FACULTEIT LETTEREN EN WIJSBEGEERTE

A CITY IN TRANSITION

URBAN CHANGES IN LATE ANTIQUITY AND THE CONTRIBUTION OF ARCHAEOZOOLOGY

Word count: 29,329

Julie Reynaert
Student number: 01400597

Supervisors: Prof. dr. Frank Vermeulen, Prof. Veerle Linseele

A dissertation submitted to Ghent University in partial fulfilment of the requirements for the degree of Master of Arts in Archaeology

Academic year: 2017-2018

UNIVERSITEIT GENT

PREFACE

This thesis came into being due to a cooperation between different researchers from the University of Ghent and from the University of Pisa. Different people have provided guidance in the development and completion of this work and without them it would not have been possible for this study to come into existence.

I would like to thank prof. Frank Vermeulen for the directions given at the start and at various points of my research and for advice in the development of certain ideas. The contact that he has made with the researchers of the University of Pisa provided the starting point for the rest of this study.

Thanks go out to prof. Veerle Linseele for advice on the use of archaeozoological techniques and help with the processing of the studied archaeozoological remains. I am grateful for the information that she has provided to supplement and expand my basic knowledge of archaeozoology.

I give thanks to prof. Simonetta Menchelli for the opportunity to study an archaeozoological sample from Roman Luni, which has provided the foundation for this study, for the aid given during the three weeks that were spent in Pisa to study this sample and for the help in the months thereafter. Thanks go out as well to the rest of prof. Menchelli's team in Pisa for the assistance and information provided.

I would furthermore like to thank prof. Claudio Sorrentino for the help given with the study of the archaeozoological remains in Pisa and for allowing me to make use of the reference collection of the *Università di Pisa* and of the laboratory for archaeozoology, including all needed material.

Lastly, thanks go out to my family, for giving me time and space to work on this thesis and for providing help however and whenever it was needed.

CONTENTS

Word count: 29,329

ABSTRACTS

A large amount of research has in recent decades been published about the period of Late Antiquity. Yet there still exist many conflicting opinions about this time, especially about transformations in the urban environment. This study aims to find out in what ways archaeozoology can contribute to the current knowledge of the city in Late Antiquity. For this, important and recent publications regarding Late Antiquity were examined to discern the current, varying theories amongst different scholars and to discern the most important factors of change between the Roman Imperial period and Late Antiquity. In order to connect this with archaeozoological evidence, a sample of animals remains from five contexts from Luni were analysed to gain an insight in the animal use in this Late Antique city. This was supplemented by an analysis of 127 known archaeozoological contexts form central Roman Italy, largely based on the work of Michael Mackinnon (2004). From this data, specific information was gained about the city of Luni and broad patterns for animal use in Late Antiquity could be distinguished. It was possible to make some observations about the Late Antique city, which should be further specified by analyses of specific regions, cities or animals, or by broadening the dataset to include the rest of Roman Italy and other periods.
Keywords: Late Antiquity, Archaeozoology, Late Antique City, Luni, Central Roman Italy

In recente jaren is uitgebreid onderzoek verschenen over de Late Oudheid, een periode waar ondanks dit onderzoek toch nog verschillende tegenstrijdige meningen over bestaan, voornamelijk over verandering in de stedelijke omgeving. Het is het doel van deze studie om te onderzoeken op welke manier archeozoölogie kan bijdragen aan de huidige kennis van de stad in de Late Oudheid. Hiervoor zijn belangrijke en recente publicaties omtrent deze periode bekeken om de verschillende wetenschappelijke theorieën te onderscheiden en om de meest belangrijke factoren te achterhalen die zorgden voor verandering tussen de Romeinse Keizertijd en de Late Oudheid. Om dit te koppelen aan archeozoölogisch bewijs werden vijf contexten met dierlijke resten uit Luni onderzocht, zodat een inzicht verkregen kon worden in het gebruik van dieren in deze Laat-Antieke stad. Dit werd aangevuld met onderzoek van 127 gekende archeozoölogische contexten van centraal Romeins Italië, grotendeels gebaseerd op het werk van Michael Mackinnon (2004). Van deze gegevens kon specifieke informatie verkregen worden over de stad Luni en konden algemene patronen worden onderscheiden voor het gebruik van dieren in de Late Oudheid. Observaties konden worden gemaakt over de stad in de Late Oudheid, welke aangevuld zouden moeten worden met onderzoek naar specifieke gebieden, steden of dieren, of met een uitbreiding van de dataset waarin andere gebieden, van Romeins Italië, of andere periodes worden opgenomen.
Trefwoorden: Late Oudheid, Archeozoölogie, Laat-Antieke stad, Luni, Centraal Romeins Italië

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Archaeology studies the remains of people in the past. Information can be gained through the study of former habitations, used tools or ceramics, or through the study of the animals that lived and were used on the sites of these past cultures. Archaeozoology is the discipline that studies the remains of these animals, and especially their bones, in archaeological contexts. It is a branch of archaeology that only gained importance and became more commonly in use from the 1960s onwards. For Roman period excavations it took at least another decade, sometimes two, before archaeozoology was incorporated in the general archaeological research and faunal reports became part of the publications (Mackinnon 2007). Around the same time, another discipline started to gain interest in the archaeological world. Unlike the years before, the period of Late Antiquity started to be appreciated as a period separate from previous Roman times and the later Middle Ages and came to be seen as an object of study on its own. Various studies were published that focused on those elements that were characteristic of Late Antiquity and differed from the previous and following periods (Bowersock, Brown, Grabar 2000, vii-xiii; Lewit 2001, 33-34; Dey 2015, 5). Despite these numerous publications, conflicting opinions still exist about this period and many aspects are not yet fully researched. Especially the fate of the city in Late Antiquity is heavily debated (see Chapter 2). It is the aim of this study to bring these two disciplines together and find out in what ways archaeozoology can contribute to the current knowledge of the city in the Late Antique period.

In order to answer this question, many of the most important or most recent publications in the research field of Late Antiquity studies were read and analysed to discern firstly the varying opinions and diverging or common theories amongst the different scholars interested in this period. Secondly, the most important factors of change between the Roman Imperial period and Late Antiquity were determined. Attention was hereby paid to one development in particular, namely the process of *ruralization* where the classical Roman city is transformed over time into an urban environment with open spaces used for cultivation and rural activities (see Chapter 2.3). In cities outside of Roman Italy archaeozoology was able to identify and clarify this particular process.
In addition to this literature study, analysis of an archaeozoological sample from the city of Luni, in northern-central Italy, was conducted. This sample consisted of animal remains excavated by the *Università di Pisa* from five Late Antique contexts dated between the fifth and the eight century C.E. Analysis of these remains has provided insight in animal use in the Late Antique city and

comparison of previously researched archaeozoological remains from the city has allowed for a comparison between the Imperial period and Late Antiquity.
This research was supplemented by an analysis of known (and published) archaeozoological contexts from central Roman Italy, including the Late Antique period, in order to gain a broader archaeozoological view. These contexts, in large part derived from the study of Michael Mackinnon (Mackinnon 2004), were compared according to period, type of site and region in order to see if any patterns or trends could be distinguished for animal use in Late Antiquity.
While missing the experience and knowledge of a learned archaeozoologist, it was attempted to the best of abilities to create a decent and integrated analysis of the studied remains, according to the knowledge, theory and time available.

The period of Late Antiquity, as primary focus of this study, has been defined by different scholars in (slightly) different ways, concerning both terminology and chronology, changing according to the specialty, interest and perspective of the scholars (Cameron 1993, 7-8; 128). The beginning has been set in the third century CE, when many cities in the Roman Empire seem to have reached their most prosperous period, and where, towards the end of the century, the first changes can be seen that seem to be so characteristic for this period (Brown 1971; Liebeschuetz 1992; Cameron 1993; Bowersock, Brown, Graber 2000). According to others the beginning of the period and of these changes should be placed in the fourth century (Christie 2006; Cirelli 2014). The end of the period has been placed between the seventh and the eight century CE (Liebeschuetz 2001a), around 700 CE (Brown 1971; Ward-Perkins 2005) or around 800 CE (Liebeschuetz 1992; Bowersock, Brown, Graber 2000; Christie 2006). In accordance with these ideas it has been decided that for this work the period of Late Antiquity will be defined as ranging from 200 up and until 800 CE, as to include both the first signs and mechanisms of the changes concerning the period as the final products that resulted from these changes.
This is a period with many changes, contrasting cultures and divergent ideas, for which it can be beneficial to look at the events that seemed to play in both the eastern and western areas of the former Roman world (Cameron 1993, 43; 128). It is for that precise reason that the second chapter of this work will give a broader view of the changes happening in the urban environments across different regions that once were under control of the Roman Empire, before focussing on a more local, Italian view in the third and fourth chapters.

This study was primarily born out of a personal interest in archaeozoology and in the information that can be gained from the analysis of the remains of past animals, in combination with a personal interest in the Roman period. When an opportunity was presented to study an archaeozoological sample from a Roman city in Italy, it similarly presented an opportunity to incorporate this research into a bigger framework and to delve into some broader problems and discussions regarding a period of which previous knowledge was only limited. The research of the archaeozoological sample, the incorporation of other studied contexts and the addition of an extensive amount of literature has created a study in which the archaeozoological remains can be seen and analysed in the light of changing circumstances in the city during the Late Antique period.

2. THE TRANSITION OF THE CITY IN LATE ANTIQUITY

The classical Roman city can be defined by a series of characteristics that seem to have been common across the Empire. Equipped with a legal and administrative status, the city was responsible for the administration and taxes of its (sub)urban and rural territory, including the villages, towns and other habitations present in this area. The territory supplied to the agricultural needs of the city, allowing the urban citizens to participate in specialized activities rather than to provide for their own sustenance, creating an urban fabric with different functions unrelated to rural activity. Next to the administrative and legal role, these include religious, political, cultural, social and economic functions. In contrast to the rural territory, these functions and activities were executed in a distinctive way and concentrated in a greater number on a smaller area, with a higher degree of integration. In addition, the proportion of the population concerned with these activities was more elevated in the cities than in the countryside (Liebeschuetz 2001a, 2-3; Wickham 2005, 593; Zavagno 2009, 4-5; Esmonde Cleary 2013, 97-100; Dey 2015, 4-5). Concerning the physical layout, the Roman city had a fairly standard collection of architectural structures. A network of streets, aligned with porticoes, connected the *forum* to the public buildings concerned with the more official role of the city, like the *curia* and the *basilica*, and to spaces like the baths and the theatre where the citizens could come to enjoy their free time and take part in public activities. Many of these buildings were frequented and often heavily subsidized by the local elite (Cameron 1993, 158-159; Liebeschuetz 2001a, 2-3; Dey 2015, 4-5).

Starting in the third and fourth century, changes started to occur in the layout and the concept of the classical city, in part related to the investment of the elite building and maintenance programs. By the sixth century, these changes could be seen throughout the Mediterranean region. (Cameron 1993, 43; 158-159; Liebeschuetz 1992, 3-4; Cirelli 2014, 39). As will be discussed in the coming chapter, these changes and the factors related to them are a significant aspect of the transitional Late Antique period.

2.1. DECLINE AND CONTINUITY

Before continuing to the different factors of change in the Late Antique city, some attention should be given to the debate surrounding the period of Late Antiquity, and the fate of the cities, that has taken the interest of a great number of historians and archaeologists over the past decades.

Traditionally, Late Antiquity was viewed as a period of decline. This vision was heavily influenced by the 18th century work of Edward Gibbon, *The History of the Decline and Fall of the Roman Empire* (Gibbon 1906) in which the period between the Roman Empire and the Middle Ages is seen as a degradation of the sophisticated Classical world and an impoverishment of a rich material culture, first and foremost under influence of the barbarian invasions. It was a well-accepted point of view at this time, when imperial superiority and the inferiority of foreign cultures were as common day as they (supposedly) had been in Roman Imperial times, especially in Great Britain. Not only Gibbon, but other historians (like Robertson 1976) around the same time wrote about the loss of Roman civilization in this dark period after the fall of the glorious Roman Empire (Cameron 1993, 4-5; Lewit 2001, 33-35; Liebeschuetz 2001b, 233-238; Ward-Perkins 2005, 1-2). These views continued into the 19th and 20th century, where they were adapted into works like *The Social and Economic History of the Roman Empire* (Rostovtzeff 1926) and *The Later Roman Empire, 284-602, A social economic and administrative survey* (Jones 1964). Especially regarding the development of the ancient city after Imperial times, an overall decline and degradation seems to have been the common outcome (Rostovtzeff 1926; Abbott and Johnson 1926, 197-231; Jones 1964; Lepelley 1992, 51-52; Cameron 1993, 4-5; Kirilov 2007, 3-4; Zavagno 2009, 8). In general, the Roman period, and especially the Imperial period, was regarded as one of the heydays of ancient history, while the following centuries were seen as inferior, filled with trouble and crisis, unworthy of any attention or more detailed study (Lewit 2001, 33).

This changed in the second half of the 20th century. While at first the idea of decline was readily accepted, now scholars were turning their attention towards the continuities of the Roman world into the Late Antique period, which came to be more appreciated and studied as a period on its own. From the 1980s onward Late Antiquity was recognized as an intriguing, dynamic period, with its own specific characteristics, either continued or transformed from elements of the previous Roman period (Bowersock, Brown, Grabar 2000, vii-xiii; Lewit 2001, 33-34; Dey 2015, 5). The general decline of the Classical city was challenged and instead focus was directed towards the signs of

continued existence of urban centres (Ostrogorsky 1985; Cameron 1993, 152-175; Zavagno 2009, 8). Studies like *The World in Late Antiquity, From Marcus Aurelius to Muhammad* (Brown 1971) and *The Mediterranean World in Late Antiquity, AD 395-600* (Cameron 1993) were developed with the Late Antique period as its primary subject and attention was especially given to the changes, transformation and continuities of this transitional time (Brown 1971; Cameron 1993, 5-6; 198-200; Ward-Perkins 2005, 3-4). A new project, *The Transformation of the Roman World*, funded by the European Science Foundation and initiated in the 1990s, offered the opportunity to scholars to attend conferences and workshops, work together on publications and in general contribute to the discussions surrounding different aspects of the Late Antique period. As the project title suggests, emphasis was again directed towards the changes and transformations in Late Antiquity and away from the idea of decline (Christie 2004, 1; Halsall 2007, 19-22).

Whilst in previous times the archaeological evidence was either largely ignored, minimalistically used or interpreted without reference to any other possibility except that of decline (Jones 1964, vii; Lepelley 1992, 51-52; Cameron 1993, 4-5; Lewit 2001; Liebeschuetz 2001b, 233-238), it was with the increasing interest in the Late Antique period that the archaeological remains began to show their worth. As excavations in various contexts, both urban and rural, started to provide more and more Late Antique remains (due to the changed interest of the excavators), new methodologies were developed to better uncover and research this new data. Studies of pottery types and other material groups provided new points of reference for chronology and comparison of different sites. Information from excavations were analysed in light of known historical sources and data from older excavations was revised. The advances in non-invasive survey techniques offered new views of the historical countryside and the relation with the surrounding (urban) settlements (Cameron 1993, 6-7; 153-157; Ward-Perkins 1996, 9; Liebeschuetz 2001b, 233-238; Wickham 2005, 9-10; Christie 2006, 1; Zavagno 2009, 11; 18). Interest in the development of ancient urban centres continued to increase. Archaeological research of Roman and Medieval centres, without neglect of the intermediate period, provided various and interesting results. Amongst others, thought was given to the direct comparison and evaluation of Roman, Late Antique and Medieval urban levels and to the changes and repairs made to Roman public buildings in later periods (Cameron 1993, 6-7; Ward-Perkins 1997, 157; Lavan 2012, 649-650). With the rise of excavations, surveys and material research, an increasing amount of archaeological evidence became available to contribute to the

Late Antiquity debate. New information came forward about diverse aspects of Late Antiquity like settlement, exchange, and population, all of which, due to the large amount of evidence, could be used for comparison between different sites and regions and for more comprehensive interpretations of life in Late Antiquity (Christie 2004, 1-3; Kulikowski 2004, xvii; Esmonde Cleary 2013, 102). As the archaeological data of the Late Antique period was now available in such a significant amount, including data which clearly showed processes unrelated to decline, scholars came to realize that the idea of an overall crisis of civilization and urban life could no longer be fully accepted (Lewit 2001, 34).

In recent years, both theories of *decline* and of *continuity* have been favoured and rejected by historians and archaeologists alike. On the one side of the debate there are those who argue to no longer use the term *decline*, saying it has a too strong cultural connotation, carrying with it the emotions and ideologies of the previous generations of scholars. When used to describe the developments of Late Antiquity, it too often automatically implies a shift towards something inferior. In addition, while the term can be used to describe local, specific and small-scale events, it is too frequently used as an explanation for the period as a whole, and to describe general, empire-wide phenomena, without taking into account regional and local variations (Whittow 1996, 58; Cameron 2001, 238-239; Whittow 2001, 241-243). These scholars view Late Antiquity as a continuity of the previous Roman period, and a transition to the following Medieval times, with many of the developments, transformations and changes finding their origin in Roman institutions and ideas (Kulikowski 2004, xv-xvi; Dey 2015, 5-7).

On the other side, there are those who argue that *decline* as a concept should not be blindly cast aside and is in fact valuable to use. Processes of change can contain both positive developments and factors of decline and it would be naive to ignore decline and put too much focus on the positive elements. For by doing this, Late Antiquity is seen as smooth, peaceful transition, with practically no elements of crisis, and as a consequence a false representation of the period is created. Several Roman traditions and ideals did in fact come to an end, and the period was not without its own troubles and problems. In contrast, one should not put too much focus on decline, as positive aspects and the rise of new elements will in turn go unnoticed (Liebeschuetz 2001a, 414-415; Liebeschuetz 2001b, 233-238; Ward-Perkins 2001, 239-241; Ward-Perkins 2005, 182-183; Wickham 2005, 11-12; Halsall 2007, 19-22). In the eyes of most of these scholars, Late Antiquity was a chasm between

the Roman and the Medieval period, where old elements disappeared to create a space where new elements arose (Liebeschuetz 2001a, 414-415; Dey 2015, 5-7).
Contributing to the ongoing discussions between different scholars are of course the problems that the evidence and the period bring with them. The changing and growing archaeological evidence requires constant revisions to older theories and hypotheses, as the interest in the period, quality of methods and amount of excavations increase. Unfortunately, interpretation of archaeological remains is not always straight-forward and can lead to different outcomes depending on the training, intellectual background, national origins and interests of the excavator. In addition, definitions of certain concepts (like *town*), are not always definite and can lead to diverse arguments (Cameron 1993, 6-7; 163-164; Ward-Perkins 1996, 4-16; Ward-Perkins 1997, 157; 176-171; Wickham 2005, 9-10).

While either the vision of *continuity* or that of *decline* formed the framework of many publications of the past couple of decades[1], recently a trend developed where the old debate was pushed to the side-lines and emphasis was directed to varying and contrasting developments of individual regions and cities. As the Roman Empire fell apart, the regions that once were part of this common unit came under control of different processes and developments. These developed at different times, under varying circumstances, resulting in a pattern of diverse regional situations throughout the area that once was part of the Roman Empire. It is sometimes problematic to gather all these varying trajectories into one single time period, but it can be said that these changes and regional variations characterise the end of Roman times and are one of the characteristics that make Late Antiquity such an interesting period. The study of these processes and trajectories, with focus on specific regions or development of individual cities, make it possible to distinguish different models and eventual similarities between different regions and bigger areas (Cameron 1993, 200; Lavan 2001b, 243-245; Destro 2004, 101; Ward-Perkins 2005, 171; Wickham 2005, 10-13; Christie 2006, 185; Poulter 2007, 2; Zavagno 2009, 14-15; 153; 170; Esmonde Cleary 2013, 101-102; Dey 2015, 8).

[1] For a bibliographic overview of works regarding the Late Antique city, divided by theme and geographical scope of the publication, see Lavan 2001a.

In line of these arguments, and in order to offer a framework for the coming chapter, a broad overview of the regional developments in various regions of the Roman Empire, with emphasis on the urban environment, seems appropriate.

Starting in the north-west corner of the Empire, Britain was one of the regions where the break with the former Roman culture seems to have been the strongest. During the fourth and fifth centuries AD, with Roman legions gone from the island, central authority and elements of Roman culture seem to diminish and with them the classical urban patterns. Many towns were abandoned or seemed to develop into small unorganized settlements, very different from the model of the classical Roman city (Wacher 1975, 411-422; Liebeschuetz 1992, 9; Reese 1992; Faulkner 2000, 25-50; Dey 2015, 8; 128). A similar pattern can be seen in the east, in the Lower Danube, Eastern Balkan region, where from the beginning of the third century the disappearance of Roman control and administration in the region and the invasion of new cultures from the east caused the diminution of Balkan cities, eventually resulting in the almost complete disappearance of urban settlement from the middle of the fourth century onwards (Liebeschuetz 1992, 9; Poulter 2007; Dey 2015, 8; 128).

In the other Eastern provinces, cities seem, in generally, to have survived much longer. In the Aegean and Anatolia, due to the vicinity of Constantinople, cities developed with a certain prosperity during Late Antiquity. Anatolian urbanism suffered some decrease in the mid-fifth and sixth centuries, but many cities still existed in the seventh century, when the prosperity of the countryside seems to have taken the upper hand and the rural environment seems to have taken control of the urban landscapes. In the Aegean and the Near East, urbanism seems to have endured into the Middle Ages, although in the eight century clear changes and sometimes deteriorations can be seen in the Eastern cities (Liebeschuetz 2001a, 400; Zavagno 2009, 19; 169-170; Niewöhner 2012, 39-10; Dey 2015, 189-213). In Northern Africa, cities seems to have maintained their classical layout without many transformations into the fourth century, only changing with the arrival of the Vandals, when new cultural institutions and structures began to replace the traditional Roman systems (Lepelley 1992). The cities in Spain, during Late Antiquity subject to alternating periods of crisis and invasions and of peace and prosperity, were reduced in number but in general seem to have endured into later times. Of great influence were the political administration and ecclesiastical structures that needed the cities as centres of influence (Díaz 2000; Kulikowski 2004, 87; Martínez Jiménez 2013; Dey 2015, 154-159). In Gaul, cities equally seemed to have thrived under the influence of the church, the ruling political power and in some places the remaining influence of the

classical elite. Even though some centres disappeared, others were subject to many new (ecclesiastical) building activities or received a new urban status (Liebeschuetz 2001a, 82-89; Dey 2015, 176).

