of domestic resources with wild taxa. This practice would have become considerably less important as a means of buffering resource shortages once a network of markets via which local production could be supplemented emerged across occupied regions, resulting in a lower incidence of large game exploitation in the mid-Roman period. Hippophagy also falls to its lowest level in the mid-Roman period, supporting the interpretation that the observed decline in large game abundance was the result of decreasing need to buffer food shortages via a diverse resource base. A lower incidence of hippophagy in the mid-Roman period, when widespread social and cultural changes are seen across occupied regions, could additionally suggest that a culturally-induced change in dietary practice had occurred in southeast Europe.

Overall, the mid-Roman period sees greater homogeneity in husbandry practice in southeast Europe than is evident in any other period, with the establishment of a cattle-focused economic system across occupied regions indicating centralised Roman control over production and provisioning. The observed decline in exploitation of more marginal resources suggests that the economic changes instituted under Roman rule brought at least some benefit to communities in occupied regions, alongside the arguably negative impact of the imposition of taxation and the loss of political autonomy of certain sections of society. Access to an Empire-wide market network would have brought greater stability to the productive economy of southeast Europe in this period, with any local resource shortages due to climate or disease less likely to have had a major impact on communities than was the case when husbandry was undertaken at a subsistence level. The appearance of significantly larger

sheep/goat in occupied regions in a period that saw a clear focus on the husbandry of cattle, meanwhile, demonstrates that the lower abundance of the former taxon need not indicate lesser investment in maximising production. Greater economic stability would have created the conditions necessary to facilitate the increased input of resources back into husbandry practice, further optimising production via the maximisation of yields from even the least important livestock taxon.

9.4 Late Antiquity

9.4.1 The late Roman period

In the late Roman period, the northern border of the Empire withdrew to the Danube following the loss of Dacia as a Roman province. The period saw the refortification of the Danube border, and the fortification of urban settlements across the Balkan provinces, along with renewed incursions of various groups from beyond the Empire from the late fourth century, resulting in increasing disruption in occupied regions (Whitby 2001; Wilkes 2005b). While settlements in the southern Balkan provinces were subject to further infrastructure development and saw continued prosperity in the late Roman period, those in the northern part of the region saw more extensive decline, with some rural depopulation evident (Whitby 2001; Mulvin 2002). In post-Roman Dacia, changes in the character of the region appear to have occurred fairly gradually. The settlement system instituted during the Roman occupation changed little in the immediate post-occupation period, though the character of any urban occupation was likely quite different to that of the Roman period (Haynes and Hanson 2004). From the late fourth century, new imperial policy restricted trade between the Balkan provinces and Dacia to two Danube crossing points (Heather and Matthews 1991), likely resulting in a decline in interaction between the two regions, and a decrease in the extent of Roman influence north of the river.

Analysis of zooarchaeological data reveals a range of changes in animal exploitation in southeast Europe in the late Roman period. The period sees a small increase in large game abundance, concurrent with a decline in the exploitation of cattle. It is possible that fluctuating Roman political control in this period necessitated increased reliance on wild resources, in response to an overall decline in the availability and consumption of meat obtained from livestock. The increase in large game abundance is fairly slight, however, and is insufficient to suggest that the majority of communities experienced any major change in

the extent of their reliance on hunting. Despite a small decline in overall cattle abundance, the cattle-focused economic system instituted in the mid-Roman period appears to have continued to function to at least some degree in both the Balkan provinces and post-Roman Dacia, though changes to patterns of production are apparent in both regions.

In the Balkan provinces, while husbandry practice continues to range from fairly generalised to focused on cattle in the late Roman period, a clear site-type-based change in practice is apparent. While cattle abundance was higher on average at rural sites than urban sites in the mid-Roman period, in the late Roman period rural cattle abundance falls considerably to below that observed for urban sites, with highly specialised cattle husbandry now only evident at a single rural site in the sample. Taken alone, this decline could be interpreted as evidence for a major change in rural production systems in the late Roman period. Cattle abundance remains high at a number of urban sites in the sample, however, suggesting that the distribution of cattle products to urban consumers was little affected by the changes observed at rural sites. Overall then, the data suggest that while an integrated economic system based on rural cattle husbandry may no longer have functioned to the extent seen in the mid-Roman period, food production and procurement systems remained sufficiently robust to continue to supply urban populations. Urban communities thus appear to have been prioritised in the distribution of cattle products, while rural populations once again consumed livestock taxa in more equal proportions, following several centuries of consumption focused on cattle.