Italy in general remained a region with a high degree of urbanization, although there were pronounced variations within different areas of the peninsula (Zavagno 2009, 19; Dey 2015, 178). In northern Italy most cities endured during Late Antiquity and into Medieval times, as they took part into the alternating conflicts between Ostrogoths, Byzantines, Lombards and Merovingian Franks, which resulted on the one hand into changed relationships and forms of control while on the other hand many elements remained unchanged (La Rocca 1992; Brogiolo 2000; Cirelli 2013). While regions such as Romagna in the north experience a period of prosperity in the fifth century (Cirelli 2014), in other regions like Marche, just to the south of Romagna, the urban environment seems to have diminished and many cities were abandoned between the sixth and the eight century (Destro 2004; Cirelli 2014). In the south of the peninsula, classical Roman cities seem to have experienced in general one of two developments, either an endurance into later times, often in relation with a revival of the urban environment, or a deterioration of the city's fabric, followed by abandonment. These two different developments are at times even noted between two cities at a fairly short distance from one another (Raimondo 2006; Volpe 2006). It seems that developments can advance in a fairly similar way throughout an entire region, yet when attention is paid to more local circumstances, different trajectories can be distinguished for cities within the same regional area.

2.2. FACTORS OF CHANGE

Different developments are noted as different regions are compared with one another. Even so, one general trend can be recognized when the urban environment of the Roman and Late Antique period is considered. The classical model of the Roman city seemed to have changed significantly throughout Late Antiquity. Although not every city endured over the course of the Late Antique period, in each of them adaptions can be seen in the physical layout of the urban fabric, in addition to a transformation of the functional role of the city and its place in the surrounding social network. Multiple and varying factors will have brought about these changes and caused the formation of the Late Antique city (Liebeschuetz 1992, 16-17; Cameron 1993, 157-162; Zavagno 2009, 15-16; 169; Dey 2015, 9-10).

The most noted and especially most archaeologically visible changes are those transformations that happened in the physical layout of the cities. In general, the urban landscape was transformed and public and private spaces obtained different functions compared to the classical Roman city. More specific, several developments in the urban environment can be distinguished. First of all, the public buildings underwent a certain process of *demonumentalization*, where they gradually fell into disuse and in many cases were eventually deserted. Alongside the public buildings, central places like the fora eventually lost their importance and the material of their monumental structures was often extracted and re-used in other areas of the city. Buildings which can be associated with pleasure and comfort, like the theatres, stadia and the baths were adjusted for other uses, reduced in size, abandoned or, as often seen in the case of the large public baths, replaces by smaller, more private structures. A second phenomenon is the *encroachment* on public areas, roads and inside public buildings by new, usually small and fairly simple, constructions. These constructions generally include either private residential structures or small shops and workplaces, often built on the streets or the forum, or between the columns of a colonnaded street (see fig. 1 and 2). Additionally, varying structures were built within larger domestic structures to divide these into multiple, smaller living units for the occupation of different families. All of these new structures were in general constructed with the use of basic and crude methods, in simple, often perishable materials like wood, or re-used (stone) material from deserted buildings. The simple, small residential structures came to take the place of the larger, materially richer houses of the previous period, of which relatively few were newly built in the Late Antique period. Due to the overtake of the new structures on the streets and

public spaces, the original street grid started to transform which eventually resulted in a fragmentation of the classical urban fabric. What can also be seen in the Late Antique period is that more and more people were buried inside the city walls, often close to residential areas or even on previous public spaces. As this had not occurred before in many cities, it can be seen as a change of ideologies associated with the urban environment. As the public monumental structures started to deteriorate and the function of many public spaces was transformed, new monumental structures started to take their place. New building projects of the Late Antique period can in general be limited to a select group of building types. Most prominent of these are on the one hand the city walls, often built from material of the former public buildings, and on the other hand the churches and religious buildings. These religious structures were continuously built, new and in monumental style, throughout Late Antiquity and came to replace the deserted classical temples. Over time, as people started to move closer to the churches and the church grew in importance, the social centre of the city shifted from the classical forum to the neighbourhood of the church. Next to the religious buildings and the city walls, residences of varying kinds of rulers were one of the select types of buildings that were newly erected during the Late Antique period. Some classical elements of the Roman cities continued to exist, but most had attained a new function in the transformed urban fabric and few elements will have remained completely unchanged. While the overall trend of demonumentalization, encroachment, a shift towards simpler (residential) structures, changes in the urban network and the rise of churches and city walls can be seen in many different cities throughout the area of the former Roman empire, not one city will have experienced the exact same changes as another. Varying developments will have taken place, at different times, with different combinations and due to different factors. The variety of urban transformation, each city moving away from the classical Roman urban model in its own distinct way, is a process that distinguishes Late Antiquity from the unity of the previous Roman period (Cameron 1993, 129; 160-162; Ward-Perkins 1997, 164; Liebeschuetz 2001a, 29-103; 369-374; 387; Wickham 2005, 591-692; Christie 2006, 183-280; Saradi 2006, 148-208; Zavagno 2009, 6-7; 155; 171; Delogu 2010, 40-48; Lavan 2012; Esmonde Cleary 2013, 113-149; 431-435; Dey 2015, 9; 127; 135). The different factors that are currently seen as the most influential contributors to the changes in the Late Antique city, although not each of them applicable to every city and every region, shall now be discussed.

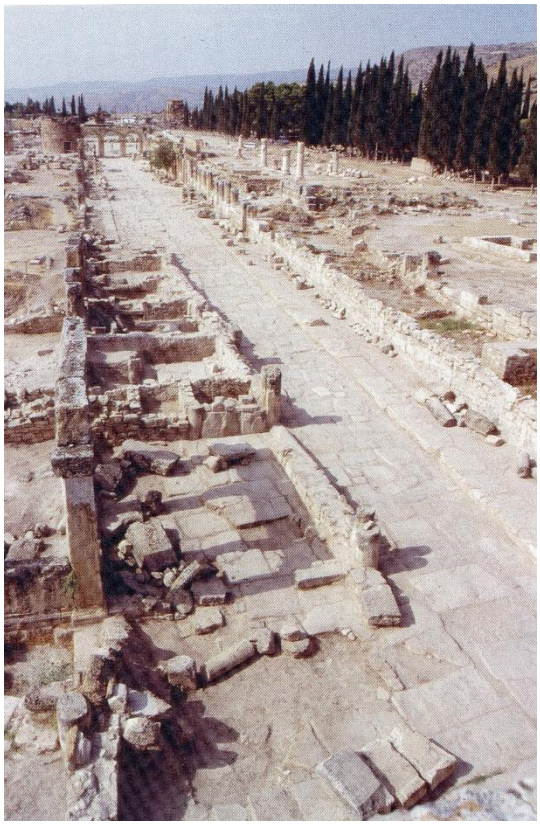


Fig. 2. Late Antique houses built upon a first century CE street in Hierapolis

Fig. 1.Late Antique shops created in the portico of the classical stoa of Messene by building walls between the stoa's columns

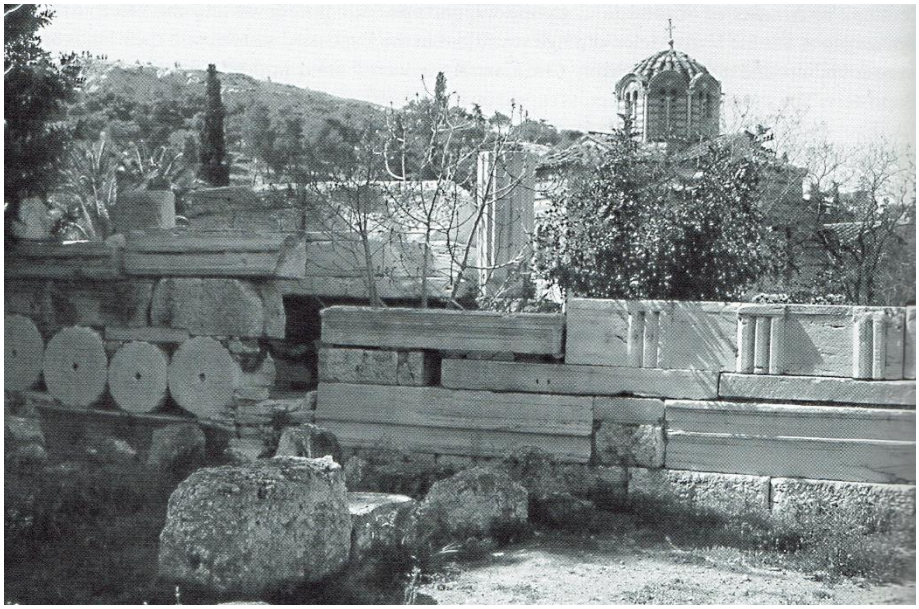


Fig. 3. Late Antique wall in Athens built from remains of former public structures

The impact of the curial class and of its disappearance

In Roman imperial times, the city's administration was controlled by the *curia*, a city council made up of a group of local landowning elites, called the *curiales* or *decuriones*, with membership handed down to their successors over the generations. Alongside the city administration, the *curia* was responsible for maintaining the order and for the upkeep of the city, for executing the tasks set by the government and for the collection of taxes. For the *curiales*, the city was their main responsibility and concern. To show their involvement in the well-being of the city, generous contributions were made to various building projects, often in competition with their fellow *curiales* (Jones 1964, 724-732; Whittow 1996, 56-57; Liebeschuetz 2001a, 3). This traditional model began to undergo several changes from the third century onwards, as financial, political and administrative reorganizations were implemented and reduced the previous autonomy of the *curiales*. Taxes were heightened and the greater part of the locally collected funds now fell directly under the control of the imperial government, instead of the local council. These developments reduced the resources of the *curiales* and provided them with a heavy burden as taxes became increasingly harder to collect. Over the course of the fourth century, the status of the curial class became increasingly unfavourable, causing multiple members of the *curia* to seek for ways to escape their hereditary role. Laws were implemented to ensure that the *curiales* would perform their tasks, yet many found alternatives that allowed them to evade the financial and social troubles of the fourth century *curia*. While some gained a place into the imperial service, bringing with it the chance to regain status and influence, others joined the church and the clergy or moved away to another city or to the countryside. As the amount of *curiales* was reduced and the funds of the remaining members of the *curia* were greatly diminished, less means were available for the funding of major building projects and the maintenance of existing public structures (Jones 1964, 69-70; 732-766; 1301-1302; Liebeschuetz 1992, 6-15; Cameron 1993, 168-169; Whittow 1996, 56-57; Liebeschuetz 2001a, 104-136; Dey 2015, 25-33; 130-131).

During the fourth and the fifth century CE, a further development reduced the influence and status of the *curiales*. A change took place in local administrations as the authority of the *curia* was replaced by a new form of city government. While in previous times the city's administration was run by the *curiales*, selected by the council on ground of their hereditary position, it was now ruled by a group of notables, selected by and with direct relations to the government. These imperial officials did not, in contrast to the *curiales*, have an official, collective obligation to the well-being

of the city and its citizens and therefore did not spend the same amount of expenses on the upkeep of the public domain and its infrastructure. The notables mostly gathered inside private residential buildings, causing the public buildings of the council, including the *curia* and the *basilica*, to become unnecessary and gradually fall into disuse. By the end of the sixth and the seventh century CE, the curial class seems to have completely disappeared (Jones 1964, 69-70; 737-766; Whittow 1996, 56-57; Liebeschuetz 2001a, 104-136; 401-408; Zavagno 2009, 13-14; Dey 2015, 25-33; 130-131). Significant in this development is that as the manner in which the city was ruled changed, alongside with the kind of people who were in charge, the city was undoubtedly transformed, maybe not everywhere in the physical sense, but certainly in its internal administrative, social and cultural structure (Cameron 1993, 268-169).

The role of the local elite

If at first the *curiales* played an important part in the maintenance of public infrastructure, the new imperial officials equally played a role in the falling in disuse of different structures. With the disappearance of the *curiales*, new elite groups took their place, including the imperial notables and members of the church, and especially the bishops (Jones 1964, 760-766; Liebeschuetz 2001, 104-136; Dey 2015, 25-33). The local elite have always been an important factor of development in Classical and Late Antique cities, amongst others influencing different networks of distribution and production with their interests and needs, at the same time drawing others, like craftsmen and merchants, to the urban centres. As the ideologies, and therefore the priorities, of the elite changed, so did the way in which their resources were spent, leading to transformations in the overall fabric of the city (Cameron 1993, 170; Wickham 2005, 595; Zavagno 2009, 6; 14; 155-156; 169; Martínez Jiménez 2013, 77). This phenomenon can be seen in the city of *Buthrotum*, modern Butrint in Albania, where during the third and fourth century CE, at the same time that the public spaces of the city, like the forum, started to fall into disuse, large elite residence were built, enlarged and vastly improved. Clearly the public infrastructure had lost in importance compared to the own private residences. This lasted until the end of the fifth century, when the private residences reduced in size and material richness (with the exception of imported products), and instead resources were spent on the erection of multiple religious buildings throughout the city's territory (Bowden, Hodges 2012, 215-218; 232).

In the eyes of the elite and the current ruling authority, the cities fulfilled an important function as a place where their status and power could be displayed. This was true in Roman times and continued to be true in the Late Antique period. Cities which had a certain relation with important leaders or members of the elite, for instance as places of residence or capitals of a certain region, tended to receive more funding and in general had a higher degree of construction and conservation of public buildings. In cities without this connection, signs of abandonment and disuse of public areas are much more prominent (Delogu 2010, 46-47; Dey 2015, 11-15; 137; 150). In Spain, for instance, it can be seen that during Late Antiquity most physical changes to the cities occurred in periods of peace, when the Visigothic kings gave the towns new functions in their newly established states and used monumental buildings projects to support these functions and to display their own power as the new rulers (Martínez Jiménez 2013, 83-86).

The influence of the Church

With the diminishing power of the *curiales*, and gradually of other (government) officials, opportunities were created for the growing institution of the Christian Church to take part in the upper levels of the city's administration and organization. Starting from the second century CE, the influence of the Church and especially of its local leaders, the bishops, started to increase. This was augmented when Christianity was accepted as a religion of the state in the fourth century CE and gained more recognition within the higher imperial networks. Over time, the members of the Church and the bishops became more involved in different aspects of the city and its territory and developed good relations with the leading members of the city. Gradually, as the different members of the local government and administration started to change and their numbers started to decrease, the Church started to take over several administrative tasks, causing their position of authority within the city to increase. By the fifth and the sixth century, the bishop had become in many cities one of the most (if not the most) influential and powerful persons. In many urban centres, attested amongst others in Italy and Gaul, the bishop was at that time seen as the leader of the city. Due to the expansion of influence and the changing relations with local members of government, the resources that previously went to the local council and administration now were in large part redirected towards the Church. In combination with the growing amount of land and property in control of the Church, this led to an increase of the prosperity of the local ecclesiastical institutions. These funds were on the one hand used to provide assistance to the local community and to people in need, and on the

other hand to contribute to public buildings activities, as the curial class had done before them. Not only a large amount of religious structures were erected, but the Church also took care of the construction of structures beneficial to the social wellbeing, like walls, baths, aqueducts and harbours (Cameron 1993, 165-170; Nicholas 1997, 17-18; Liebeschuetz 2001a, 137-168; Christie 2006, 74-182; Saradi 2006, 181-184; Dey 2015, 18).

Regarding building activities, most attention must surely have gone to the construction of churches. In general, cities in Late Antiquity contained a large amount of churches that, as they were built, came to dominate the urban environment. At first most were situated on the outside of the towns, in the suburbs or adjacent to the city walls, as it was not always possible to obtain building space inside the walled area. As the significance of the Church in the social life of the citizens started to increase and the religious buildings became the new places for congregation and gatherings, focus from the citizens moved from the old classical centre towards the often suburban churches and other religious institutes, causing classical structures like the forum to lose its social importance. These classical places thus frequently fell into disuse and could be confiscated by the Church to be re-used or to serve as a surface over which to build new religious structures. It is therefore often that Late Antique churches can be found on the same spot as the Roman forum or an imperial palace. In some cities, the only substantial new buildings that were erected during Late Antiquity were religious buildings and especially churches (Cameron 1993, 165-166; Nicholas 1997, 17-18; Díaz 2000, 23-25; Kulikowski 2004, 215-255; Christie 2006, 74-182). Next to a transformation of the physical layout of the city, the new churches also provided a new point of attention for both the social and the mental world of the people. Not only did they cause the local citizens to shift their attention towards the new structures and sometimes even move residences closer to these (suburban) buildings, they often attracted pilgrims and travellers from other regions. Especially when churches started to accommodate relics and bodies of saints, more and more people were attracted to the churches. In particular in the East (in the homeland of Christ), many places became widely popular and even received funds from emperors to construct and enlarge religious structures. Due to this increased attention and an influx of many different kinds of people, cities gained in prosperity and sometimes even expanded beyond their former Roman limits (Harries 1992; Walmsley 1996, 127-128; Liebeschuetz 2001a, 387; Christie 2006, 74-182).

With the new religion, the physical appearance of the city was changed and gradually the social world and views of the citizens were transformed (Cameron 1993, 165-166; Liebeschuetz 2001,

412). This changed way of life caused people to think differently about previously common institutions. Many of the former elements of the classical city, like the theatre and the amphitheatre, the public baths and the forum were viewed as indecent, profane and even sinful. These new ideologies influenced the continued disuse of these public places and in part caused them to become rejected as part of urban life (Cameron 1993, 165-169; Kirilov 2007, 18). Also the views of the local elite were altered, firstly as many members of the *curiales* sought to evade their administrative roles and enrolled into the institution of the Church, thereby causing the elite families to become more involved in the religious spheres (Jones 1964, 69-70; 737-757; Cameron 1993, 169-170; Whittow 1996, 58; Liebeschuetz 2001a, 104-136;). Secondly (partly due to the first phenomenon), because the most efficient way in which to express their status in this period was, instead of contributing to the classical public infrastructure, to fund the construction of religious structures and enrich the interiors by providing rich materials like marble and silver (Whittow 1990, 28-29; Whittow 1996, 58; Nicholas 1997, 17; Saradi 2006, 181-183; Zavagno 2009, 7). As in the previous paragraph, the local elite contributed to the transformation of the (Christian) urban fabric.

New occupiers, invasions and warfare

Throughout Late Antiquity, various regions of the former Roman Empire were subjected to invasions of new groups of people, coming mostly from northern and eastern regions and frequently bringing conflict and warfare. These developments often causes a decrease in the population, both in cities and on the countryside, along with changes in settlement models as habitations were abandoned, people moved to more secure locations and fortifications were built to defend against the invaders. In addition, some settlements and cities were deserted as the inhabitants were not able to maintain the structures and themselves with a reduced population or with the destruction caused by the conflicts. (Liebeschuetz 1992, 15-16; Cameron 1993, 3-4; 11; 159-166; 197-198; Halsall 2007; Kirilov 2007, 18-19; Giudice 2013, 8-9; Dey 2015, 134).[2]

In Italy, the invasions and accompanying conflict, especially during the fifth and sixth centuries, had various effects on the urban environment. Many cities were damaged, some partly abandoned leaving open, unused spaces, others completely deserted. Fortifications were built around the cities, in times including only limited parts of the city, at others moved towards better defendable positions.

[2] An overview of the different invasions, the new occupiers and the different temporal developments in different regions can be found in Cameron 1993, Chapter 2, 33-56, and more in detail for the Roman West in Halsall 2007.

Often the threats and the associated developments led cities to shrink to the size of a simple village or to become a purely military settlement (Brogiolo 1993, 85-96; Christie 2012, 11-14). In the city of *Interamnia*, Teramo in Abruzzo, a fortification was built at the end of the sixth century, including only a limited part of the former urban area. Interestingly, the cathedral was included inside the fortifications, but the walls were built across the ancient forum area, reusing material from classical structures that had fallen out of use (Christie 2012, 11-14). This shows that times of insecurity can cause the urban layout to be transformed, dismissing former prominent areas and giving importance to the structures inside the new fortifications.

Another effect of the arrival of new people is that they often had a different view on aspects of the urban environment than the previous inhabitants. In some cases the new occupiers had no affiliation with the existing urban centres, choosing to cast them aside in favour of their own kind of settlement. This kind of phenomenon can be seen for instance in Anatolia, where the arrival of the Turks meant that cities were constructed and developed in ways that were distinctly related to their cultural ideas, leading to a rejection of the former Roman elements (Dey 2014, 128-129; 212). In Africa, the new groups of Vandals did continue to occupy the former classical centres, but they had no interest in keeping the traditions and elements of the former system, as they had no connection or knowledge hereof, leading to a gradual deterioration of these classical elements (Lepelley 1992, 68). The arrival of the Lombards in Italy in the sixth century resulted in a similar development. The Lombard chiefs took their place as new leaders of the city and claimed its territory and its public buildings as their own property. Any structure that was of use in its current form was maintained, while others were transformed, amongst others into residences, and the ones that seemed unnecessary were abandoned or used as a source for building material. In addition new buildings were erected, in their own cultural style, burials plots were laid out inside former public buildings and buildings activities were primarily directed towards the upkeep of the city walls (La Rocca 1992).

Natural factors

Several natural factors can have an (partial) effect on developments and transformations in the urban environment. Climate changes, leading to periods of draught or, adversely, to times with an abundance of floods, can lead to a reduction in the food supply and a decline in the supply of water, causing famine, possibly followed by decease, and often forcing people to leave their current

habitations for places with more resources or to form bigger communities where resources can be shared in other to help one another. Other natural events, like earthquakes or volcanic eruptions, can destroy many structural elements of the city, which were not always restored. In Late Antiquity it is often seen that priority was given to the rebuilding of churches, relating to the changed religious ideologies, or to the renovation of the city's fortification, in line with the insecurity of the times (while in some cases the invasions did leave no opportunity for the surviving population to restore the damaged structures). Depending on the individual local and regional conditions, a city was either able to regain itself after a large natural event, or was left in ruins. Mostly, it is seen that the inhabitants did as much as possible to salvage the damages and to be able to continue life in their city. Periods of prolonged trouble, in combination with economic, political or social changes, often had the most effect on the urban transformations (Liebeschuetz 2001a, 409-410; Saradi 2006, 40-41; Vanhaverbeke, Martens, Waelkens 2007, 636-637; Christie 2012, 15-18; Martínez Jiménez 2013, 85). An event that is seen as characteristic of the Late Antique period is the emergence of the plague. From the first half of the 6th century CE till the second half of the 8th century CE, this disease spread across the former Roman Empire, appearing in different regions for varying periods of time and in varying intensity. Primary consequence was the devastating mortality and the extensive loss of population, especially in the urban environment where people lived in close quarters. In general, the plague and the declined population it itself did not have a major impact on urban transformations, but it made the city fragile, giving other factors like invasions, famine, economic and cultural crisis, the chance to do more damage to the urban infrastructure (Cameron 1993, 164; Liebeschuetz 2001, 53; 391-392; 409-410; Saradi 2006, 40; Kulikowski 2007; Little 2007; Christie 2012, 15-18; Martínez Jiménez 2013, 81-85; Dey 2015, 143).

Conclusions

Considering the above mentioned factors, it should be noted that an attempt was made to discuss the most common factors noted by scholars dealing with the change of the city in Late Antiquity and that probably not every single cause of change has been considered. It can be concluded, however, that not one factor was on its own responsible for changes in the Late Antique city, like the desertion or reuse of public buildings, the appearance of new, simpler, structures on former public areas, or the upsurge of new religious structures. Cities will each individually have had to deal with its own set of factors and experienced its own form of transformations.

As shown above, the physical changes in the city can reflect the underlying changes in the social, religious and cultural networks of the urban environment (Cleary Esmonde 2013, 104). It is clear that the traditional model of the Roman city, as described in the beginning of this chapter, had experienced multiple transformations and can even be said to have disappeared over the course of Late Antiquity. It is the question if the remaining cities and settlements can still be seen as urban centres. Although they were often smaller, with a reduced population and some of the structures less monumental than in previous centuries, it can certainly be said that they still had important functions as administrative centres, as residence of the local elite (in varying forms throughout time) or as military places. Whether this is sufficient to classify a city as *urban*, has to be evaluated in combination with regional elements, individual characteristics and the material remains (Ward-Perkins 1997, 162; Liebeschuetz 2001a, 5-6; Cirelli 2014, 39).

What emerged from these transformations, varied in each city and each region, is an array of different kinds of cities which can be broadly grouped into a few categories, none excluded from variations and from overlap between categories. The first kind is, controversially, the *continuous* city, where almost no transformations in the Roman urban fabric can be noted and the classical structures were continued to be used in a great extent in the same way as before. Second is the *shifted* city, where the main habitation had moved to a different part of the city, as a result from a shift of attention (for example from the classical forum to the new church), or where a large part of the population had moved to a different place altogether, resulting in a new settlement on a new location. A third kind, partly similar to the second, is the *fortified* city, where the most important functions of the city are collected or moved within a walled area, often as a reaction to changed social and cultural circumstances. Fourth is the *city of islands* where the settlement is concentrated in different areas, often around important structures, belonging together but separated by open areas. Fifth and finally is the *ruralized city* where open spaces are deliberately retained within the former urban area, to be worked and maintained for agricultural cultivation (Brogiolo 2000, 312-313; Zavagno 2009, 11; 18). The ruralized city, and in part the city of islands, shall be the subject of the next chapter.

2.3. RURALIZATION OF THE CITY

The process of ruralization, in the context of Late Antiquity, is the development of a classical Roman city into an urban environment with open spaces used for cultivation and rural activities. This development can both result in a *ruralized city* or a *city of islands* as previously described, or a variation hereof (Brogiolo 2000, 312-313). In general, the process involves the gradual disuse of certain areas within a city which are then reutilized as gardens for the cultivations of vegetables and other edible greens, as vineyards or as fields for the pasturing and maintenance of domestic animals. These areas could be situated all over the city, both in more secluded parts or just outside the city walls in the suburbia, as well as in the more occupied parts, right alongside the residential areas. A large part of the urban population was engaged in the upkeep of these rural areas, the maintenance of the gardens and the care of the animals. These were either citizens who had put their previous urban occupations aside in exchange for rural activities, or inhabitants from the (surrounding) countryside who had moved into the urban area and brought rural knowledge and techniques with them (Ostrogorsky 1959, 65; Mannoni 1983, 263; Bierbrauer 1988, 515; Wickham 1988, 650; Ward-Perkins 1997, 164; Brogiolo 2000, 312-313; Saradi 2006, 447-459; Baron, Reuter, Marković 2018, 2). It is sometimes argued that the simple construction techniques that characterize many residential structures in Late Antiquity, which are similar to techniques used in structures in the countryside, indicate a shift towards rural habits and beliefs (Mannoni 1983, 263; Saradi 2006, 447-459). The contrast between the city and its surrounding rural environment seemed to have become less distinct than it had been in Roman times, as more rural activities were executed within the urban limits and amid previously important public structures, yet the city will probably have remained a separate urban centre within its rural territory (Wickham 1988, 650; La Rocca 1992, 173; Christie 2006, 259-263; Saradi 2006, 448; Baron, Reuter, Marković 2018, 2).

The ruralization of the city should not necessarily be viewed as a negative development, a process where (parts of the) urban environment disappeared and gradually the rural environment came to take its place. Instead, it should be seen as an active evolution of the citizens towards a greater independence from the larger, changing system. The population sought to find ways to ensure a more reliable food-supply, to adjust quickly to changing conditions and to be able to rely, if necessary, solely on the local environment and resources. Therefore the techniques, activities and open areas that were at first situated outside the urban environment were now introduced inside the city, in many cases even inside controlled and secured sections (Curta 2001; Delogu 2010, 45-47;

Giudice 2018, 2; Baron, Reuter, Marković 2018). That this process can be seen as a choice of the citizens does not exclude situations where the population was forced to start cultivation within the city walls in order to survive in times of crises. In his *Funeral Oration over Julian*, Libanius wrote in the fourth century CE how war and famine cause a decline in population and a search for food, until "*the cities themselves formed both city and farmland and the uninhabited spaces inside the defences provided land enough for farming*" (Libanius *Orations* 18.35; Saradi 2006, 454).

The process of ruralization, as in the transformation of the classical urban environment with the introduction of open areas and rural activities (Brogiolo 2000, 312-313), should not be confused with another process that is frequently labelled as ruralization. This is the process in Late Antiquity where the city's elite seemed to have moved away from the city to take up residence in the surrounding rural environment. This would have been demonstrated by the large number of villas that seemed to have been built and enlarged during the third and fourth centuries CE (Liebeschuetz 2001a, 129; Chavarría Arnau 2004, 71; Kulikowski 2004, 85; Wickham 2005, 168-232; Dey 2015, 19-20; Niewöhner 2017, 46-48). Despite the fact that this process shall no further be discussed in this study, it should be noted that archaeological evidence is available that contradicts this theory (especially for Spanish regions) and challenges the idea of the elite moving away from the city (Kulikowski 2004, 130-133; 149).

2.3.1. Archaeological evidence for ruralization

The ideas about ruralization have been primarily based upon archaeological evidence related to this process. Before individual examples of several cities will be discussed, some attention shall be paid to phenomena that archaeologists have noticed during excavations of Late Antique levels and that can possibly be related to ruralization.

Often involved in discussions about ruralization are the so called layers of *dark earth* (*terra scura* in Italian or *terres noires* in French) that are frequently found above Roman levels and underneath Medieval levels, usually forming a separation layer between the two periods. The layers are composed of a dark, highly organic earth in varying levels of thickness and with little or no archaeological material. Despite multiple analyses, it is not yet certain how and from what material these layers are formed. It seems like there are different processes that can lead to the formation of

the *dark earth* layers and that they are not limited to the Late Antique period, or any period at all, or specifically to an urban environment. What is currently known is that they are often the result of changed human actions and specifically the changed use of a certain area, in particular when the layers are found above older, abandoned buildings. In general, they are interpreted as either the decayed remains of wooden structures, or as an area used for agricultural activities, like gardening or the keeping of animals, with the organic content of the layer derived from the plants, animals or from imported fertile soil. Although often, and especially in the past, viewed as layers of abandonment, and sometimes even used as an argument for ceased urban activities, the *dark earth* layers should rather be seen as an indication of changes in the way that the traditional urban environment was used (Ward-Perkins 1997, 160; Verslype, Brulet 2004; Christie 2006, 259-263; Halsall 2007, 357-359).

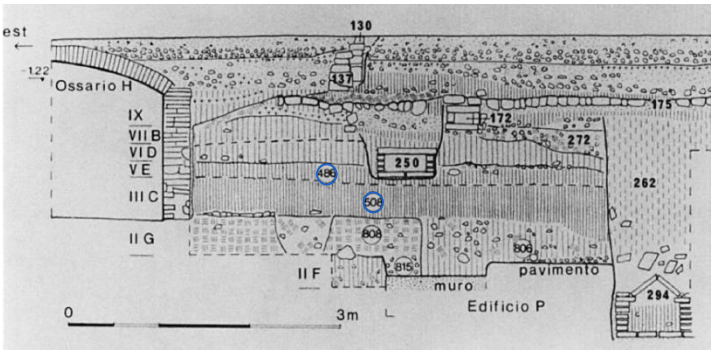


Fig. 4. Stratigraphic section of the San Giorgio site in Bologna. Numbers 508 and 486 indicate a layer of dark earth that is situated above the Roman levels and under the Medieval and later levels

Next to the levels of *dark earth* and open areas noticed inside Late Antique cities, other indications for increased rural activities inside the urban environment are noted, namely the appearance of agricultural tools and installations. Tools with specific functions related to agricultural and rural activities are found inside the city, indicating the use of these tools by the urban citizens. Discovery of cowbells inside the city walls could be an indication that cattle was kept within the city (Milinković 2007; Baron, Reuter, Marković 2018, 2)[3]. In addition, several installations like oil and wine presses, mills and ovens, of large size and with considerable production capacity, are found inside Late Antique cities, often on the location of former public buildings, inside private residences and encroached onto the streets and porticoes. While smaller installations did appear in Roman cities, the kind of installations found in Late Antiquity were previously only located in the suburbs or in the countryside (Saradi 2006, 447-459). The presence of these tools and installations inside the urban area show the increased desire of the citizens to be able to provide for themselves.

[3] These finds have been attested in particular in the Balkan area.

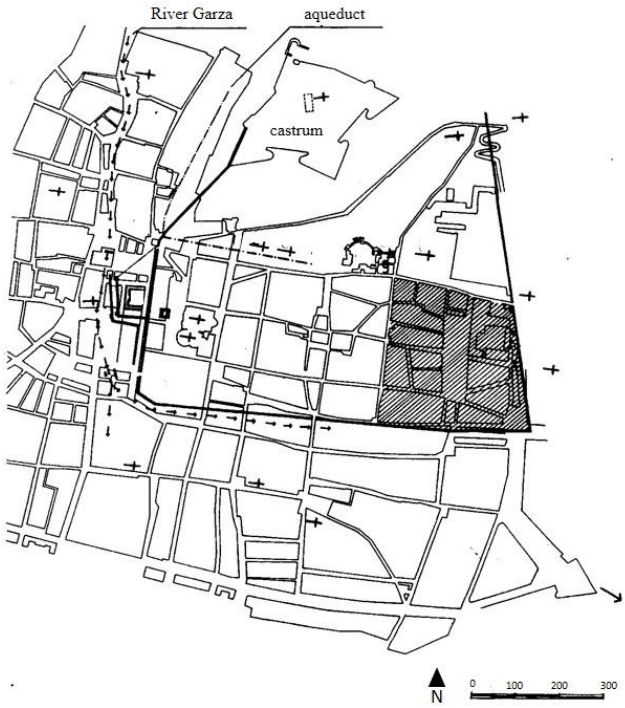


Fig. 5. Map of Late Antique (Lombard) Brescia with indication of open area for cultivation (striped area)

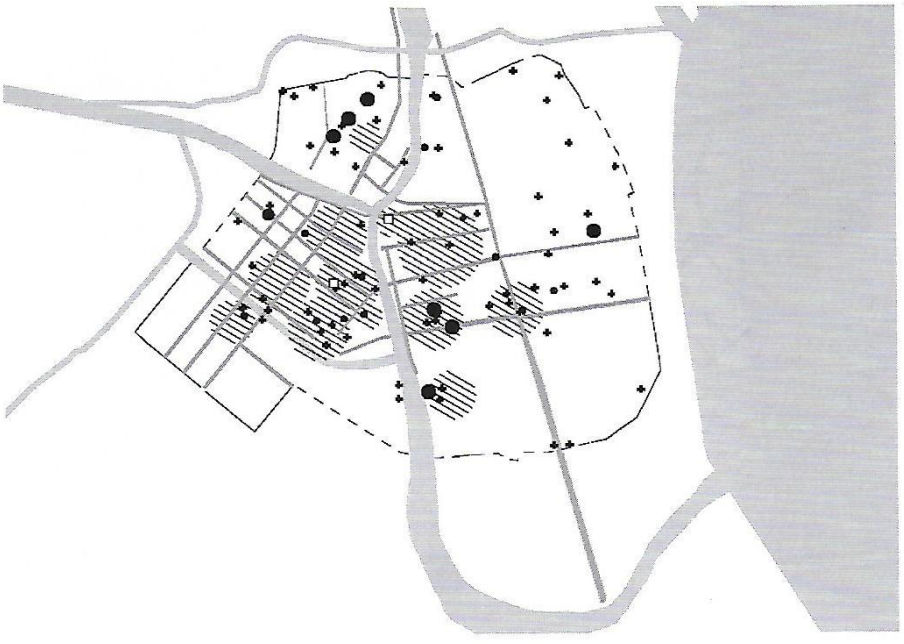


Fig. 6. Map of Late Antique Ravenna with indication of churches (black dot), burials (cross) and inhabited areas (striped area), which shows that large part of the city was uninhabited

Ruralization in the cities

The process of ruralization has been attested for several Late Antique cities in Italy.

The city of Brescia in northern Italy had transformed over several centuries from a classical Roman city to the seat of a Lombard duke. In the seventh century, the city consisted of a small population, mostly concentrated in the north of the settlement. In the eastern part, excavations have discovered several dark layers of earth, in some areas more strongly attested than others, with a high content of organic material. These layers were dated to the seventh century CE (sometimes continuing until the twelfth century CE) en were in multiple places found on top of the remains of earlier buildings. It seems that a large area in the eastern part of the Lombard town was open, agricultural ground (see fig. 5). This area is interpreted as land for the cultivation of crops and the keeping of domesticated animals. Soil would have been brought inside the city from the surrounding rural territory to create this area, which main function was probably to supply to the duke and the city's elite (Brogiolo 1993, 88-96; Brogiolo 2000, 313-316; Christie 2004, 9; Christie 2006, 261). Late Antique Ravenna, located in north-east Italy, has been characterized as a city with different foci of settlement as both simple and more elaborated buildings were grouped around the churches and separated by open areas (see fig. 6), of which several were used for agriculture and gardening (Augenti 2006, 199-200). A similar pattern can be seen in nearby Classe, where the population is concentrated around the churches and the harbour and where open areas near the residences are used for cultivation (Augenti 2012, 67).

In sixth century CE Ascoli, located in the valley of the river Tronto in Adriatic Marche, large open areas have been recognized which were previously, in Roman times, occupied by different structures and buildings. These structures seem to have been fallen in disuse, amongst others due to Lombard invasions in the sixth century, and were re-used as gardens and cultivation areas. A possible stimulus for the re-use of these areas for cultivation, instead of the rebuilding of public and residential structures, was the poverty of the countryside at that time, caused by the ongoing invasions and warfare and accordingly the move of the rural population towards safer places (Giorgi 2004, 327-329; Cirelli 2014, 43). In another city in Marche, Suasa, a large domus building achieved new functions during Late Antiquity, as a part of its monumental garden was transformed into a small cemetery, several areas within the houses were subdivided to create smaller residences and another part of the garden was turned into a cultivation area, probably for gardening and growing of vegetables (Bogdani, Giorgi 2010, 335-352; Giorgi, Lepore 2010; Cirelli 2014, 41). In *Pisaurum*,

modern Pesaro in Marche, new, smaller, walls were built at the end of the third century CE. Inside these walls, more open spaces were distinguished, which were used as burial ground or for cultivation (Vermeulen 2012, 87).

Several examples of this ruralization process can also be attested for cities outside of Italy. In Caesarea, on the coast of modern Israel, an area in the south of the city had fallen into disuse, probably around the seventh century, possibly earlier, and the Roman buildings gradually fell into decline. The area was then reused for cultivation, as irrigation channels were laid out across the area and cultivation plots were created between the channels (Holum et al. 1992, 98-100; Liebeschuetz 2001a, 58-59). The city of Hierapolis in western Anatolia saw a transformation of its forum area during the tenth century CE. As the forum and surrounding areas were deserted, soil coming from the nearby hills was allowed to accumulate and fill the area, creating a new surface that could be used for agriculture. Some small water channels have been found close by the Nymphaeum which probably might have been in relation with some cultivation areas. Some agricultural installations, including wine and oil presses were installed and a couple of small residence have been excavated that probably belonged to rural workers (Arthur 2012, 288). In *Calleva Atrebatum*, modern Silchester in south Britain, evidence has been found for the keeping of animals inside and in the immediate neighbourhood of the town during the fifth to seventh centuries CE, including the procession of their bones for extraction of fats. In combination with the small-scale production of iron, this shows that the population were making use of local resources and specific skills to maintain their (small) habitation at a time when a large portion of the population had moved to other locations (Fulford 2012, 346).

The case studies presented above show indications for ruralization, primarily based on structures and layers found (or absent) inside the city and their distribution compared to the previous Roman settlement. In addition to this, it is possible to find indications of ruralization with the incorporation of archaeobotanical and archaeozoological remains, in relation with the archaeological material evidence and some other techniques.

The city of *Justiniana Prima*, at present an archaeological site called Caričin Grad in southern Serbia in the Balkans, was built in the sixth century and existed for a couple of generations before being deserted around 615 CE. Although not a former Roman Imperial city, interesting archaeozoological

and archaeobotanical remains have been able to prove ruralization in the Late Antique city. From the analysis of the animal remains and the comparison between the first phase of the city and the second, last phase, it was noted that the use of domesticated animals changed over time. While in the first period the citizens mainly used the animals for their primary products (meat, bones, fat and skin), this changed in the second period when more emphasis was put on milk and wool, secondary products. In the second period the sheep and goats remains were namely derived from animals which were kept alive until a later age (over 3 years) than in the first period, thereby allowing people to use their secondary products for a longer time. In addition, it was seen that percentages of cattle remains decreased over time as that of pig and especially sheep and goat increased. This is because sheep and goats could be kept closer or even inside the cities and were less demanding to maintain than cattle. The analysis of the archaeobotanical remains showed that a diversity of cereals were grown in the surrounding of the city and some structural installations indicate that these cereals were processed inside the city walls. This evidence gathered from *Justiniana Prima* indicates that a specific rural strategy was maintained inside and close by the city, allowing it to provide for its own resources without necessary dependence on a regional network (Baron, Reuter, Marković 2018).

In Sagalassos, a city in southern Anatolia, research has provided much insight in the development of the city from Roman into Late Antique times. With its height of prosperity in the fourth century CE, Sagalassos witnessed a transformation during the successive centuries. As in other Late Antique cities classical monuments fell into disuse while churches took their place, fortifications were build, larger structures were subdivided and newer structures were erected on previous public places. At the end of the fifth century and during the sixth century CE transformations can also be seen in agricultural activities in the immediate neighbourhood of the city, along with altered strategies for (local) food productions and changed use of several areas inside the city. The city was gradually becoming more ruralized, a process that has been attested in several parts of the city thanks to extensive archaeological, archaeobotanical and archaeozoological research. Inside the city's structures several indications have been found for a more rural use of space. Some water reservoirs were re-utilized as a dump of urban waste, including butchery refuse. Rooms inside formerly high-standard buildings were similarly used as a dumping space, while other were used for keeping animals or for the storage of animal manure. A public latrine of a large bathing complex was in the seventh century CE converted for the accumulation of waste material. With the use of different techniques, including faecal biomarkers, calcium analysis and macro botanical and pollen analysis,

the corresponding seventh century layers were analysed and it was discovered that the majority of the waste material consisted of the excrements of herbivores. Probably these excrements were collected from animals kept inside or close to the city, gathered in the former latrines to create a fertile compost that could thereafter be used to enrich nearby cultivation areas. Analysis of the archaeobotanical remains of the city have further showed that walnut and cereals, including millet and barley, were cultivated in the nearby suburbs or even within the city itself. Additionally, study has been conducted on the excavated animal bones. As animals take up certain chemical elements from their environment through their food and the pasture in which they are grazing, which then accumulate in their bones, it was decided to study if polluting human activities like metallurgy, garbage disposal and fertilization of the fields had any impact on the animals living in ancient Sagalassos. These analyses have shown that elements derived from these polluting activities, including arsenic, manganese, lead and zinc, were present in much higher amounts in the domestic animal bones during the fifth and sixth centuries CE than in the fourth century CE. This indicated that the animals were kept much closer, in the immediate environment or even inside of the city, where they would take up more polluting elements. When the percentages of the domestic animals were compared, it was also noted that the amount of cattle tended to decrease in the course of Late Antiquity, as the amount of sheep and goat increased. This means that not only were the animals held nearer to the city, there was also a higher emphasis on smaller, less expensive animals that could be easier transported or held within the urban area, and had fewer consequences if one was lost. Sagalassos turned more towards local resources that could be found, kept and maintained in close proximity, offering more security in less certain times (De Cupere 2001; Degryse et al. 2004; Vanhaverbeke et al. 2004; Vanhaverbeke, Martens, Waelkens 2007; Baeten et al. 2012).