Livestock metrical data for the late Roman Balkan provinces reveal a somewhat different picture in terms of the extent of change. There is no evidence for any decline in cattle or sheep/goat size in the late Roman period, despite the other changes in husbandry practice enacted and experienced by communities in the Balkan provinces in this period. Despite fluctuating Roman political control then, and a decrease in the abundance of cattle at rural sites, the data suggest that it was nevertheless possible for communities in the Balkan provinces to maintain the larger cattle developed in earlier centuries. This lack of change suggests that the earlier size increase was at least in part the result of the import or selective breeding of larger individuals, stimulating a genetic change in the cattle and sheep/goat populations of southeast Europe. Had increased livestock size originally been achieved primarily by improved feeding regimes, the political and economic disruption evident in the late Roman period would arguably have been likely to have resulted in a decline in size, with

increased input of resources into livestock feeding difficult to maintain in this context. Political instability would arguably have had considerably less impact — at least in the short term — had size increase initially been achieved via a change in breeding practices, however.

In Dacia, the absence of any urban sites from the sample for the late Roman period precludes analysis of the relative extent of change experienced by rural and urban communities in this period. The livestock relative abundance data reveal husbandry practices ranging from generalised to focused on cattle at rural sites in the late Roman period, though the very high cattle abundance observed at a proportion of rural sites during the Roman occupation is not seen at any site in the late Roman sample. The data thus indicate a decrease in focus on cattle husbandry on the part of rural communities, though the observed decline is insufficient to suggest a return to the husbandry practices of the pre-conquest period. The persistence of an overall focus on cattle at rural sites suggests that rural communities continued to practise husbandry along Roman lines despite no longer having direct access to the market economy that stimulated the emergence of specialised cattle husbandry in the region during the occupation. The impact of Rome on the productive economy of Dacia was thus of longer duration than the period of direct administrative control.

The extent to which changes instituted under Roman rule persisted beyond the period of occupation varies across different aspects of husbandry practice, however. Livestock metrical data indicate a decline in average cattle and sheep/goat size in Dacia following Roman withdrawal from the province, suggesting divergent trajectories of change between the forms of husbandry practised, on the one hand, and the character of the animals husbanded, on the other. Thus while husbandry continued to focus on cattle in post-Roman Dacia, the capacity — and perhaps the desire — of Dacian communities to maintain larger livestock once direct access to Roman markets had been lost seems to have disappeared. While a range of archaeological evidence attests to continued economic interaction between the Balkan provinces and Dacia in the earlier part of the late Roman period — perhaps facilitating the continued practise of some level of specialised husbandry in the latter region — the restriction of cross-border trade from the late fourth century may have rendered the maintenance of larger livestock no longer economically viable for Dacian communities.

Overall then, zooarchaeological data reveal a decline in reliance on cattle in late Roman southeast Europe. This change, evident in particular at rural sites, suggests a decline in state

control of production and provisioning, likely precipitated by increasing political and economic disruption across occupied regions. It should be noted, however, that the observed decrease in cattle abundance is only relatively small, and is insufficient to indicate a return to the more generalised husbandry practices of the late Iron Age and early Roman period — cattle remain more abundant overall than sheep/goat and pigs, with continued specialised exploitation seen at multiple sites. Even in post-Roman Dacia, where the clearest decrease in cattle abundance is observed, the fairly specialised exploitation of this taxon is still seen at around half of all sites in this period. While intraregional variation in the extent of disruption is indicated by a range of archaeological evidence in the Balkan provinces, with the north subject to greater social and economic instability than the south, there is no evidence for any comparable variation in livestock exploitation. Thus while zooarchaeological data reveal a range of changes that reflect those observed in other forms of archaeological data, in many ways the productive economy of southeast Europe experienced relative stability and continuity from the mid-Roman to the late Roman period.