The above examples show that ruralization can not only be attested through the presence of open areas and agricultural structures within a city, but that the analysis of archaeozoological (and archaeobotanical) remains can give an indication of changing processes within the urban environment. In general, a strategy towards smaller animals, so more sheep, goat and pig instead of cattle, and towards the keeping of these animals nearby or within the city walls can point to an increased aspect of ruralization within a certain city.

3. LUNI ON THE TRANSITION FROM ROMAN TO LATE ANTIQUE TIMES: STUDY OF THE ARCHAEOZOOLOGICAL REMAINS

Study of the Roman and Late Antique remains of Luni, both in older and in more previous years, has provided much information about the two periods and the changes between them (Frova 1973; Frova 1977; Potter 1992, 11; 73-74; Menchelli, Sangriso, Genovesi 2016; Menchelli et al. forthcoming(a)) and offers an opportunity to relate this information to the excavated archaeozoological remains.

3.1. LUNA, THE CITY

The city of *Luna* was founded as a *colonia* on Ligurian territory in 177 BCE. Its location had already proved beneficial for the overtake of the Ligurian tribes, as a point of departure when travelling overseas to Spain and as a stopover for travellers along the Tyrrhenian coast. In Roman times situated in the region of Etruria, nowadays the city of Luni is located in Liguria, between Carrara and Sarzana (Pliny the Elder *Naturalis Historia* 3.5.50; Banti 1937; Frova 1973, 34-36; Potter 1992, 74). With its foundation, the city was laid out in an orthogonal street grid within the city walls, which form a more or less rectangular shape, save from the south-eastern corner (see fig. 7). The *Decumanus Maximus* was part of the Via Aurelia which connected Genoa to Pisa and Rome and ran from west to east through the city, passing along the southern edge of the forum. The *Cardo Maximus* ran in a north-south direction towards the *Porta Meridionale* and probably the city's harbour, only to be interrupted in the middle by the forum. The centre of the city was occupied by the forum with its porticoes and by the *Capitolium* temple, situated just to the north of the forum and the *Decumanus Maximus*. To the south of the forum some residential and storage buildings and a small religious structure have been excavated. In the northern part of the city, a second larger temple, the *Grande Tempio* was located, while in the north-east corner there was a roofed theatre. Apart from the central forum area, another area of public importance was located in the west of the city, where excavations have revealed the location of the third-fourth century *curia*, which in later centuries was converted and rebuilt into a Christian basilica. To the east of the city, on the outside of the city walls, an amphitheatre was located (Banti 1937, 62-64; Frova 1973, 29-48 ; Potter 1992, 75).

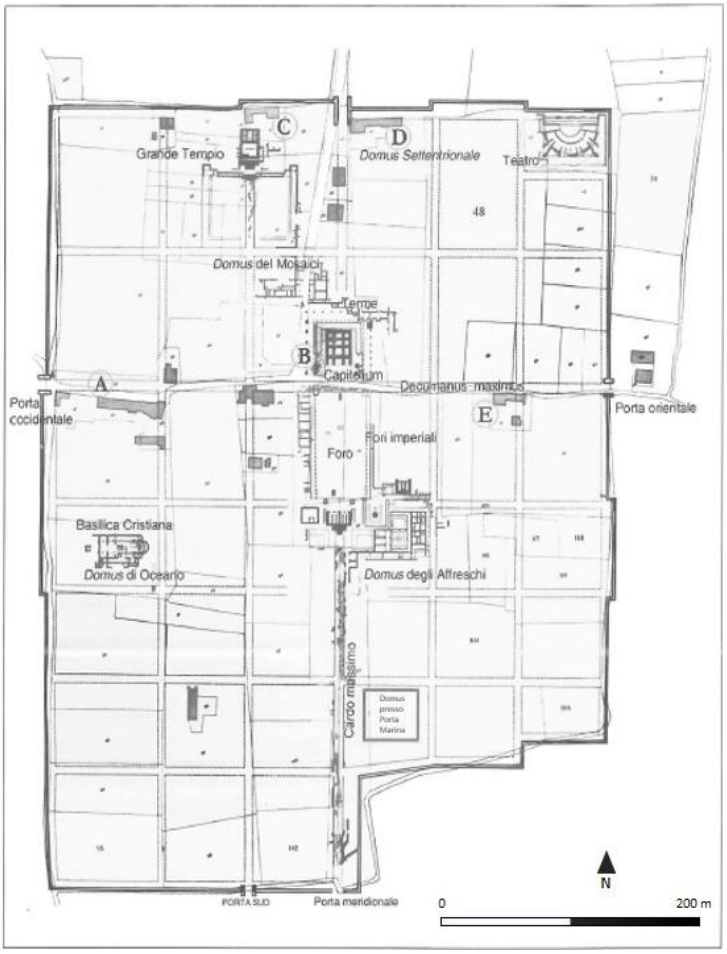


Fig. 7. Map of the ancient city of Luni with indication of uncovered archaeological remains

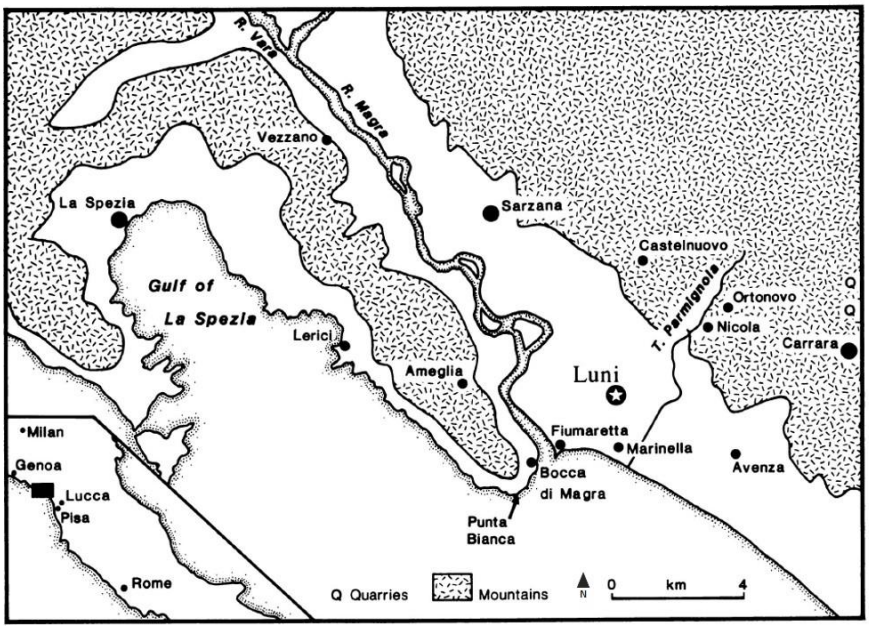


Fig. 8. Current location of Luni in Italy and in the lower Magra valley, with indication of the surrounding mountains and close-by marble quarries

Geographically, the city of Luni is located on a coastal area at the foot of the Apennine mountains, where the river Magra flows into the Mediterranean sea (see fig. 8). It was situated at the eastern side of the river and its harbour can probably be situated in one of the river bends, close by the sea (Banti 1937, 57-62; Delano Smith et al. 1986; Fazzini, Maffei 2000; Bini et al. 2009). The mountains, the coastal area and the river valleys provided opportunities and limitations for the inhabitants of Luni's territory. In general, the area was a rough landscape with unfertile grounds, only suitable for agriculture (of cereals) in limited areas along the coast and in the river valleys. Not much agricultural production would have been possible in the area, except for the cultivation of olives, vines, fruit trees, pine and chestnut on terraced hills. Corresponding to this idea, habitation in the territory of Luni has been shown to consist mostly of small farms located on the hills between the second century BCE and the first century CE, probably for the purpose of growing vines and olives. On these rough grounds, and even higher up the mountain, sheep and goats could well be herded, as they are perfectly suited to graze on poor terrain (Delano Smith et al. 1986, 85-93; 107-109).

The products known from Luni correspond with these circumstances. According to Pliny the Elder the best wine in Etruria was made in the territory of Luni (Pliny the Elder *Naturalis Historia* 14.8.68), and a specialized cultivation on the hillsides for the production and export of wine, and possibly oil, is assumed (Ward-Perkins 1981a, 184; Delano Smith et al. 1986, 107-109). Another product mentioned by the classical authors are the enormous cheeses of Luni with a symbol of a half-moon. These were said to weigh around 450 kg and be able to feed a large amount of people. It is certain that these cheeses were bigger than the average Roman cheeses and probably these were produced with new high-temperature and high-pressure techniques so that they could be preserved for a longer period of time. As this cheese is listed by Pliny amongst other types of sheep cheese, these cheeses were probably produced from sheep's milk (Pliny the Elder *Naturalis Historia* 11.97.241; Martial *Epigrammaton Libri* 13.30; Frova 1973, 58; Kindstedt 2012, 103-108). Next to these products, and the possible export of timber (Strabo *Geographika* 5.2.5; Frova 1973, 58), Luni was most renowned for its white Luni marble[4]. From around 40-30 BCE the marble which was amply present in the city's territory was exported and used in high amounts in public building projects in Rome, other parts of Italy and in the provinces. This local resource contributed highly to

[4] Also called Carrara marble, as the current marble quarries are situated in modern Carrara (Potter 1992, 11; 75; 166).

the importance of the port of Luni and thereby increased the prosperity of the city and its territory (Strabo *Geographika* 5.2.5; Banti 1937, 494; Frova 1973, 56-57; Ward-Perkins 1981a, 184; Potter 1992, 11; 75; 166).

As the export and (overseas) trade of these products continued to increase and benefitted to the growth of the city, it became a prosperous urban centre which did not seem to be limited by its poor rural territory. This changed when in the first century CE wine from the provinces, especially Spain, came to dominate the market and the vine farms on the hills around Luni could no longer cope with the competition and fell into disuse. The use of Luni marble declined drastically in the third and fourth century CE and eventually also that source of income for the city fell away. Trade still continued as Luni remained an important centre on exchange routes from the northern inlands, through the Apennine river valleys, towards the coast, and for people travelling along the Tyrrhenian coast, but was more limited, small-scale and local than it had been in previous times. The city came to depend more on local, basic resources and the cultivation of vines on the hills was largely replaced by chestnut trees, which were probably of great importance to the city's economy (Ward-Perkins 1981a; Delano Smith et al. 1986, 140-143).

During the third and fourth century CE many public monuments of the city were deserted and stripped of their marble. The forum fell into disuse and, like other Roman structures, was gradually covered with an layer of earth. In the sixth century new residential structures were built over the former public centre of the city. These houses (see fig. 9) were made of perishable material, presumably wood, with a floor of yellow clay and walls supported by wooden posts and in some parts built upon older Roman remains of for instance the forum portico (Ward-Perkins 1977, 633-638; Ward-Perkins 1981a; Ward-Perkins 1981b; Ward-Perkins 1997, 157-159; Potter 1992, 211-212). In this period the city was part of the Byzantine territory and was a residence to a bishop. This lasted till 640 CE when the city fell under the control of the Lombards (Ward-Perkins 1981b; Potter 1992, 218-219; Fazzini, Maffei 2000, 247-249). The changes of new control in the seventh century were likely accompanied by natural events, as increased episodes of rain would have created flooding in several parts of the city, probably causing residences to no longer be accessible for habitation (Fazzini, Maffei 2000, 258-259). Luni continued as a settlement, and especially as a Christian centre with a bishop, during the following centuries, with its cathedral a point of attraction for the inhabitants of its territory. When the cathedral was moved to Sarzana in 1200 CE, habitation ceased to exist and the city was deserted (Ward-Perkins 1977; Ward-Perkins 1981a, 79; Delano

Smith et al. 1986, 82; Potter 1992, 218-219; Fazzini, Maffei 2000, 247-249). Not every part within Luni's city walls has yet been researched or excavated but it would seem that habitation in Late Antique Luni was mostly focused around the area of the cathedral, while some other residences and buildings were loosely scattered over the remaining part of the, largely unoccupied, urban area (Ward-Perkins 1977, 633-638; Ward-Perkins 1981a, 79; Potter 1992, 218-219).

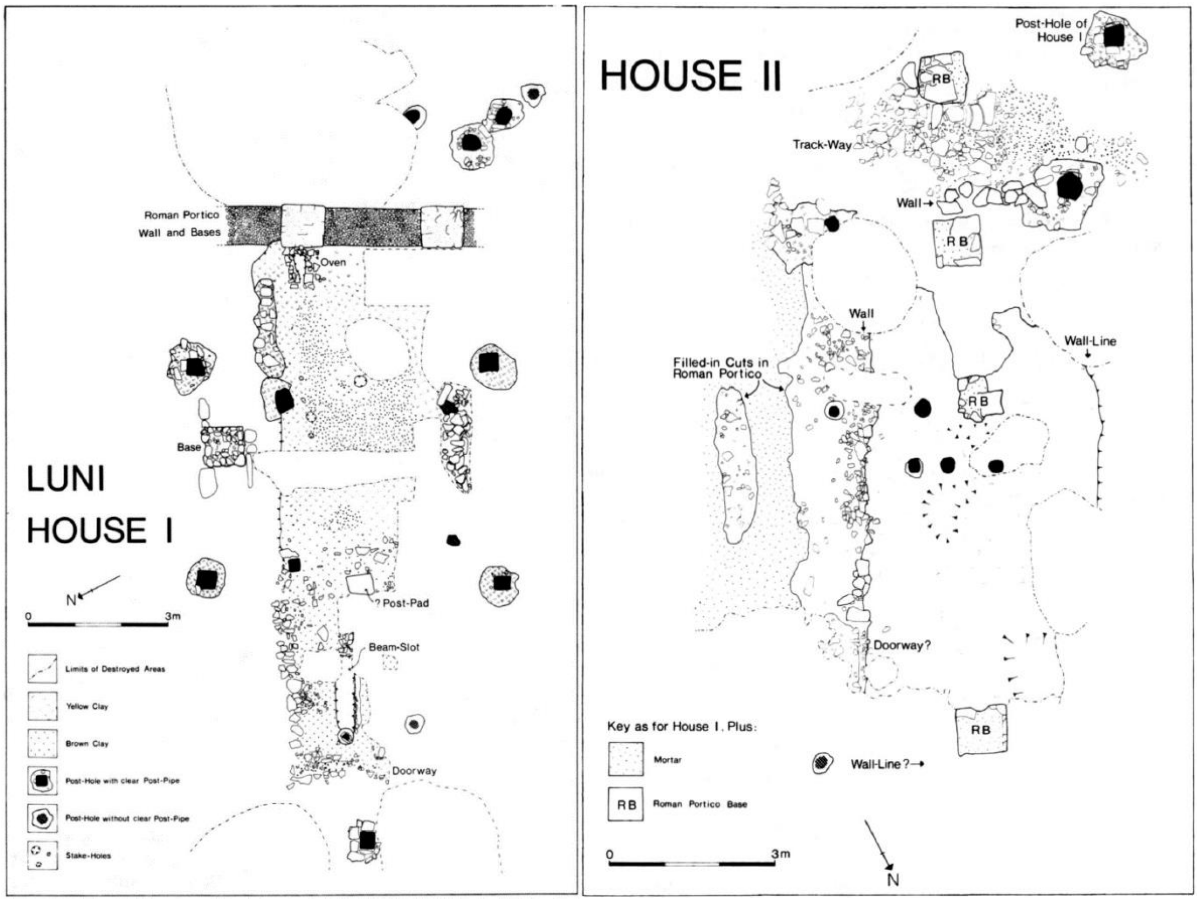


Fig. 7. Two houses built over the former forum area of Luni in the sixth century CE

3.2. LUNI, *DOMUS PRESSO PORTA MARINA*

The archaeozoological material under consideration for this study is part of a larger selection of material (both osteological and non-osteological) collected during excavations carried out by the *Università di Pisa* in Luni. These excavations, initiated in 2014 and currently still in progress, are situated in the south-east sector of the Roman city, close by the *Porta a Mare* and possibly the city's harbour, and directly to the east of the *Cardo Maximus*, an area with little previous research. In this location, named *Le Domus presso Porta Marina*, two *domus* were unearthed, both built at the beginning of the first century BCE (see fig. 10-11; Menchelli, Sangriso, Genovesi 2016; Menchelli et al. forthcoming(a)).

Of the northern *domus* (A) a *cubiculum* (A1), part of an *ala* (A2) and an *atrium* (A3) have been identified. Structural reorganizations between the fourth and fifth century CE have destroyed some of the original remains of the *domus*. These reorganizations include the enlargement and modification of the *impluvium* in a large rectangular basin (with the original floor of the *impluvium* still *in situ*), the addition of a round cistern in the *cubiculum* and the connection of these two structures with a pipe system. This new installation has been interpreted as possibly belonging to a *fullonica*, a place for the cleaning and processing of clothes, changing the function of the house from residential to productional. In the sixth century CE the installation fell out of use and was covered by several levelling layers, on top of which a wall and a wooden structure were built (Menchelli et al. forthcoming(a)).

The southern *domus* (B) was slightly bigger and better preserved than its neighbour. A total of seven rooms have been excavated, amongst which an *atrium* (B4) and a *tablinum* (B7) with mosaic floors have been identified. As with the northern *domus* several changes were made to the house structures over the course of the centuries. In the *tablinum* a channel and a pit were cut through the mosaic and a wall was built on top of it. These changes, of which the chronology is not yet clear, probably indicate the transformation of the room in an outside area. In Late Antiquity a large structure, still partly excavated, was built on top of the *atrium*. With walls with a thickness of 120 cm and a small adjacent room, the structure has been interpreted as a tower, probably with a defensive function. Several ground-levelling layers have been excavated in the southern *domus* that seem to be contemporary with the construction and/or use of this tower. Activity, both in the area of the southern and the northern *domus* seems to end in the seventh – beginning of the eight century (Menchelli et al. forthcoming(a)).

Fig. 8. Location of the site of Domus presso Porta Marina in the city of Luni

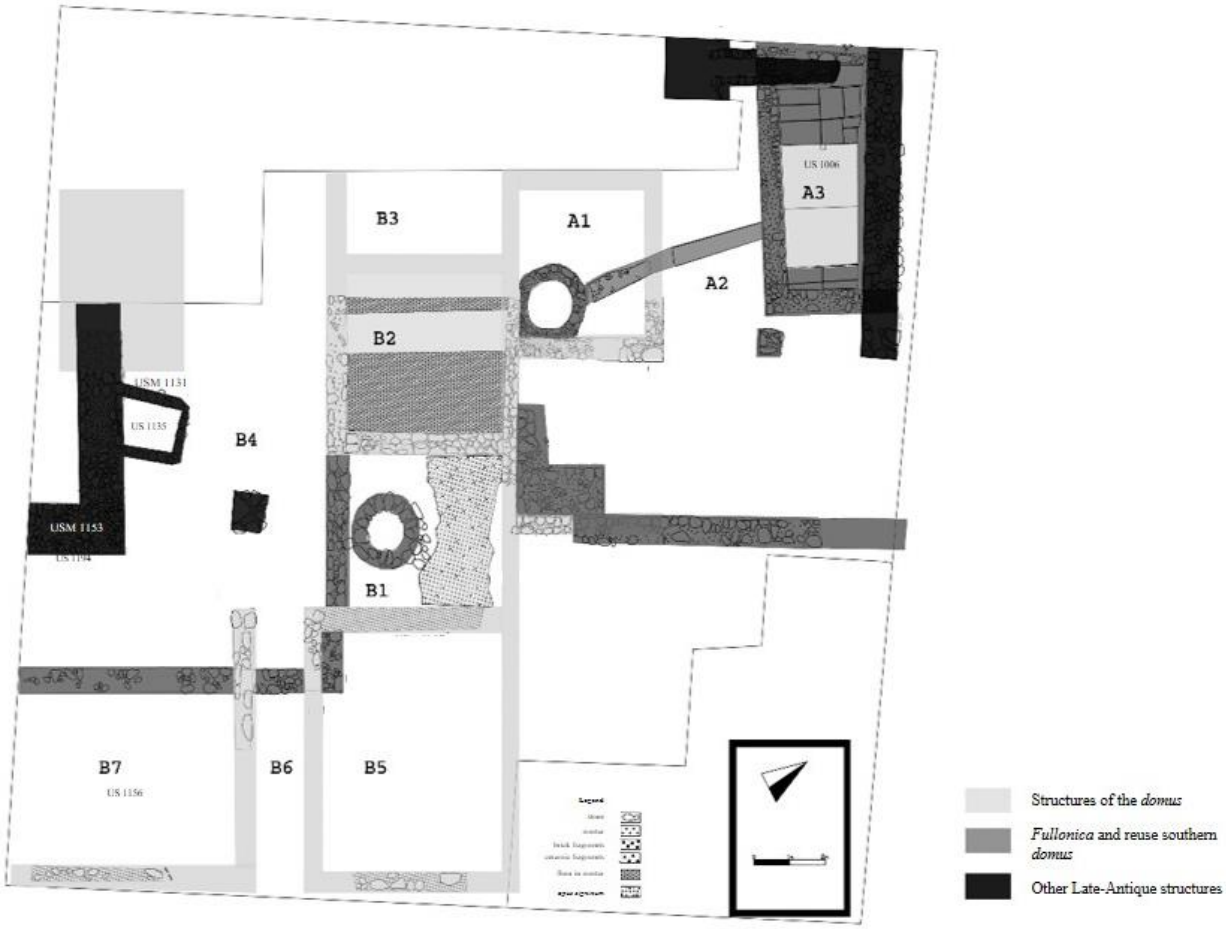


Fig. 9. Domus presso Porta Marina, the excavated structures and layers

3.3. ARCHAEOZOOLOGICAL MATERIAL

3.3.1. Methodology

The animal remains from the excavation at *Domus presso Porta Marina* were collected by hand and carefully excavated with trowels. Except from the too small and fragmented items, all bone material was collected. The studied material comes from five different contexts (which are discussed in more detail below), of which only the youngest layer (US 1006) could have had some later disturbances. All of the other contexts were found undisturbed (Personal communication prof. Menchelli). Following table shows the amount of material studied, divided in the amount of non-identifiable elements and the number of identified specimens.

Stratigraphic unit (US*)	Non-identifiable elements	Number of Identified Specimens (NISP)	Total
1135	5	12	17
1194	1	5	6
1156	144	84	228
1124	279	449	728
1006	347	348	697
Total	776	898	1,674

*Table 1. Studied archaeozoological material from Luni, Domus presso Porta Marina, divided per excavated context. *US is the context, the stratigraphic unit (unità stratigrafica in Italian), to which the material belongs*

For the identification of the material, use was made of the archaeozoological reference collection of the *Università di Pisa* and the work of Robert Barone (Barone 1980). Of the total amount (N=1,674) of archaeozoological elements, 53.6% could be identified as belonging to a certain class or species[5]. The non-identifiable elements are those animal remains that were too fragmented and did not have any morphological features to allow recognition of which class it belonged to (Reitz, Wing 2008, 164).

Different methods were used for the quantification of the archaeozoological remains. Firstly, the *Number of Identified Specimens* (NISP), the number of bone fragments that could be identified (Reitz, Wing 2008, 202-205; Groot 2010, 109-110), was counted. Each fragment was seen as a

[5] Of the total NISP of 900, 15 remains could not be identified as belonging to a certain species, but only as fish, bird or mammal remains.

single specimen, except when they could be reconstructed with another fragment to form a larger piece of bone[6]. Of the identified species, the *Minimum Number of Individuals* (MNI), the minimal amount of individual animals that will have contributed to the creation of the excavated remains, was calculated. As many animals have a right bone and a left bone for specific skeletal elements (for instance one humerus in the left leg and one humerus in the right leg), it is possible to calculate if the bones of more than one animal are present in an archaeozoological sample. Two left specimens of a certain bone will indicate that at least two animals were present (Reitz, Wing 2008, 205-210; Groot 2010, 110-11). For the MNI calculation, all fragments of a certain species were analysed per context. The skeletal elements per species were separated and for each element the amount of right and left fragments was counted. Attention was hereby paid to fragments that could have belonged to the same bone, including the amount of separate distal and proximal ends. The NISP and MNI data for each context is represented in table 2. Lastly, all bones were weighed and measured. The measurements were taken according to the criteria described by Von den Driesch 1976. The specific information per identified specimen, including weight, measurements and conservation, can be found in Appendix 1.

Criteria for the determination of the mortality age of the animals was based on Silver 1963 for the fusion data and Grant 1982 and Higham 1967 for the dental data. The fusion data for sheep/goat, cattle and pig were categorized according to the fusion age categories used by Michael Mackinnon (Mackinnon 2004, 239, Appendix 19). These categories are based on the ages of fusion listed by Silver (1963). Most of the ageing data, especially the dental data, was based on a limited amount of specimens. Therefore too little information was available to allow for any seasonal patterns of mortality.

No pathological conditions could be noted on the bones, probably due to the limited expertise in this area. Due to limited research time and inadequate experience, it was not possible to make a clear differentiation between goat and sheep remains, with the exception of some horn fragments. It was therefore decided, as done more often in archaeozoological research for Roman Italian sites (Mackinnon 2004, 102), to take these two species together as one group of ovicaprines.

[6] In that case, the two fragments would be glued together as one.

	US 1135		US 1194		US 1156		US 1124		US 1006	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Molluscs										
Murex sp.	-	-	-	-	-	-	7	7	-	-
Cardium sp.	-	-	-	-	-	-	6	6	1	1
Glycymeris Glycymeris	-	-	-	-	-	-	1	1	1	1
Ostrea sp.	-	-	-	-	-	-	3	3	2	2
Unidentified mollusks	-	-	-	-	-	-	-	-	1	1
Fish										
Unidentified fish	-	-	2	2	-	-	-	-	2	1
Birds										
Chicken (*Gallus gallus domesticus*)	1	1	-	-	5	2	19	4	28	3
Galliforms (*Galliformes sp.*)	-	-	-	-	3	1	1	1	10	2
Unidentified birds	-	-	-	-	1	1	4	2	4	4
Microfauna										
Mouse	1	1	-	-	-	-	-	-	-	-
Wild mammals										
Fallow Deer (*Dama dama*)	-	-	-	-	1	1	-	-	1	1
Roe Deer (*Capreolus capreolus*)	-	-	-	-	-	-	-	-	1	1
Domesticated mammals										
Cat (*Felis catus*)	-	-	-	-	-	-	3	1	2	1
Dog (*Canis familiaris*)	-	-	-	-	-	-	1	1	3	1
Donkey (*Equus asinus*)	-	-	-	-	-	-	2	1	-	-
Horse (*Equus caballus*)	-	-	-	-	1	1	28	2	-	-
Pig (*Sus domesticus*)	5	1	3	1	32	4	170	8	161	9
Cattle (*Bos Taurus*)	2	1	-	-	21	3	82	3	50	2
Sheep / Goat (*Ovis aries / Capra hircus*)	3	1	-	-	19	2	117	5	79	4
Sheep (*Ovis aries*)	-	-	-	-	-	-	3	2	-	-
Goat (*Capra hircus*)	-	-	-	-	-	-	2	2	-	-
Unidentified mammals	-	-	-	-	1	1	-	-	2	1
Total	**12**	**5**	**5**	**3**	**84**	**16**	**449**	**49**	**348**	**33**

Table 2. Domus presso Porta Marina, Number of Identified Animals and Minimum Number of Individuals per context. Contexts are arranged in chronological order. 'Unidentified' means the element could not be identified on species level, solely on class level.

3.3.2. Studied contexts, preservation and taphonomy

On the previous page the archaeozoological remains per context, divided into NISP and MNI data, can be found. Information about the excavated contexts can provide insight in the taphonomic processes to which the animal remains were subjected. For the location of the contexts in the excavation area, see fig. 11. on page 41.

US 1135 was found inside structure USM 1131 and was interpreted as the garbage fill of this small room adjacent to the tower. Aside from the animal remains, the layer contained building material, earth and material from the larger tower structure (USM 1153). Similar garbage fills have been found on several locations in the city of Luni and are probably related to the collapse of the city's sewer system in Late Antiquity. The context is dated to the fifth century CE (Menchelli et al. forthcoming(a); Personal communication prof. Menchelli and team).

US 1194 is similarly a context in relation to the tower and constitutes the fill of the foundation ditch, located on the inner side of the tower structure (USM 1153). Next to some residual Late Republican material connected with the building of the original *domus*, the context contained no absolute dating elements. In relation to other structures and layers, this context can be roughly dated to the fifth-sixth century CE (Menchelli et al. forthcoming(a); Personal communication prof. Menchelli and team).

US 1156 is to be located in the *tablinum* (B7), where in Late Antiquity a channel and round pit were dug through the mosaic, probably for the draining of rain water. This pit was later used as a garbage dump and filled with black earth, some ceramics and a large amount of bones. Due to preservation measures for the mosaic no further excavations were possible in this area and the fill could not be precisely dated, but its use as garbage-pit should be located somewhere in the fifth-sixth century CE (Menchelli et al. forthcoming(a); Personal communication prof. Menchelli and team).

Unlike the previous contexts, **US 1124** is located in the northern house. It is one of the three layers found in the rectangular basin in room A3. These layers were part of building activity to level the ground and create a new walking surface after the installation of the *fullonica* fell in disuse. This filling layer can be dated to the middle of the sixth century CE (Menchelli, Sangriso, Genovesi 2016, 18; Menchelli et al. 2018, 5; Personal communication prof. Menchelli and team).

US 1006 consists of the very last layer of activity in the excavation area. Directly underneath the modern agricultural layers, this context was present throughout the excavation area[7] and was made up of a black-grey clay mixed with building material, ceramics, metal and bones. Based on several amphora fragments this context was dated to the seventh-eight century CE (Menchelli, Sangriso, Genovesi 2016, 110; 118-119; Personal communication prof. Menchelli and team).

In general all the contexts showed a fair conservation of the animal remains. The bones seemed relatively sturdy and did not show much cracks and signs of flaking. There were fresh breaks visible on the bones, yet older break patterns as well, indicating that the bones had already been broken when they were deposited in Late Antique times.

For a more objective analysis of the bone preservation, it is possible to calculate the amount of teeth that survived in relation with the number of identified specimens. As teeth generally preserve better than bones, the ratio between the two gives an indication of the preservation of the animal remains after they were deposited. Good preservation and the deposition of the complete skeleton will give a 20-30% of recovered teeth. If the ratio is lower than 10%, only parts of the animals were deposited (post-cranial bones excluding the head and teeth) or during excavation not all fragments have been recovered. The use of a sieve during excavation could for instance uncover more small teeth fragments than recovery by hand. If the ratio if greater than 50%, more cranial elements with teeth might have been deposited or taphonomic processes might have affected the bones in a higher degree than the deposited teeth (Mackinnon 2004, 47-51).

Stratigraphic unit	Number of teeth	NISP[8]	Degree of preservation (%) (number of teeth/NISPx100)
1135	2	12	17
1194	1	5	20
1156	16	84	19
1124	96	432	22
1006	83	343	24
Total	198	876	23

Table 3. Degree of preservation of the recovered archaeozoological remains, based on the Number of Identified Specimens and the number of teeth.

[7] And therefore not explicitly indicated on fig. 11.
[8] Mollusks have been excluded from this Number of Identified Specimens count, as this calculation considers the number of identified bones and teeth.

From the degree of preservation as shown in table 2 it can be concluded that all the contexts have a fairly good, and similar, preservation, with the ratio around 20%, and that recovery techniques and taphonomic processes had no great influence on the conservation of the animal remains.

There was however a reasonable amount of fragmentation, as most of the unidentifiable bones consisted of very small fragments and even unidentifiable fragments from larger elements were present in the sample. Of the identified bones, about two thirds were preserved for less than half of the total element[9]. To calculate the rate of fragmentation, the total number of retrieved skeletal fragments (bones and teeth[10]) is divided by the NISP data. A higher ratio indicates a higher percentage of elements that were too fragmented to allow identification, and therefore it indicates a higher degree of fragmentation (Mackinnon 2004, 51-52).

Stratigraphic unit	Total Sample	NISP	Degree of fragmentation (Total sample/NISP)
US 1135	17	12	1.4
US 1194	6	5	1.2
US 1156	228	84	2.7
US 1124	728	432	1.7
US 1006	697	343	2.0
Total	1676	876	1.9

Table 4. Degree of fragmentation of the archaeozoological remains, based on the total sample of recovered remains and the Number of Identified Specimens.

The data shown above indicates that the ratio of the contexts falls between 1.2-2.7. Use of this method for Roman-period sites in Central Italy has shown that a ratio between 1.5-2.5 is an indication for a moderate, but not extreme, degree of fragmentation (Mackinnon 2004, 52). The data therefore indicates that the contexts show a moderate degree of fragmentation.

The preservation and fragmentation of the remains is highly influenced by the various taphonomic processes that the archaeozoological sample is subjected to before, during and after deposition (Mackinnon 2004, 47; Groot 2010, 77). The studied material is derived from contexts that were identified as garbage fills or levelling layers, often containing multiple kinds of material, like ceramic, metal and building material, next to the animal bones. Analysis of the bones has shown that on a number of fragments[11] indications of fire were found. Several fragments were found either

[9] Percentages of preservation of the specific specimens can be found in Appendix 1.
[10] Mollusks have again been left out.
[11] 9 bones out of the total 898 NISP

with black marks or a completely black colour, in a few cases they showed white marks. No pattern was visible in the burn marks and it does not seem like the bones were subjected to fire on purpose, as the marks are only limited. Possibly they were laying on the surface in the vicinity of a small (cooking) fire. In addition to the burning marks, on a very limited amount of bones[12] gnawing marks were found. They can be seen as an indication that at least a small part of the bone material was not buried immediately, but left on the surface and accessible to carnivores, pigs and dogs (Groot 2010, 82). It seems probable that the animal bones were not always immediately deposited, but in some cases were left in places accessible to animals living on the site or to fire, before being thrown into garbage pits or gathered with the surrounding ground to create a new levelling layer. This could have caused some fragmentation of the bones.

There is no specific information on the acidity of the soil, but from the in general good preservation of the finds the excavators have the impression that the acidity of the soil is not very aggressive and damaging (Personal communication prof. Menchelli). The collection of the material by hand might have had some influence on the sample, as very small fragments were not collected (Personal communication prof. Menchelli). This recovery technique might have caused smaller bones to be overlooked, thereby influencing the sample of the smaller animal species. It will however have little influence on the sample of medium-sized and larger (mammal) species (Mackinnon 2004, 45-46).

In US 1006 one worked bone had been uncovered (see fig. 12). The fragment is 10,7 cm in length, and has a width of 11 mm at its widest point and 5 mm at its smallest point. Traces of the working and polishing of the bone are still visible and it was decorated with three lines around its body. It was interpreted as a needle, possibly for the making of nets, or as an instrument for cosmetics or medicine. No other worked bones were found on the site (Personal communication prof. Menchelli, prof. Sorrentino).

Fig. 10. Worked bone fragment from US 1006, interpreted as needle or instrument

[12] 4, possibly 5, out of a total of 898 identified bones

3.3.3. Information by species

Sheep/Goat (ovicaprines)

The ovicaprine bones constitute about 24.8 % of the total identified animal remains. As previously mentioned (see 3.3.1), no differentiation was made between sheep and goats and the two species were analysed together. The distribution of the skeletal elements of the studied species are represented in Appendix 2. The separate skeletal elements are additionally grouped according to the major parts of the body (head, torso, front legs, hind legs and leg extremities). The leg extremities are taken as a separate group, as these elements carry a low amount of meat compared to the rest of the leg. This grouping of elements allows for a better insight in the complete or only partial deposition of animals (Mackinnon 2004, 196; Groot 2010, 112-114). Regarding the sheep/goat remains it seems that almost all skeletal elements are represented in the sample and that the separate body parts are represented in fairly equal amounts. Only elements from the head are present in a larger number, but this can be explained by the large number of teeth, which are generally better preserved (Mackinnon 2004, 47). It seems that in general whole ovicaprines were deposited or used on the site.

	Fusion age (months)											
	12			**14-36**			**47-48**			**48-60**		
	scapula, pelvis, humerus dis., radius pr.			phalanx 1, phalanx 2, tibia dis., femur pr., ulna			metapodial dis., femur dis., tibia pr.			calcaneus, radius dis., humerus pr.		
	NF	Fus	F	NF	fus	F	NF	fus	F	NF	fus	F
US 1135	-	-	-	-	-	1	-	-	-	-	-	-
US 1156	-	-	3	-	-	2	-	-	1	-	-	-
US 1124	-	-	6	3	2	9	-	-	1	1	-	-
US 1006	-	-	6	-	-	5	-	-	1	2	1	3
Total	**0**	**0**	**15**	**3**	**2**	**16**	**0**	**0**	**3**	**3**	**1**	**3**
Percentage	0	0	33	7	4	35	0	0	7	7	2	7

Table 5. Fusion data for sheep and goat remains (n=46).
The bones are grouped into unfused elements (NF – not fused), elements of which the fusion line is still visible (fus – in fusion) and bones that are fully fused (F – fused). Under the fusion age in months, the (part of the) skeletal elements are given that fuse at this age.

For the determination of age, 46 out of the 223 sheep/goat elements could be used for the fusion data and 10 elements could be used for the dental data. The fusion data are similar for all contexts, with an absence of animals under 12 months. 7% of the remains belong to individuals that died before the age of 3, and 7% to animals younger than 4-5 years. Of 7% can be said with certainty that they are of animals that surpassed the age of 5.

	Dental age category (in months)							
	0-2	**3-6**	**7-12**	**12-24**	**24-36**	**36-48**	**48+**	**72+**
US 1124	-	-	-	1	4	1	1	-
US 1006	-	-	-	-	-	-	-	1
Total	**0**	**0**	**2**	**1**	**4**	**1**	**1**	**1**
Percentage	0	0	20	10	40	10	10	10

Table 6. Dental data for sheep and goat elements (n=10).

The dental data allow to break down the mortality patterns of the ovicaprines in more precise categories, but there was only data available from 10 contexts and a total number of 10 mandible fragments. No elements are present for animals under 7 months, 2 elements belong to individuals that died between 7 and 12 months, and 1 element to an individual between 1 and 2 years. Most of the elements, a total of 4, belong to ovicaprines between 2 and 3 years of age, and another element belongs to an individual between 3 and 4 years. One element belongs to an animal that seems to have survived to 8-10 years.

From the ageing data, it is clear that sheep and goat were probably primarily kept for their secondary products like wool, goat-hair and milk, rather than for their meat. To profit from these products, the animals were kept till an older age, generally between 2 and 6 years, so they could be used for their milk and wool/hair, before being killed for their meat (De Cupere 2001, 87; Mackinnon 2004, 121-131). The fusion and dental data seems to correspond to the exploitation of the secondary products. No very young animals were killed, only a few were killed under 1 year of age. Most animals seem to have been killed between 2 and 4 years, and a number seem to have survived beyond 5 years. Probably the production of wool and hair, used for the manufacturing of clothes, carpets and blankets (Toynbee 1973, 163-166), and the production of milk were the primary reasons for keeping

these animals. Although the cheese from Luni is primarily known from the Imperial age (Pliny the Elder *Naturalis Historia* 11.97.241; Martial *Epigrammaton Libri* 13.30), it is possible that the milk of these animals in Late Antiquity was used to produce similar kind of cheeses.

The presence of butchery marks on the bones (see Appendix 3 and the discussion in Chapter 3.3.4.), suggests that these animals have been used for consumption, probably as a secondary purpose. Most of the bones will probably have derived from consumption refuse.

No elements for the identification of the sex of sheep and goat were available and due to the fragmentation of the bones, it was not possible to take good measurements for the calculation of size or height.

Cattle

The cattle remains constitute 17.3% of the total number of identified animals, a total of 155 elements. Of these elements 33 could be used for the determination of age, 30 for the fusion data and only 3 for the dental data.

	Fusion age (months)											
	7-10			**12-18**			**24-36**			**42+**		
	scapula, pelvis			humerus dis., radius pr., phalanx 1, phalanx 2			tibia dis., metapodial dis., calcaneus			femur, tibia pr., humerus pr., radius d., ulna		
	NF	Fus	F	NF	fus	F	NF	fus	F	NF	fus	F
US 1156	-	-	-	-	-	1	-	-	-	-	-	1
US 1124	-	-	3	-	1	9	-	-	4	2	-	1
US 1006	-	-	-	-	-	6	-	-	-	-	-	2
Total	**0**	**0**	**3**	**0**	**1**	**16**	**0**	**0**	**4**	**2**	**0**	**4**
Percentage	0	0	10	0	3	53	0	0	13	7	0	13

Table 7. Fusion data for the cattle remains (n=30).
Bones are grouped into unfused elements (NF), elements in fusion (fus) and fully fused elements (F).

The majority of the bones with fusion data (53%) are bones that fuse between the age of 12 and 18 months. As these bones could also belong to animals which are older, even 4 or 10 years old, it only tells that most of the cattle survived beyond 1.5 years. More informative are the bones which are yet unfused or in fusion. These show that 3% of the cattle remains belong to individuals that had died

between 12 and 18 months and 7% to individuals younger than 3.5. The bones which fuse last indicate that at least 13% of the remains belong to animals that survived beyond 3.5 years. It would seem that the cattle generally died at an older age.

	Dental age category (in months)							
	0-6	**6-12**	**15-18**	**18-24**	**24-36**	**36+**	**48+**	**60+**
Us 1156	-	-	-	-	1	-	-	1
US 1124	-	-	-	-	1	-	-	-
Total	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**1**
Percentage	0	0	0	0	67	0	0	33

Table 8. Dental date for cattle elements (n=3).

Although the dental data for cattle was derived from only 3 mandible fragments, it does complement the fusion data. Two of the fragments belong to younger animals which died around the age of 2.5, while the third fragment belongs to an older animal of 5-6 years.

Next to using their meat for consumption, cows could be used as workforce or for their milk. Although cow's milk was not as common throughout Roman Italy as sheep or goat's milk, at least at some sites there is evidence for its use. In general cows would be able to produce milk from the age of 3 onwards (Toynbee 1973, 149-162; MacKinnon 2004, 93-94). Looking at the fusion and dental data, it would seem that a part of the cattle on the site died before 2.5-3.5 years of age. As these were younger animals, not yet capable of milk production, their main use seems to have been for their meat. In contrast to this, the animals that died at an older age were probably also used as a working animal, for breeding purposes and possibly for the production of milk.

An abundance of skeletal elements which carry a high portion of meat, like the scapula, humerus, pelvis or femur, might indicate that only the meat-bearing bones had been imported into the settlement and the animal had been slaughtered (and raised) elsewhere. On the other hand, if a high proportion of elements from the leg's extremities are found, this might suggest that these elements were dumped as waste and the animal's meat was transported somewhere else (Mackinnon 2004, 196-198). When considering the skeletal elements of cattle (as presented in Appendix 2), it does not seem like a specific part of the animal was favoured above another, suggesting that the whole animal

was used on site. Butchery marks (see Appendix 3 and Chapter 3.3.4) confirm that cattle was used for consumption. Not enough complete elements were present to allow a determination of the sex or a size reconstruction of the cattle.