9.4.2 The early Byzantine period

The early Byzantine period was characterised by considerable variation in the extent of political and economic stability, both spatially and temporally. While coinage reforms may have stabilised the economy, major settlements in the eastern Balkan provinces were likely less integrated into the economic system than those elsewhere, while rural communities across the region came under increasing economic pressure through the period (Lee 2001; Curta 2006; Guest 2007). Further urban infrastructure development occurred in the sixth century, but this century also saw the outbreak of plague, which may have resulted in considerable depopulation in some areas (Cameron 2001; Ward-Perkins 2001). Continued movements of groups of people outside the Empire led to further incursions into Roman territory, and a change in the social and cultural character of the region to the north of the Danube (Lee 2001; Haynes and Hanson 2004). While evidence for trade across the Danube attests to continued Roman economic and cultural influence beyond the Empire (Gandila 2018), the character of this influence in Dacia was clearly very different to that observed during the occupation. The social impact of Roman influence north of the Danube may have been similar to that of the early Roman period, when communities located at the periphery of the sphere of Roman influence were nevertheless impacted by the Roman presence.

The early Byzantine period sees much greater change in animal husbandry than occurred in the late Roman period, though evidence for a decline in large game exploitation in the later period suggests that the observed changes in husbandry practice were more likely the result of wider social and cultural transformations across the study region than a consequence of economic decline. In the Balkan provinces, there is a clear decrease in the abundance of cattle, and an increase in both sheep/goat and pigs, in the early Byzantine period, resulting in fairly generalised exploitation at the majority of sites, though specialised cattle exploitation is apparent at two sites. Due to the absence of rural sites from the early Byzantine sample — perhaps in part due to an overall decline in the frequency of rural occupation in the Balkan provinces — it is not possible to ascertain the nature of the husbandry practices undertaken by rural communities. The clear decline in cattle abundance observed at urban sites, however, suggests that the cattle-focused economic system instituted in the mid-Roman period, and maintained to some degree into the late Roman period, had by the early Byzantine period largely ceased to function. Despite widespread economic reforms in the early Byzantine period then, many communities appear by this period to have reverted to subsistence-level production and exploitation.

In Dacia, husbandry patterns become highly variable between sites in the early Byzantine period, suggesting that the changing social and cultural character of the region may have led to more localised approaches to livestock exploitation. While the sample for the early Byzantine period is fairly small, and thus may not be representative of husbandry practice across the region as a whole, the wide variation in livestock ratios observed demonstrates that highly divergent practices were present in Dacia in this period. Although specialised cattle exploitation continues to be seen at certain sites, the overall extent of intersite variation suggests that this cattle focus was not the result of the continued functioning of the economic system instituted under Rome, but rather a consequence of greater regionalisation due to political, social and cultural fragmentation of Dacia in a period that saw considerable demographic change to the north of the Danube. Thus while Dacian communities experienced some degree of economic continuity in the first centuries after Roman withdrawal, and perhaps retained links with communities in occupied regions to the south, by the early Byzantine period the productive economy was very different in character to that of the occupation period. Due to the limited size of the early Byzantine Dacian sample, however, more data would be necessary to confirm this.

Across the study region as a whole, the early Byzantine period sees a clearer divergence in urban and rural exploitation patterns than can be seen in any other period. At rural sites, a late Roman cattle decrease is followed by an early Byzantine increase, and a return to the highly specialised cattle husbandry of the mid-Roman period. At urban sites, however, the early Byzantine period sees a clear decline in cattle abundance, with the taxon comprising less than 50% of the livestock remains at the majority of sites. Since the lowest proportions of cattle are seen in the Balkan provinces, where the early Byzantine sample is composed entirely of urban, semi-urban and military sites, the influence of regional context and site type cannot easily be distinguished. Thus the early Byzantine period sees a decline in the exploitation of cattle by urban communities in occupied regions, but a continued cattle focus at rural sites to the north of the Danube. Given wider cultural and economic developments across the Balkan provinces in this period, and their likely impact on rural communities, a rural cattle decline in this region can also be hypothesised.

Livestock metrical data reveal little further size change from the late Roman to the early Byzantine period in any region. Data for the Balkan provinces reveal the continued persistence of larger cattle and sheep/goat into the early Byzantine period, further supporting the argument that the initial increase in livestock size observed in this region was achieved via a genetic change in the populations of these two taxa. The lack of any evidence for a decline in average size suggests that the various political and economic changes that characterised the early Byzantine period had little impact on the ability of communities in the Balkan provinces to maintain populations of larger livestock. In Dacia and the area beyond the Empire, cattle and sheep/goat remain smaller on average than in occupied regions. While the early Byzantine period saw increasingly varied livestock ratios across the study region then, indicating an increase in regionalised and localised approaches to animal husbandry, the lack of livestock size change demonstrates that for as long as a region remained under Roman control, the maintenance of large livestock continued to be possible.

Overall, zooarchaeological data for the early Byzantine period indicate greater stability in the productive economy than was experienced by communities of the late Roman period, with a decrease in reliance on more marginal resources evident. The data also reveal a decline in the practise of highly specialised cattle husbandry in occupied regions, and increasing divergence from Roman practices in Dacia, suggesting that the early Byzantine period was nevertheless a time of considerable change in livestock exploitation in southeast Europe. The emergence of

more varied, regionalised approaches to production and provisioning in the context of overall increased economic stability indicates the influence of social or cultural factors on the ways in which husbandry was practised. Rather than a response to the collapse of established provisioning systems then, the changes in livestock exploitation observed in the early Byzantine period can be interpreted as evidence for a change in food cultures and dietary preferences across the study region.

10 Conclusions

10.1 Animal exploitation in late Iron Age to early Byzantine southeast Europe

In the late Iron Age, animal husbandry was for the most part undertaken at a subsistence level in southeast Europe. While a degree of specialised cattle husbandry is evident in the northeast of the study region, this can be interpreted as a cultural preference within a favourable environment, and, in the context of the more generalised husbandry practices seen elsewhere in the study region, does not indicate market-oriented production. Though a range of archaeological evidence attests to wide economic contacts and trade links between southeast Europe and neighbouring regions, there is no evidence that the productive economy saw an equal level of integration into broader networks. Relatively high large game abundance in the late Iron Age indicates reliance on and knowledgeable exploitation of the resources available in the local environment, within an economic system largely focused on the exploitation of domestic animals.

In the early Roman period, in the first centuries BCE and CE, the institution of Roman control and the establishment of provinces to the south of the Danube did not result in any major changes in animal exploitation. This is the case both with regard to husbandry practice and the productive economy, and with regard to the extent of reliance on hunted resources. While a range of archaeological evidence attests to the establishment of Roman ways of life across the Balkan provinces, the early occupation thus had little impact on production and provisioning. North of the Danube, while Roman coinage may have provided an impetus for economic and social change, the clearest change in terms of animal exploitation is an increased reliance on pigs, suggesting disruption to established food production systems concurrent with Roman military activity in the region.

In the mid-Roman period, the expansion of Roman political power north of the Danube, and the establishment of a province in Dacia, were accompanied by the institution of a cattle-focused economic system across the provinces of southeast Europe. There is a clear change in the size of cattle and sheep/goat in the mid-Roman period, demonstrating that Roman influence on the animal economy extended beyond the organisation of production and provisioning to the conformation of the animals themselves. Larger cattle are found at urban settlements than at rural sites — including villa estates — in the Balkan provinces and Dacia in the mid-Roman period, perhaps suggesting rural production of larger cattle for an urban

market. This pattern is also seen in the sheep/goat data for the Balkan provinces, but not for Dacia, indicating divergent site-type-based patterns in the two regions. While specialised rural production and urban consumption are evident across occupied regions in this period, they are particularly clear in Dacia. The zooarchaeological evidence indicates the rapid establishment of Roman economic control in this region following its institution as a province, corroborating the picture provided by other forms of archaeological evidence.