Pig

The highest percentage (41.3%) of the total archaeozoological sample consisted of pig remains.
As differentiation between wild and domestic pig was not possible based on the morphological traits of the bones, the measured bones were compared to a standard of a wild boar population using the logarithmic size index method. With this method, all the measurements of different skeletal elements are converted so that they can be compared to one standard (Payne, Bull 1988; Meadow 1999). The standard, derived from a modern wild boar population in Turkey (Payne, Bull 1988), and the measurements from the studied contexts are presented in Appendix 4.

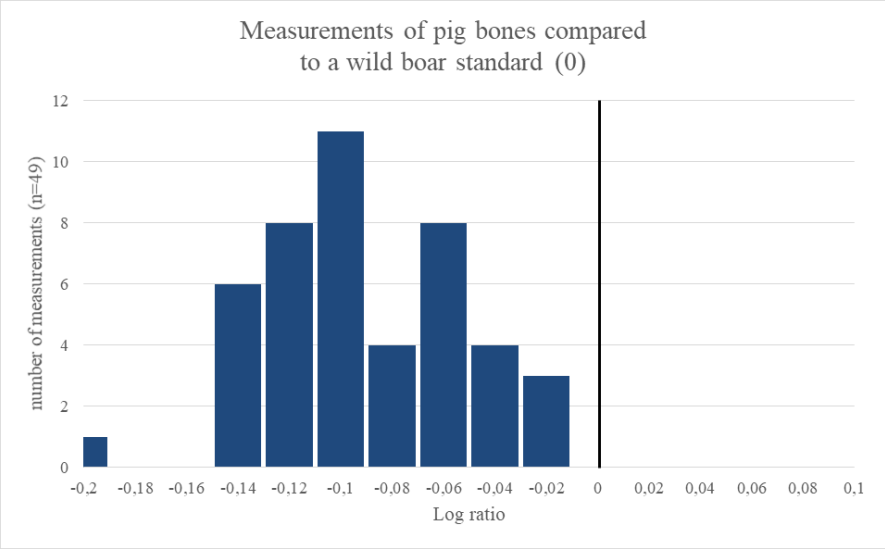


Fig. 11. Measurements of pig bones (n=49) in comparison to a wild boar standard (0) derived from Payne, Bull 1988.

The data show that all measurements fall below the standard of the wild boar and therefore seem to belong to domesticated pigs. The data seem to be grouped as a normal distribution, indicating that the animals belonged to a single population (Personal communication prof. Linseele).
Additionally, withers height was calculated (see Appendix 4) and compared to other data from Roman Italian sites to see if these correspond to other domesticated pigs in the same time period. The calculations are based on three astragali and although the astragalus is not the most reliable for

this calculation, it is the most commonly used for Roman Italian sites and therefore good for comparison (Mackinnon 2004, 110; 147). From this (limited) sample, it seems that the pigs on the site had a withers height between 62.7 and 78.7 cm. When compared to data from other Late Antique sites in Italy, this corresponds well with the height ranges known for domesticated pigs in this period[13] (Mackinnon 2004, 147-148).

	Fusion age (months)											
	Foetus	**Juvenile**	**11**			**19-23**			**31-35+**		
			scapula, pelvis, radius pr., humerus dis., phalanx 2			tibia dis., metapodial dis., fibula dis., phalanx 1			calcaneus, femur, humerus pr., radius dis., tibia pr., ulna, fibula pr.		
			NF	fus	F	NF	fus	F	NF	fus	F
US 1135	-	-	-	-	-	-	-	1	-	-	-
US 1156	-	-	-	-	9	1	-	3	-	-	-
US 1124	-	2	1	-	15	8	2	12	8	1	-
US 1006	3	3	-	-	5	10	4	9	4	1	1
Total	**3**	**5**	**1**	**0**	**29**	**19**	**6**	**24**	**12**	**2**	**1**
Percentage	3	5	1	0	28	19	6	24	12	2	1

Table 9. Fusion data for pig remains (n=102).
Bones are grouped into unfused elements (NF), elements in fusion (fus) and fully fused elements (F).

For the determination of age, 129 out of a total of 372 pig elements could be used, 102 for the fusion data, 27 for the dental data. Looking at the fusion of the long bones, and particularly at the bones which had not yet fully fused (and therefore indicate that the animal it belonged to had not yet reached a certain age), it is noted that the majority of the pigs died at a younger age. Around 9% of the remains belong to individuals that died younger than 1 year (3% belonging to foetuses), around 25% to individuals younger than 2 years and around 14% to individuals that had yet to reach the age of 3. Of only 1% of the remains can be said with certainty that they belong to individuals that had surpassed the age of 3.

[13] North Italy: 59.8-78.8 cm, Central Italy: 57.3-84.1 cm, South Italy: 62.1-71.6 (Mackinnon 2004, 148, Table 44). The data corresponds somewhat better to the ranges known from North and Central Italy, which is expected as Luni is located in Liguria, in northern-central Italy.

	Dental age category (in months)								
	fetal/ newborn	**1-3**	**3-6**	**6-12**	**12-18**	**18-24**	**24+**	**30+**	**60+**
US 1156	-	-	-	1	-	-	-	-	-
US 1124	-	-	-	1	3	2	4	3	4
US 1006	-	-	-	2	1	2	4	-	-
Total	**0**	**0**	**0**	**4**	**4**	**4**	**8**	**3**	**4**
Percentage	0	0	0	15	15	15	30	11	15

Table 10. Dental data for pig elements (n=27).

The dental data, based on the eruption and wear of teeth, give us no information about animals younger than 6 months, but do allow to break down the mortality patterns of the older ages into more detailed categories. An even spread can be seen between 6 months and 2 years, with 15% of the remains in the 6-12, the 12-18, and in the 18-24 month category. A large group of the remains (30%) belongs to individuals between 2 and 2,5 years and another 11% to individuals over 2,5 years. In contrast to the fusion data, the dental data indicates that 15% of the remains belong to individuals that survived past the age of 5.

According to the fusion and dental data, the majority of the pigs died before the age of 3, with the biggest portion between 1 and 2,5 years. As pigs in ancient times would have reached their maximum weight and optimum meat quality around 2-2,5 years, it seems that these animals were used and bred for consumption. The presence of some older animals, used for breeding, and some foetuses and very young animals, might suggest that the pigs were bred on the site (MacKinnon 2004, 156; Baron, Reuter, Marković 2018, 9).

The distribution of the skeletal elements (Appendix 2) and the butchery marks (Appendix 3, Chapter 3.3.4), similarly suggest the animals were used for consumption and that in general all parts of the animal were used.

Determination of sex was possible based on the canine teeth. These are larger for males than for females and slightly differently shaped for each sex (Mackinnon 2004, 143). A total of 24 canine fragments were recovered, of which 2 could be attributed to females and the other 22 to males,

resulting in a 92% of male pigs on the site. This high percentage might be explained because the male canines are bigger and possibly more noticeable during excavations, or because males were unnecessary in large amounts for the continuation of the livestock and could therefore be used for consumption. Especially if the pigs were not kept on the site, but needed to be imported from somewhere else, it is to be expected that a larger amount of expendable males were sent to the consumption site (Mackinnon 2004, 158).

Equids

The equid remains make up 3.5% of the total NISP. Of the 31 identified equid remains, 29 were identified as belonging to horse, while 2 teeth fragments could be attributed to donkey. As shown in the element distribution (Appendix 2), one horse radius was uncovered in US 1156, while the remaining equid fragments all derived from US 1124. The horse fragments from US 1124, with exception from the teeth, all belonged to either the front or the hind leg. Several fragments of the hind leg (several tarsalia, astragalus, calcaneum and a metatarsus, all left, see fig. 14), seem to belong to a single individual. The relative completeness of the horse bones, in comparison with the cattle, pig and sheep/goat bones, and the absence of any butchery marks, indicate that horse was probably not consumed. This corresponds with current knowledge of the use of the horse in antiquity. Horses were generally not used for consumption, but instead were used for transport, as a riding animal or in some cases to pull a vehicle, or as an aid for hunting (Toynbee 1973, 185-196; De Grossi Mazzorin, Riedel, Tagliacozzo 1998; Mackinnon 2004, 74).

Fig. 12. Metatarsus, metacarpal, tarsalia, astragalus and calcaneum of a horse from US 1124

	Fusion age (months)					
	9-15		**15-24**		**36-42**	
	scapula, phalanx 2, phalanx 1		humerus dis., radius pr., metapodial dis., pelvis, tibia dis.		calcaneum, humerus pr., femur, tibia pr., radius dis., ulna	
	NF	F	NF	F	NF	F
US 1156	0	0	0	0	0	1
US 1124	0	3	0	7	1	0
Total	**0**	**3**	**0**	**7**	**1**	**1**
Percentage	0	25	0	58	8	8

Table 11. Fusion data for horse remains (n=12).
Bones are grouped into unfused elements (NF) and fused elements (F).

Information about mortality was available based on the fusion of the long bones. Out of the 29 bones, 12 could be used for age determination. The radius fragment of US 1156 belonged to an individual over 3-3.5 years of age. Based on two elements of US 1124 belonging to the hind leg of the same animal, one fused metatarsus and one unfused calcaneum, it can be said that this animal had died between the age of 15 months and 3 years. Other elements in this context belong to animals at least older than 15-24 months.

Withers height could be calculated for three specimens using the greatest length and the lateral length of the metacarpus, according to the method of May (May 1985; Groot 2010, 117).

Skeletal element		**GL (mm)**	**L1 (mm)**	**Withers height GL (cm)**	**Withers height L1 (cm)**
metacarpus	Right	213	205	127.5	131.3
metacarpus	Right	230	222	138.5	142.2
metatarsus	Left, with fragmented distal end	272	265	142.5	141.3

Table 12. Calculation of the withers height of horse (n=3), using standards given by May 1985.

These measurements seem to correspond with calculated withers heights from other Late Antique Italian sites, falling between 131.2 and 153.9 cm (De Grossi Mazzorin, Riedel, Tagliacozzo 1998, 91, Table 1). Interestingly, specimen 1124.11 is the fused metatarsus that belonged together with other tarsalia fragments, of which an age between 15-36 months could be calculated. So one of the horses on the site was a 15-36 year old individual with a withers height of 141.3-142.5 cm.
Sex could not be determined for the equid remains.

For donkey, only two teeth fragments were identified. Except for the presence of donkey on the site, not much information could be gained from these two fragments. Determination of age was attempted, but proved unsuccessful. In antiquity, the donkey was seen as a strong animal that could be used for severe and tough chores while requiring only little and simple feed (Toynbee 1973, 185-196). Possibly the animal here was used for that kind of heavy labour.

Cats and Dogs

The cat remains, consisting of 5 fragments, constituted only 0.6 % of the total NISP. In US 1124 one mandible with teeth and two fragments of the right hind leg were found, possibly belonging to the same individual. In US 1006 two fragments of the front leg were found, again possibly from the same individual. All these elements were fused and all the adult teeth were present on the mandible and had fully erupted, indicating that the cat remains probably belonged to adult individuals. No information of sex or size could be obtained. Domestic cats in Roman times were mostly used to catch rodents (Toynbee 1973, 90) and as these have similarly been attested on the site (see below), it is likely that these felines were kept for this purpose.

The dog remains consist of 4 fragments and constitute 0.4% of the total NISP. These remains consists of one mandible in US 1124 and a canine, a fragment of a metatarsus and a fragment of a pelvis in US 1006. All these elements belonged to adult individuals. No information about sex was available and unfortunately the elements did not allow for a reconstruction of size. Dogs could be used for multiple purposes in antiquity, including hunting, guarding, guiding sheep or as companion (Toynbee 1973, 102-134). The limited amount of material does not allow for a good interpretation of the use of these individuals.

Cats and dogs were generally not used for consumption in Roman times (Mackinnon 2004, 74), and the absence of butchery marks on the limited sample seems to confirm this.

Wild mammals

0.3 % of the total NISP belonged to wild mammal species. The identified wild mammals are fallow deer (one fragment of the cranium and one fragment of the tibia) and roe deer (one phalanx). Save from the presence of these animals, not much information could be gained from these three fragments. The limited amount of wild mammals in the sample conforms with the data known from Roman Italy, as in general these species take up only a very small part of the total archaeozoological remains. Most of the times these remains derived from hunted animals, brought to the sites for consumption, with deer generally one of the most commonly consumed wild animals on Roman sites (Mackinnon 2004, 190-191; 212-213).

Microfauna

Only 1 rodent bone was identified (0.1% of the total NISP). This femur fragment could be identified as belonging to a mouse species, but a more specific attribution was not possible. The distal end was unfused, indicating that this belonged to a young animal. Although some mice, specifically the dormouse, were kept and fattened by the Romans for consumption (Toynbee 1973, 203-204), this bone element should best be interpreted as an intrusive, presumably just an animal living on the site in the period that it was occupied, with its bones mixed with other human refuse after the animal had died (Gautier 1987, 49).

Birds

The bird remains constituted 8.5% of the total NISP, of which 5.9% could be identified as belonging to domesticated chicken, 1.6 % as belonging to galliforms[14] and 1% could only be identified as (wild) birds. From the element distribution (Appendix 2) it can be seen that most fragments belonged to either elements of the wings or of the legs. Especially the femur and the tibia, elements of the leg, are well represented.

Of the 53 chicken fragments, 28 were fused. Of the others no fusion data was available due to fragmentation. It would seem that most of the animals were of an adult age, although it should be noted that the bones of young chickens are generally less well preserved and often not noticed during excavations (De Cupere 2001, 32-33). Sex of chicken could be established based on the presence of

[14] More specific identification was not possible.

spurs on the tarsometatarsus of roosters (Groot 2010, 70). Ten tarsometatarsus elements of chicken were identified, of which 4 had a visible spur and could be identified as male. As the absence of a spur or signs of a spur does not necessary mean the bone is from a hen (De Cupere 2001, 33), and due to the fragmentation of the bones, the further elements could not be sexed.
Measurements of humeri of chicken[15] were compared to measurements from other archaeozoological contexts from Roman Italy (De Grossi Mazzorin 2005). From this analysis it seemed that the chicken on the site were similar in size to small and medium sized chickens from other Late Antique (fifth to eight century CE) contexts.

As meat of chicken was frequently consumed in Roman times (De Grozzi Mazzorin 2005, 353-355), the chicken remains are here, even with the absence of butchery marks, interpreted as consumption refuse. The other bird elements, including the galliforms, are not counted as remains of consumption, as too little sure information for this attribution could be obtained from their remains.

Fish and Molluscs

A total of 4 fish elements were identified (0.4% of the total NISP), two in US 1194 and two in US 1006. The three vertebrae and one mandible could not be attributed to a specific fish species.

Several fragments of molluscs were identified, contributing to 2.4% of the total NISP. Four different species of molluscs could be identified. For their distribution in the contexts see table 2 on page 44. *Murex sp.* is an edible Mediterranean gastropod that is primarily known for its use in the production of purple dye. The seven identified shells are however too small in number and not fragmented enough to be used for the production of purple dye, and consumption should rather be assumed (Reese 2002, 296-298; Alberti 2008). *Cardium sp.* is a Mediterranean cockle that is present in waters close by the shore and that was commonly used for consumption (Reese 2002, 299-300). *Glycymeris glycymeris*, dog-cockle in English, is another Mediterranean species that can be used for consumption (Reese 2002, 300-302). *Ostrea sp*., oyster, is an edible Mediterranean species that was consumed and even cultivated in Roman (and later) times (Reese 2002, 303).

[15] Greatest length (GL) and greatest breadth of the distal end (Bd) of three humeri (von den Driesch 1976, 117; De Grossi Mazzorin 2005), one from US1124 and one from US1006.

As Luni was located close to the sea and the identified molluscs are all Mediterranean species, it is possible that they arrived on the site due to floods or unintentional actions by humans, but as they are all edible species, it is similarly possible that they were brought to the site for consumption.

Fig. 13. Recovered mollusc remains from US 1124. From top to bottom, left to right: Murex sp., Cardium sp., Glycymeris glycymeris, Ostrea sp.

3.3.4. Butchery practices and animal consumption

In US 1156, US 1124 and US 1006 butchery marks were found on the bones of pig, cattle and sheep/goat. No marks were found on the material of US 1135 and US 1194, but this could be due to the small sample of the contexts. Only on a small portion of the bones butchery marks were found[16], and although slightly more butchery marks were found on pig bones, no significant difference can be seen between the three animal groups. The location and the type of butchery marks are represented in Appendix 3.

Both cut- and chop-marks are found, mostly on the distal or proximal ends of the bones. Marks on the scapula and pelvis indicate slaughtering patterns where the legs were separated from the torso. Marks on humerus, radio and ulna elements, and on femur and tibia elements, indicate the further division of the legs into smaller pieces of meat. Marks have also been found on phalanxes, indicating that the feet was similarly separated from the rest of the leg. Several vertebrae were found chopped in half, longitudinally (see fig. 16), possibly indicating that the carcass was divided into a left and a right halve (MacKinnon 2004, 163-171). On one sheep/goat atlas a deep chop mark was found (see fig 17), which can possibly be related to the slaughtering of the animal by a blow to the neck.

Fig. 14. Pig vertebrae, longitudinally chopped in half, from US 1124

Fig. 15. Ovicaprine atlas with a chop mark from US 1124

[16] Of the total bones of pig, cattle and sheep/goat, 1% contained butchery marks in US 1156 (n=1), 10% in US 1124 (n=36) and 6% in US 1006 (n=16). So a total of 53 bones contained butchery marks.

For an idea of the consumption of meat on the site, a comparison is made of the relative presence of the main consumed species, namely sheep/goat, cattle, pig and chicken. For this comparison three different methods are used to allow for a more detailed analysis, as they all represent different data. The NISP represents the number of excavated (and identified) remains per species, the MNI represents the (minimum) number of animals on the site and the bone weight represent the contribution of the different animals to the diet, as the bones of animals that carry more meat, like cattle, are heavier than the bones of medium-sized animals with lesser meat (Groot 2010, 109-111).

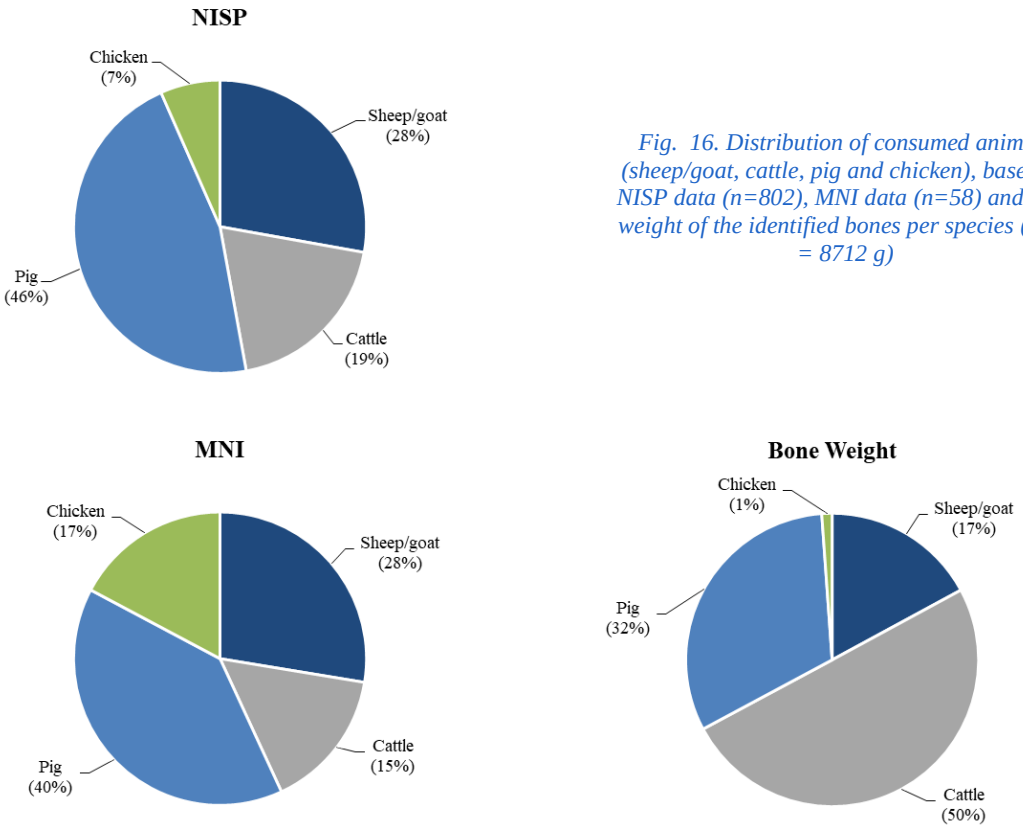


Fig. 16. Distribution of consumed animals (sheep/goat, cattle, pig and chicken), based on NISP data (n=802), MNI data (n=58) and total weight of the identified bones per species (total = 8712 g)

A comparison of the NISP of these species show that pig is the most abundant animal, followed by sheep/goat, cattle and chicken. When the MNI data is considered, pig and then sheep/goat remain the most abundant, but chicken has surpassed cattle. So although fewer chicken remains were uncovered[17], chicken and cattle seem to have been present in about the same amount on the site.

[17] This can be explained because chicken bones are more fragile and smaller than cattle bones (and other mammal remains), causing them to be more susceptible to taphonomic processes and be more often overlooked during excavations (De Cupere 2001, 32).

The total bone weight per species[18] shows that cattle, instead of pig, takes up the biggest amount. Although fewer individuals were present or brought to the site, their meat probably had a greater contribution to the diet that the meat from the other animals, as one cow contains more meat than a single pig. Pig does still take up about a third of the total bone weight, while sheep and goat only contribute to 17%. Chickens, with their light bird bones, take up only a very small percentage of the total bone weight.