In the late Roman period, there is little change overall in livestock exploitation or in the size of the animals raised in the Balkan provinces, suggesting continued Roman influence over the economy of the region, despite fluctuating political control. A decline in rural cattle husbandry provides some indication of the possible impact of political developments on production systems, however. In Dacia, relatively little change in husbandry practice is seen following Roman withdrawal, with a continued focus on the exploitation of cattle, though large livestock mostly disappear from the region. While the Roman withdrawal led ultimately to political, social, cultural and economic change across Dacia, it appears that production systems, like settlement patterns, were little affected in the immediate post-occupation period. Beyond the Empire, a slight increase in the prevalence of sites exhibiting high cattle abundance in the mid- and late Roman periods could suggest the expansion of the sphere of Roman economic influence beyond the imperial border in these periods, as is indicated by other archaeological evidence for cross-border contacts.

In the early Byzantine period, broader changes in production and provisioning occur, though there is little further change in livestock size in any region. The continued cattle focus of the late Roman period in Dacia disappears in the early Byzantine period — husbandry patterns attest to increasingly varied and localised practices in the former province in the latter period. In the Balkan provinces, the re-emergence of more generalised livestock exploitation at the majority of sites indicates that the organised economic system of the mid- and late Roman periods had ceased to function to the extent necessary to maintain the production and supply of cattle products in the quantities observed in earlier periods. Fluctuating Roman political control south of the Danube was thus accompanied by a decline in economic influence.

The persistence of larger cattle and sheep/goat into the early Byzantine period in the Balkan provinces suggests that the political and economic changes that characterised the period had less impact on the animals themselves than on broader systems of production and

provisioning. Declining economic stability in the region would arguably have led to decreasing ability to maintain improved livestock feeding regimes — one method suggested for the development of larger livestock. Given that Roman economic influence in the Balkan provinces was clearly declining in the early Byzantine period, but no decrease in livestock size is seen, it is likely that the emergence of larger livestock in this region in earlier centuries occurred at least in part via the import of larger animals from elsewhere, and the genetic 'improvement' of the local herds. Economic instability would arguably have had a less immediate impact on livestock size had a genetic change in the composition of the population previously occurred. Overall, the impact of the Roman presence on the conformation of the livestock of southeast Europe was clearly longer-lasting than the period of the Empire's control over the wider economic systems into which those animals were integrated at the height of Roman power.

Due to the long spans of time represented by each of the periods considered in this study, the observed changes in livestock exploitation are unlikely to have been experienced by communities across the study region as rapid or abrupt shifts in cultural or economic systems. Certain economic changes revealed by other forms of archaeological evidence, such as the reform of the imperial coinage, represent identifiable turning points after which a difference in some aspect of the economy would be apparent. In contrast, changes in the productive economy would most likely have occurred over several generations. An increased focus on cattle in the mid-Roman period, or the breeding of larger livestock, for example, are changes that, once instituted, would have taken some time to affect the day-to-day experience of farming communities — though urban consumers might arguably have seen more abrupt changes in the range and relative abundance of the various animal products available to purchase via markets.

Despite the lumping of the zooarchaeological data into broad periods with somewhat arbitrary and necessarily abrupt cut-off points then, the major period-by-period changes in animal exploitation and the productive economy indicated by the data would have occurred at a much slower pace than the changes seen in many other aspects of the economy. In the Balkan provinces, cattle abundance first decreases at rural sites in the late Roman period, before declining at urban sites several centuries later in the early Byzantine period. In Dacia, the Roman withdrawal does not bring about an immediate change to the productive economy, with cattle abundance remaining higher than was the case in the pre-conquest period for

several centuries after the end of the occupation. Thus cultural and economic change occurred at many different scales and tempos. This study demonstrates that while the observed changes in large game exploitation, hippophagy, dog size, animal husbandry, and the productive economy are inextricably linked to wider political, social, cultural and economic developments across the study region and study period, the timing, pace and extent of those changes nevertheless varied considerably spatially and temporally, and followed different trajectories to many other concurrent changes.