Aside from the bone weight, it is possible to calculate the contribution of each animal to the meat consumption by comparing the average amount of meat each animal contains. For this calculation meat weight constants have been established for sheep/goat, cattle and pig[19] in Roman Italy, respectively 27.5 kg, 200 kg and 50 kg per individual. By multiplying these constants with the NISP and/or the MNI a better representation will be given of the relative amount of meat each species will have delivered (Mackinnon 2004, 189-196; 228-233).

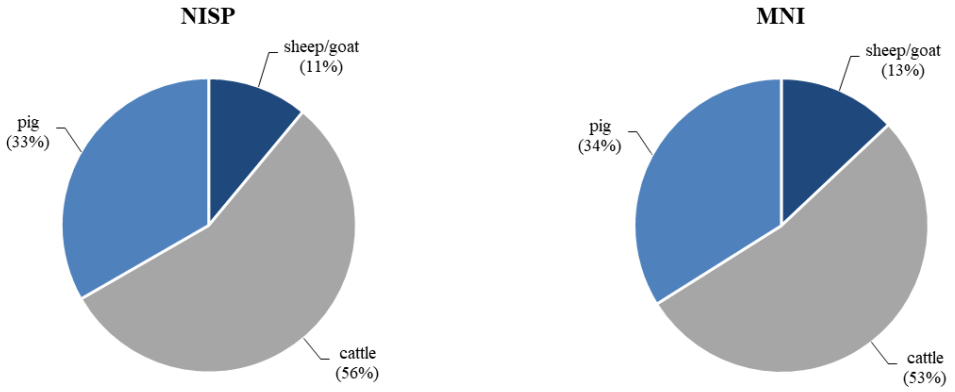


Fig. 17. Relative meat contribution of sheep/goat, cattle and pig, based on meat weight estimates calculated with NISP and MNI data

From these calculations come forward that cattle will have contributed to more than half of the meat consumption on the site, while pig contributed to about a third and sheep/goat only to 11-13%. Chicken will also have been consumed, but only in small amounts compared to the other animals. Presumably, just like sheep and goat, they were primarily used for their secondary products and therefore of inferior importance for their meat compared to pig and cattle.

[18] Teeth and horn were excluded from the weight calculations.
[19] Chicken has been left out of these calculations, as not mea weight constant was available for this species, and as their remains probably constituted only a small percentage of the total meat weight.

3.4. RESULTS: THE ANIMALS AT LUNI

Analysis of the archaeozoological material has provided an insight in the presence and use of animals on the site of Luni, *Domus presso Porta Marina*.

The most common animals on the site are sheep/goat, cattle and pig, with pig the most abundant species. This species was primarily used for consumption and it seemed that most pigs were killed when they had reached their maximum weight and would have provided the most meat. Interestingly, their abundance seems to correspond with the theory that pig predominated in the more northern Roman regions (including northern Italy), where they were boiled or cooked in closed cooking pots, resulting in a tender, broth-like dish ideal for colder climates (Arthur 2007). This was confirmed by the ceramic material, as the majority of the cooking ware found on the site were closed cooking pots (Menchelli et al. forthcoming(b)). After pig, sheep and goats were the most numerous animals on the site. While used for consumption, their meat was presumably of secondary importance as it is suspected that their wool, hair and milk will have been the primary reasons these animals were kept. Cattle, while not as numerous in number as pig, sheep and goat, had the highest contribution to the consumed meat on the site, as a single individual could provide for a large amount of meat. It is possible that some of the older animals might have served as a working animal.

Besides these three main domesticated animals, horse and donkey were identified, and some cats and dogs seem to have been present on the site. These animals will not have been consumed, but probably served to aid the occupants of the site with labour, transport, guarding or keeping away small pests. Wild animals were only present in small amounts, but include two species of deer, possibly hunted, and one small rodent. Bird remains have also been recovered, of which the majority belonged to domesticated chicken. Influence from the nearby sea can be seen in the presence of a few fish remains and several molluscs species, all Mediterranean and edible.

Other archaeozoological material from Luni has been published for the excavations in the forum area of the city[20]. The Roman material is derived from one context dated to about 200 A.D. and four

[20] Aside from this published material, archaeozoological remains from Luni have also been studied by Judith Cartledge and presented in her master thesis: Cartledge J., 1979. Faunal studies in northern Italy, Master Thesis, Department of History and Archaeology, University of Sheffield (Ward-Perkins 1981a, 183). Unfortunately, due to various circumstances, this thesis is not readily available and could not be used in this study.

contexts of Late Antiquity (300-700 A.D.)[21]. As with the material presented above, the animal remains show that pig, sheep/goat and cattle were the most abundant animals. From the data it was concluded that sheep and goats were kept for their secondary products, with the animals grazing in the nearby coastal plain and mountains. Cattle was either slaughtered at a young age for its meat, or kept as a work animal and killed at an old age. Pigs were consumed before they reached the age of 3 and were probably kept in pastures near the city (Barker 1977). It has been noted that in Late-Antiquity many chestnuts were planted on the hills surrounding the city, which could have been used for the pasturing of pigs (Ward-Perkins 1981a).

The context from the Imperial period allows for a comparison of the animal remains between Imperial times and Late Antiquity. The three groups of domesticated mammals were compared, as these constituted the majority of the animal remains and can give insight in changing patterns of animal consumption.

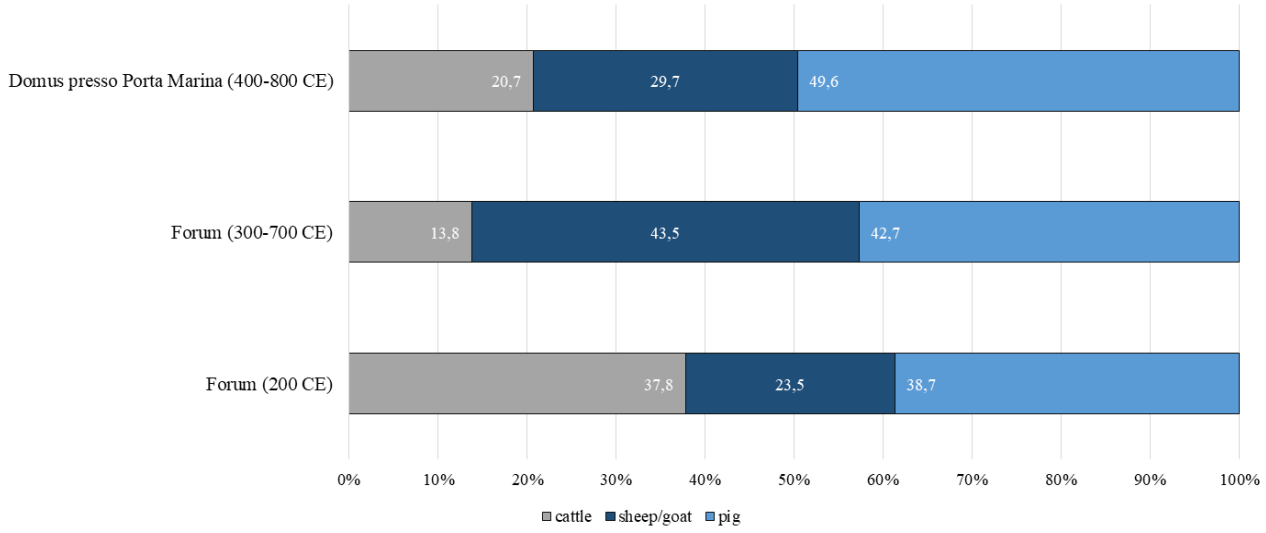


Fig. 18. Comparison of the distribution of cattle, sheep/goat and pig in the city of Luni. The data is based on the relative NISP percentages of these three groups of animals, derived from the Imperial forum context (n=106 (total NISP for cattle, sheep/goat and pig)), from the Late Antique forum contexts (n=1,526) and from the Domus presso Porta Marina contexts (n=750).

[21] Three other contexts were also published, but these are dated to later centuries and therefore fall outside the scope of this study.

From this analysis, it can be noted that the amount of cattle reduces over times, while the amount of pig, sheep and goat increases.

The increase of sheep and goat in Late Antique Luni can possibly be viewed in the same light as the previous described developments in Sagalassos and Justiniana Prima (Chapter 2.3). Growing insecurity and the willingness to control their own resources caused people to give preference to sheep and goat over cattle, as these smaller animals were cheaper, easier to maintain and to transport and could provide more than just their meat (De Cupere 2001, 139-145; Degryse et al. 2004; Vanhaverbeke, Martens, Waelkens 2007; Baron, Reuter, Marković 2018). Cattle were expensive animals to purchase and to maintain and therefore valuable to loose. Sheep and goat on the other hand do not require rich pasture or a lot of water, can be kept close to the city or moved to other places if needed, and can provide for milk and wool/hair in addition to their meat. Similarly, pigs do not necessary require any pasture, can even be kept inside of the city and can provide for an ample amount of meat that is relatively easy to preserve (Mackinon 2004, 95-96; 121-123; Baron, Reuter, Marković 2018, 9-14). In changing times people might have been persuaded to rely more on these smaller mammals that could adapt easier to changing circumstances.

In Late Antiquity the city of Luni experienced a reduction of long-distance trade and therefore a diminishment of its resources. Power over the city moved from Roman to Byzantine to Lombard control and areas of the city were abandoned as habitation moved to the cathedral and presumably only a limited amount of residences remained in the rest of the urban area (Ward-Perkins 1977; Ward-Perkins 1981a; Ward-Perkins 1981b; Delano Smith et al. 1986; Ward-Perkins 1997; Potter 1992, 211-219). It is likely that parts of the city that were now no longer occupied were used for cultivation, or for the pasture and keeping of sheep, goat and pig. The increase of sheep and goat, and of pig, in Luni can be related to the process of ruralization, as the city became less densely inhabited, impoverishment of the city and reduction of trade caused the inhabitants to rely more on local resources and as tensions between different groups in power may have created additional reasons for keeping these smaller, easier manageable species, presumably in close distance to the city.

4. A BROADER ARCHAEOZOOLOGICAL VIEW: CONTEXTS FROM CENTRAL ROMAN ITALY

An analysis of other archaeozoological contexts from Roman Italy can provide an insight in animal use throughout the Roman period and can confirm if the situation noted in Late Antique Luni corresponds to or rather deviates from the general pattern. Additionally, it can provide information about possible trends and changes in animal use throughout the transition from Imperial times to Late Antiquity.

4.1. CURRENTLY KNOWN ARCHAEOZOOLOGICAL CONTEXTS

In order to obtain a dataset for the comparison and analysis of the archaeozoological remains, a list has been compiled of archaeozoological contexts that are currently known (and published) from Roman sites on the Italian peninsula. Similar lists have previously been published by Anthony King, in a comparison of mammal bones across the Roman Empire, with emphasis on diet and therefore pig, goat, sheep and cattle remains (King 1999), and by Michael Mackinnon, who has produced a detailed analysis of zooarchaeological remains for Roman Italy in his study (Mackinnon 2004). The work of Mackinnon consists of a total of 97 sites with data collected both from published works and from unpublished studies by himself and other researchers (Mackinnon 2004, 37-39) and has been taken as the foundation on which this study will build.

To create a reasonable data sample, the study area was delineated to central Roman Italy, as here the majority of the archaeozoological contexts were found (Mackinnon 2004, 37) and as this would include both the case study Luni and important urban centres like Rome and Pompeii. The area that is here taken as central Italy consists of the current Italian regions which are separated from the north and the south of the peninsula by the Apennine Mountains, namely Liguria, Toscana, Umbria, Marche, Lazio, Abruzzo, Molise and Campania (following Mackinnon 2004, 33-34).

To the 57 central Italian sites presented in MacKinnon's study (Mackinnon 2004, 38-40), another 42 sites have been added. These sites were derived from more recent publications, dating between 1990 and 2018. An overview of the complete list of central Roman Italian sites, a total of 99, with

reference to the publications from which the data have been derived[22], can be found in Appendix 5. For the geographical location of the sites, see fig. 21.

As this list of zooarchaeological sites is in fact a continuation of Mackinnon's list, a large part of the terms and definitions he used will be similarly used here. For a more detailed comparison of the data, the sites[23] are also grouped into a settlement/site type, a specific time period and a geographical location.

The sites are divided into four different types, primarily based on the definition of the city in the publications and reports, in some cases supplemented by factors as size and status. Firstly, a distinction has been made between *rural* sites, and sites located in the urban environment. Of the sites located in the urban environment, two types were recognized. *Urban 1* sites are the settlements that in Roman times had been given the status of *municipium* and contained certain elements like a forum, public buildings, fortifications and an aqueduct. Their influence and size may have differed throughout the centuries and need not have been exactly similar as another urban 1 site. Any other settlement or site within an urban environment, often with an unknown status, is grouped as an *urban 2* site. In many cases this category includes sites which have been identified as a village or as a smaller settlement in the suburban environment of a larger city. The last type, the *special* sites, include (ritual) deposits, burials, sometimes of specific animals, and sanctuaries. The *special* types form a separate category, as they do not always give information about food consumption or economy and often have a specific selection of animal remains (Mackinnon 2004, 32-33).

Because some sites are fairly accurately dated to a specific century and others can only generally be appointed to a specific period, and because some cultural periods are not always chronologically similar over the whole of Italy, three general time periods have been created into which the different sites are grouped. The *Republic period* covers the years from *500 till 50 BCE*, the *Imperial period*

[22] For the unpublished reports there will be referred to Mackinnon 2004, with reference of the listing of this report in his publication. Data from unpublished reports have been derived from Mackinnon 2004, as it was not available elsewhere.

[23] The names of the sites names are either derived from their location or the way the site is called in the excavation reports.

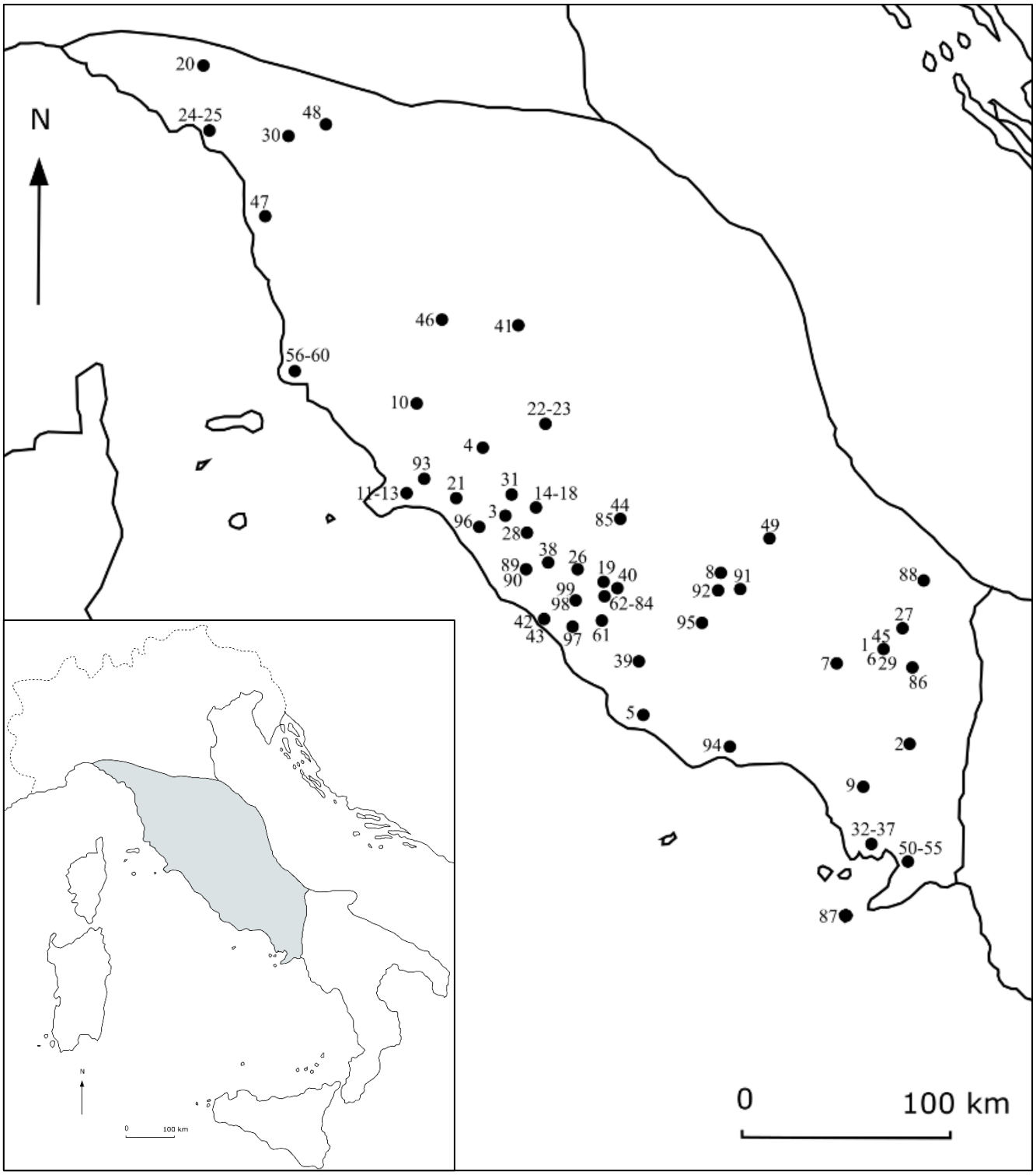


Fig. 19. Location of the 99 analysed Roman sites in Central Italy. Names and additional information about the sites can be found in Appendix 5.

ranges from *50 BCE till 300 CE*, and *Late Antiquity* is seen as the period from *300 till* 500 CE[24] (Mackinnon 2004, 35-36). In light of this study, the Late Antique period shall be broadened till *800 CE*, in order to gather more Late Antique data and to include the complete period of interest.

In some cases sites were used over multiple centuries and the excavated archaeozoological remains belong to multiple of the above mentioned time periods. When possible, if information was given in the publications on specific chronology of the remains or excavated contexts from which they derived, the data was grouped into the corresponding time period. Some sites therefore include different time periods. To avoid confusion, the datasets belonging to a certain time period are labelled as *contexts* within a certain site (Mackinnon 2004, 56). The site of *Campochiaro*, for instance, has two different contexts, one dating to the first period and the other dating to the third period. Similarly, the site of *Pompeii, House of Amaranthus* has two contexts because one contains the remains of a ritual deposit, a *special* deposit, while the rest of the data corresponds to the surrounding *urban 1* settlement. So while 99 sites make up the list in Appendix 2, in fact a total of 127 contexts are analysed and compared in this study.

Lastly, the sites are grouped according to the current Italian region in which they are situated. These eight regions of central Italy are largely similar to the regions in Roman (Augustan) times (Mackinnon 2004, 33). As it is not always certain to which region a site belonged in antiquity, it has been chosen to look at the current geographical location and therefore the current region in which the site is situated. It is noted that the archaeozoological sites are not evenly situated across central Italy, as 51 sites are located in Lazio (of which 22 in Rome), 17 in Toscana, 15 in Campania, 8 in Molise, 4 in Abruzzo, 2 in Liguria and 2 in Umbria, and none in Marche. This can possibly be explained due to the interests and focus of different archaeozoologists and the availability of the data. A lot of publications were for instance available from Jacopo De Grossi Mazzorin, who has done extensive research in Rome. All sites located in Molise were uncovered and researched in the Biferno survey project (Barker and Clark 1995; Mackinnon 2004, 37-39), without which no archaeozoological site in Molise could have been added to the current list.

[24] In order to allow comparison with Mackinnon's data, the period 300-500 CE is used instead of the 200-500 CE period of Late Antiquity as described in the introduction.

4.2. COMPARISON OF ARCHAEOZOOLOGICAL REMAINS

For the analysis of the animal remains and in order to distinguish certain trends during the transition from Imperial times into Late Antiquity, it is necessary to find datasets that are comparable between different sites. Therefore a method of quantification is needed that is commonly used amongst different researchers. In the case of the archaeozoological record, this is the NISP quantification method. NISP is the *number of identified specimens* per animal species, a count of the total number of bone fragments that could be identified as belonging to a certain animal species (Reitz, Wing 2008, 202-205; Groot 2010, 109-110;). The NISP numbers were recorded for (almost) each context in the list and can offer a good comparison between the relative quantity of animals in and between contexts (Mackinnon 2004, 61-62). In Appendix 6 the NISP data for the different contexts can be found. The total NISP count of the contexts has been given, together with the according NISP data for the mammal, bird, fish, reptile and amphibian remains.

It should be noted that the numbers given in the table are approximate. As mentioned by Mackinnon, the total number of bones that were excavated, including the fragments that could not be identified, were not always recorded in the excavations reports. In some cases, only mammal bones were recorded, without making mention of the other animal classes (MacKinnon 2004, 56). Only identified animal bones have been included in these NISP counts. Molluscs and invertebrates have been left out, as have the remains that could only be identified on a general level (belonging to a small, medium or big animal, not more specific). [25] The attempt has been made to be as complete as possible with the collection of the data, but due to the availability of the data and/or the way in which it was published, this was not always achievable. In the appendix the abbreviation *na* has therefore been included to indicate when the data was not available.