10.2 Cultural and economic change in Roman and late antique southeast Europe: a zooarchaeological perspective

The zooarchaeological evidence discussed in this thesis provides insights into the extent of cultural and economic change in Roman and late antique southeast Europe in three key ways. Taxonomic quantification and age data reveal the extent of specialisation in husbandry practice and livestock product exploitation. Metrical data provide evidence for changes in livestock size. Finally, the abundance of large game taxa and evidence for the consumption of horsemeat demonstrate the extent of reliance on more marginal resources.

As demonstrated by zooarchaeological studies of many regions of Europe, and by the data presented in this thesis, the Roman occupation prompted a clear increase in specialised husbandry practice, with greater reliance on cattle and pigs in many regions. While the extent of specialisation clearly provides a valuable measure of change in the productive economy, and a means of inferring wider cultural and economic change under Roman rule, it is inferred from a relative measure — the ratio of one livestock taxon to another. Thus an apparent increase in reliance on one taxon, to the extent that specialised husbandry is inferred, could actually result from an absolute decrease in the quantity of meat obtained from other taxa, and thus a decline in meat consumption overall. The emergence of 'specialised' husbandry does not automatically imply increased reliance on domestic animal resources therefore.

Additionally, in order to accurately infer the extent of change in the productive economy under Roman rule via the analysis of livestock ratios, it is important to consider pre-Roman husbandry practice. Where pre-Roman practice focuses on sheep/goat, for example, an increase in cattle and pigs during the Roman occupation could result in fairly generalised

husbandry practice overall, despite clear Roman influence on livestock exploitation. Overall, the analysis of livestock relative abundance provides a valuable tool for the evaluation of cultural and economic change under Roman rule, but several factors must be considered in order to ensure the accurate interpretation of the patterns observed.

As revealed by many previous zooarchaeological studies, and by this research, the Roman occupation resulted in clear changes in livestock morphology, with larger and more productive livestock emerging across occupied regions. The evaluation of change in the productive economy via analysis of developments in livestock size depends upon an absolute, rather than a relative, measure of change within each taxon — if the bones of a population of cattle are larger than those of a cattle population from an earlier period, size increase has occurred, irrespective of changes observed in other livestock taxa. However, since factors other than human decisions regarding feeding and breeding practices can influence the size of an animal — such as the climate — and the size distribution of an animal population — such as sexual dimorphism — the use of livestock size change to infer cultural or economic change is also not without interpretive issues. Once again, provided these factors are carefully considered in the interpretation of data, changes in livestock morphology can also provide a valuable means of tracking cultural and economic change

While the analysis of livestock relative abundance and livestock size change are the principal focus of this research, a consideration of the extent of reliance on more marginal (from a Roman point of view) resources can also provide valuable insights. The analysis of large game relative abundance provides a means of assessing changes in meat quantity obtained from domestic sources. While this is, once again, a relative measure, it nevertheless provides an insight into the extent of reliance on more marginal food sources, and thus into the extent of stability in the productive economy, and the extent of Roman control over food production and provisioning. Evidence for hippophagy can provide both a further indicator of marginal resource exploitation, and also an indication of cultural change. Alongside evidence for a decline in specialisation and a decrease in livestock size, an increase in reliance on marginal resources can provide an important means of identifying a decline in Roman economic influence.

This research aimed to explore the nature and extent of change in animal exploitation in Roman and late antique southeast Europe, and thus to evaluate the timing, pace and extent of

wider cultural and economic change. Via the meta-analysis of zooarchaeological data, and the identification of spatial and temporal trends within that data, this thesis has identified and evaluated evidence for the spread and later decline of Roman influence over the productive economy in southeast Europe. It has considered the impact of political, social, cultural, economic and environmental influences on animal exploitation, assessing the role of these factors in stimulating the patterns observed in the zooarchaeological data.

As demonstrated by the many previous zooarchaeological studies discussed in this thesis, and by the results of this study, zooarchaeological meta-analysis provides a valuable means of exploring changes in animal exploitation and of evaluating wider cultural and economic change. By careful consideration of the various political, social, cultural, economic and environmental influences on animal exploitation, and of the various methodological issues associated with the interpretation of zooarchaeological data, it is possible to distinguish the relative roles of different factors in stimulating change sufficiently well to enable the evaluation of cultural and economic change via zooarchaeological meta-analysis.

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