A comparison of the percentages of NISP for the different classes of animals can give an indication of the animal remains that are found in the contexts of central Roman Italy (see fig. 22). The majority of the animal remains belong to mammalian species (91%), while only a small portion of bird remains, and even less fish, reptile and amphibian remains, are recovered on the Roman sites. When the data is considered only for the specific kinds of contexts, either urban 1, urban 2, rural or special,

[25] This can only be said with certainty for the contexts added for this study, but not surely for each site that was studied in Mackinnon 2004, as it was not possible to re-examine each of the studied sites (like the unpublished reports).

the same trend can be seen. Mammal remains clearly predominate, the bird remains constitute between 7.0 to 8.4% of the animal remains (with an exception of the urban 2 contexts), while the fish, reptile and amphibian remains together occupy only 1.2 to 2.7 % of the total recovered remains.[26] No remains of these last three classes have been recorded in the seven urban 2 contexts, but there seems to be some bias here because of the low number of urban 2 contexts in the database. When the three other types of contexts are considered, it seems that all of them have at least the same amount of contexts where no fish, reptile and amphibian remains are recorded.[27]

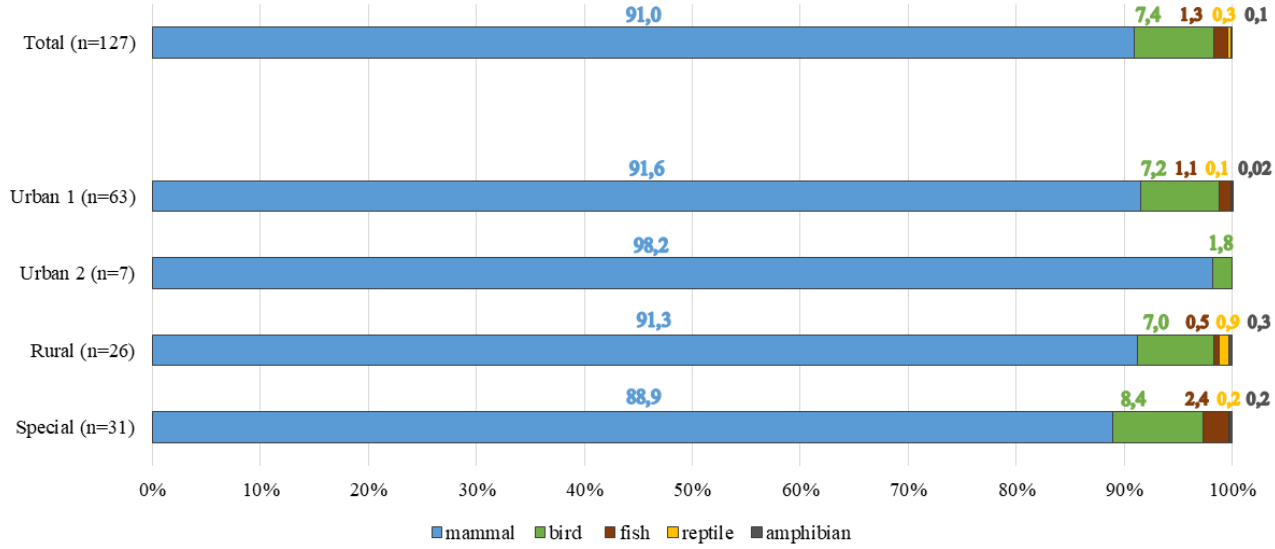


Fig. 20. Percentages of mammal, bird, fish, reptile and amphibian remains for central Roman Italian contexts, based on the NISP data. The number of contexts used in the analysis is indicated next to the type of site.

As the mammal remains take up the biggest percentage of the recovered (and recorded) animal remains of Roman sites in central Italy, a further analysis of the NISP for different mammal species has been carried out (see Appendix 7 and fig. 23).

The most common animal in every type of context is the pig, followed by sheep/goat and by cattle. The remaining animals make up only 14.2 % of the total mammal remains (between 4.0 and 28.3% when specific context types are considered). The special contexts show a higher percentage of these

[26] These small amounts can partly be explained by the small size of many bird, fish, reptile and amphibian species compared to mammals, causing the remains of these animals to preserve in lesser amount, to be less recognizable during excavations and to be harder to identify.

[27] 18 urban 1 contexts, 8 rural contexts and 13 special contexts have no recorded remains of fish, reptiles and amphibians.

other animals, especially dogs, when compared to the other three types of contexts. This can be explained when the nature of the special contexts is considered, as these in general do not conform to the general pattern and more often reflect cultural and ritual practices instead of food consumption and husbandry techniques (Mackinnon 2004, 33; 121; 142; 192; 201-204). For instance, 4 out of 32 special contexts are dog burials, where (nearly) all of the remains are made up of dog bones, thereby contributing to the high percentage of dog remains for the special contexts. Rural contexts also show a higher percentage of other animals, including dogs and wild animals. Dogs were possibly more frequently kept (and buried) on rural sites as hunting dogs, guard dogs or for sheep herding (Toynbee 1973, 102-134). Wild animals were in general more consumed at rural settlements and therefore make up at greater part of the animal remains in the rural contexts than in the urban or special contexts (Mackinnon 2004, 60; 212; 244).

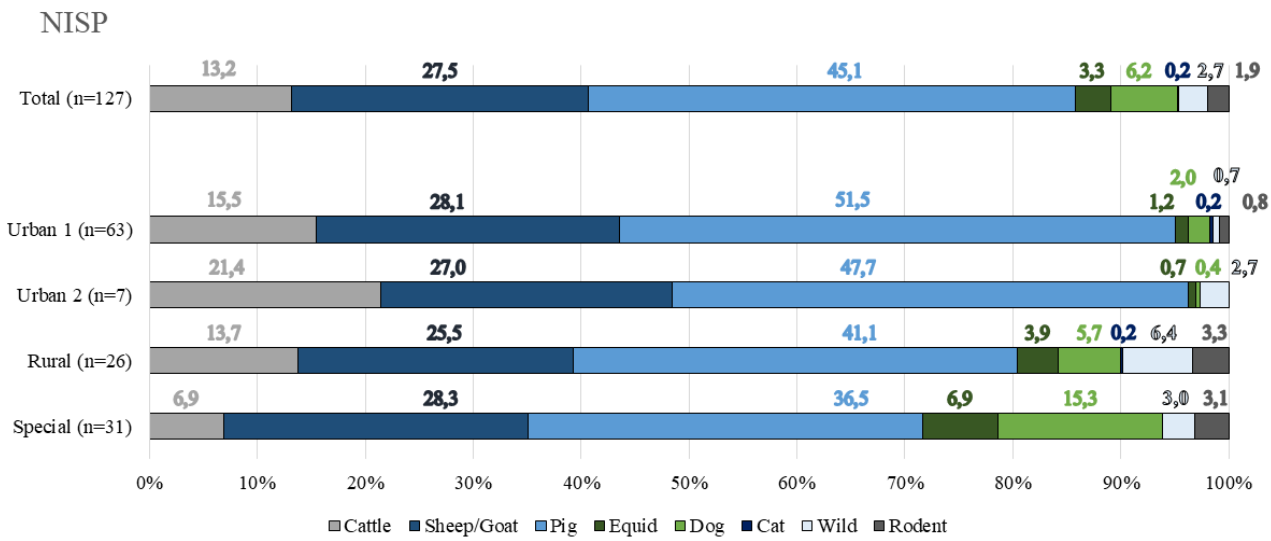


Fig. 21. Percentages of mammalian species for central Roman Italian contexts, based on NISP data. The number of contexts used in the analysis is indicated next to the type of site.

Another method for the quantification of animal bones is the determination of the MNI, the *Minimum Number of Individuals*. Here the amount of left and right elements of the identified bones are considered to calculate the minimal number of individual animals that will have contributed to the creation of the archaeozoological collection of a certain context (Reitz, Wing 2008, 205-210; Groot 2010, 110-111). The MNI data is presented in Appendix 8 and in fig. 24.

When the data from the MNI counts is considered, similar patterns are visible as with the NISP count. Pigs take up the highest percentage, followed by sheep and goat and by cattle. These three groups of animals still take up the majority of the animal remains, but in the MNI count the percentages of the other animal groups are higher. This is due to the fact that with MNI a single fragment will always contribute to an MNI of 1, while multiple fragments of different skeletal elements can similarly contribute to an MNI of 1, therefore causing species of which less elements are present in the contexts to be represented in higher frequencies than would be the case with NISP counts (Groot 2010, 110). Whilst MNI does show similar patterns, it was only recorded for 74 out of the total 127 contexts. MNI is a quantification method that is less frequently used, or in any case less frequently mentioned in published reports for Italian zooarchaeological studies (Mackinnon 2004, 61), and is therefore not further considered for this study. Similarly, as calculations of the meat weight (as in Chapter 3.3.4) are rarely represented in publications (Mackinnon 2004, 189-190; 227), these are not further considered here.

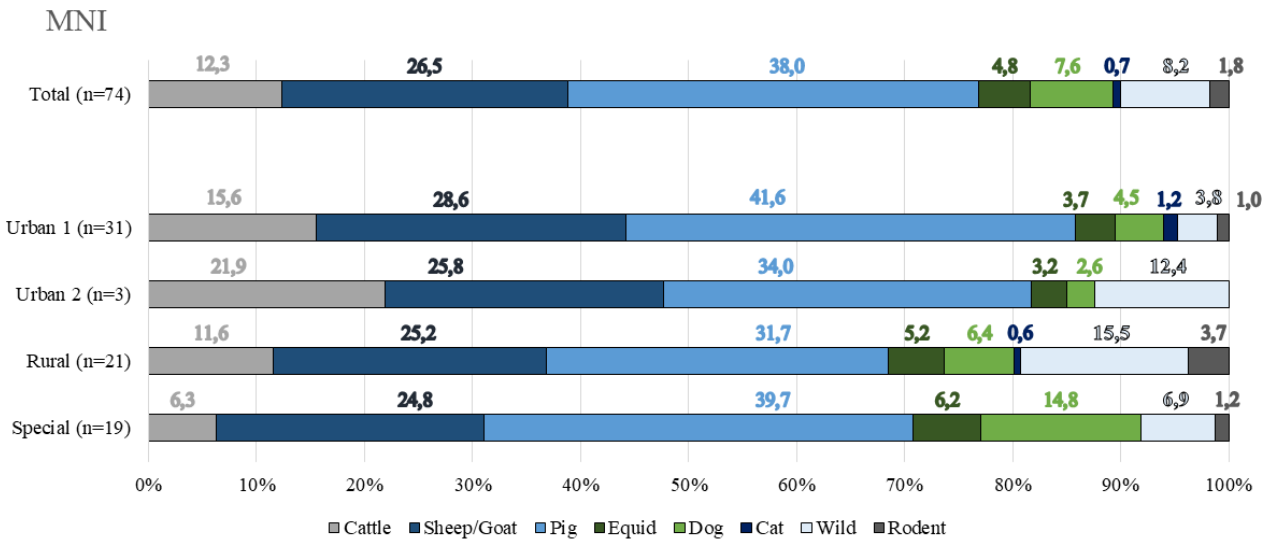


Fig. 22. Percentages of mammalian species for central Roman Italian contexts, based on MNI data. The number of contexts used in the analysis is indicated next to the type of site.

The three types of data presented above, the NISP counts for the different animals classes and specified for the mammalian species, and the MNI counts for the mammalian species, show that the most frequent animals found on archaeological sites in central Roman Italy are pigs, sheep and goats, and cattle. This trend, and the greater abundance of mammals, was previously noted by

Michael Mackinnon (Mackinnon 2004, 61; 74), and now seems to be confirmed by the addition of archaeozoological contexts of recent years. These four species formed an important part of daily life and diet in Roman times and were an essential resource in antiquity (Mackinnon 2004, 74; Salvadori forthcoming). Therefore the presence of these animals throughout Roman times and into Late Antiquity shall be analysed in more detail.

4.2.1. Presence of cattle, sheep/goat and pig on central Roman Italian sites

The relative percentages of pig, sheep/goat and cattle has been calculated for the studied contexts based on the available NISP data (see Appendix 9).[28]

To gain a general idea of the relative presence of these animals on central Italian sites, their numbers have been compared for the three time periods under study (Republic, Imperial and Late Antiquity), together spanning the time from 500 BCE till 800 CE.

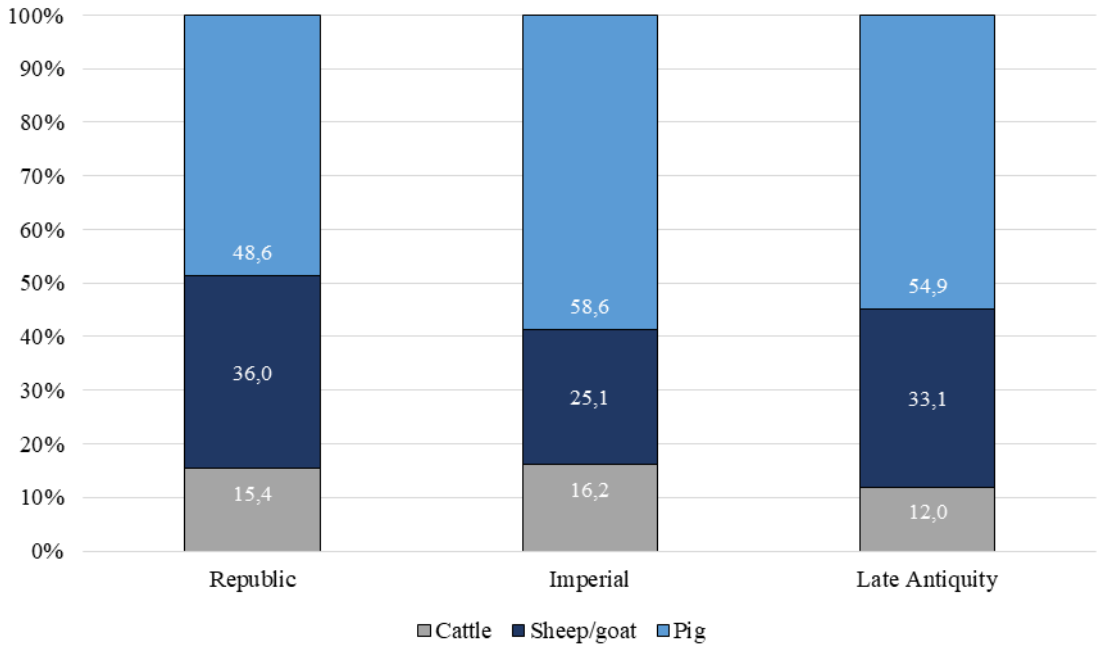


Fig. 23. Distribution of cattle, sheep/goat and pig on Central Italian sites throughout Roman times, based on NISP from a total of 122 contexts.

[28] Five contexts (Fidene, Musarna, , Nomentana, Pompeii 94 and S. Angelo di Civitella) have been left out of these calculations, as no NISP data for pig, sheep/goat and cattle was available for these sites.

In general a pattern can be seen when looking at the changes in the pattern from Imperial times into Late Antiquity.[29] There is a decrease in the amount of cattle and in the amount of pig, while the amount of sheep and goat seems to increase in the Late Antique period. This pattern would seem to correspond with the ideas of the changing times of Late Antiquity and the possible processes of ruralization and insecurity that have been discussed in Chapter 2. With the continuing changing patterns of power and control in Late Antique Italy, with frictions between the Romans, the Ostrogoths, The Byzantines, the Lombards and the Franks, and the battles that sprung forth from these, the feeling of unity in the peninsula will have fallen away and an increasing sense of insecurity will be felt amongst the local people (Wickham 1981; Brogiolo 2000; Arthur 2004; Cirelli 2013). As in other regions of the former Roman Empire, like the Balkans and Anatolia, sheep and goats might be favoured over cattle as those species are not as sensitive to reduced resources, less costly to maintain, less valuable to loose, easier to keep close to town and to move when needed, and can furthermore provide for multiple secondary resources as milk, cheese, wool and hair (De Cupere 2001, 139-145; Degryse et al. 2004; Mackinnon 2004, 95-96; 121-123; Vanhaverbeke, Martens, Waelkens 2007; Baron, Reuter, Marković 2018). Pigs are similarly easier to maintain, even within the urban environment, but as pigs are primarily used for their meat (De Cupere 2001, 143; Mackinnon 2004, 153-156; Baron, Reuter, Marković 2018, 14), this might explain why in a less secure time preference is given to species that can provide multiple useful products.

A more detailed analysis of the data is required to discern if this general pattern is also applicable when more specific situations are regarded. An analysis of the percentages of cattle, sheep/goat and pig has therefore been carried out for the four specific types of contexts, in order to see if this pattern could also apply to urban environments and the ruralization of the city.

[29] Focus will be put on these two periods and changes from Republican times into Imperial times will be represented but not discussed, as they fall outside the scope of this study.

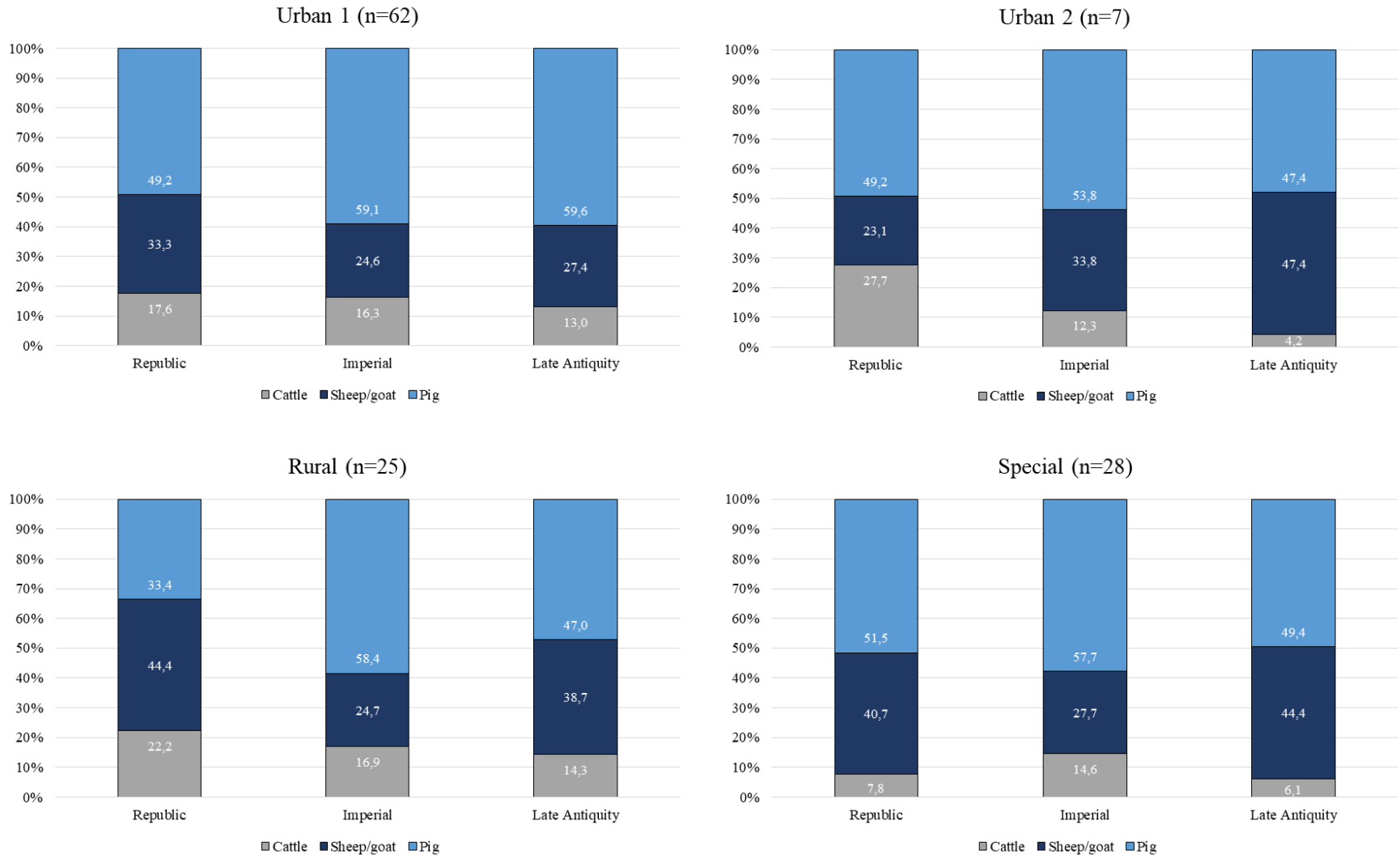


Fig. 24. Distribution of cattle, sheep/goat and pig throughout Roman times on urban 1, urban 2, rural and special sites in central Italy, based on NISP data from a total of 122 contexts.

When comparing the different settlement and context types an overall decline in the amount of cattle in Late Antiquity can be noted, most pronounced in urban 2 and special contexts (decline of 8-9 %) and somewhat less prominent but still visible (-3%) in urban 1 and rural contexts. Additionally, an overall increase in the amount of sheep and goat seems to have occurred from the transition of Imperial times to Late Antiquity. While only a slight increase in urban 1 contexts (+3 %), the others contexts show an increase of 14-17 %. The amount of pig seems to diminish during Late Antiquity in urban 2, rural and special contexts (6-11 % decrease), while it seems to remain more or less the same in urban 1 contexts (0.5 % increase).
The decrease in cattle does not appear to be limited to the transition to Late Antiquity, but is in fact visible throughout the Roman period (500 BCE – 800 CE). The only exception here are the special contexts, but, as noted before, these contexts reflect specific cultural and religious practice and not the general pattern of economic and food management strategies (Mackinnon 2004, 33; 121; 142; 192; 201-204).

To further study this pattern, an analysis of the relative percentages has likewise been carried out for the specific geographical regions of central Italy (see fig. 27). The regions of Abruzzo, Liguria, Molise and Umbria have been left out of this analysis, as the total number of contexts for these regions[30] fell under the amount of 10 and was therefore deemed too small for a proper and reliable analysis. Special contexts are not included here, so as to exclude the influence from religious and cultural practices.
Again, a decrease in the amount of cattle can be noted from Imperial times to Late Antiquity in all three studied regions. However, an overall decrease throughout Roman times is only visible for Lazio, as in Campania and Toscana a slight increase of cattle is noted in Imperial times, to be followed by a decrease in Late Antiquity. The amount of sheep and goat seems to increase in all three regions in Late Antiquity (3% in Campania, 4% in Lazio and 10% in Toscana). The percentages of pig, however, show an increase of 1% in Campania, but a decrease of 2% in Lazio and of 9% in Toscana.

[30] Abruzzo (n=1), Liguria (n=3), Molise (n=7), Umbria (n=3). Marche has been excluded from the total study as no zooarchaeological contexts were found in this region.

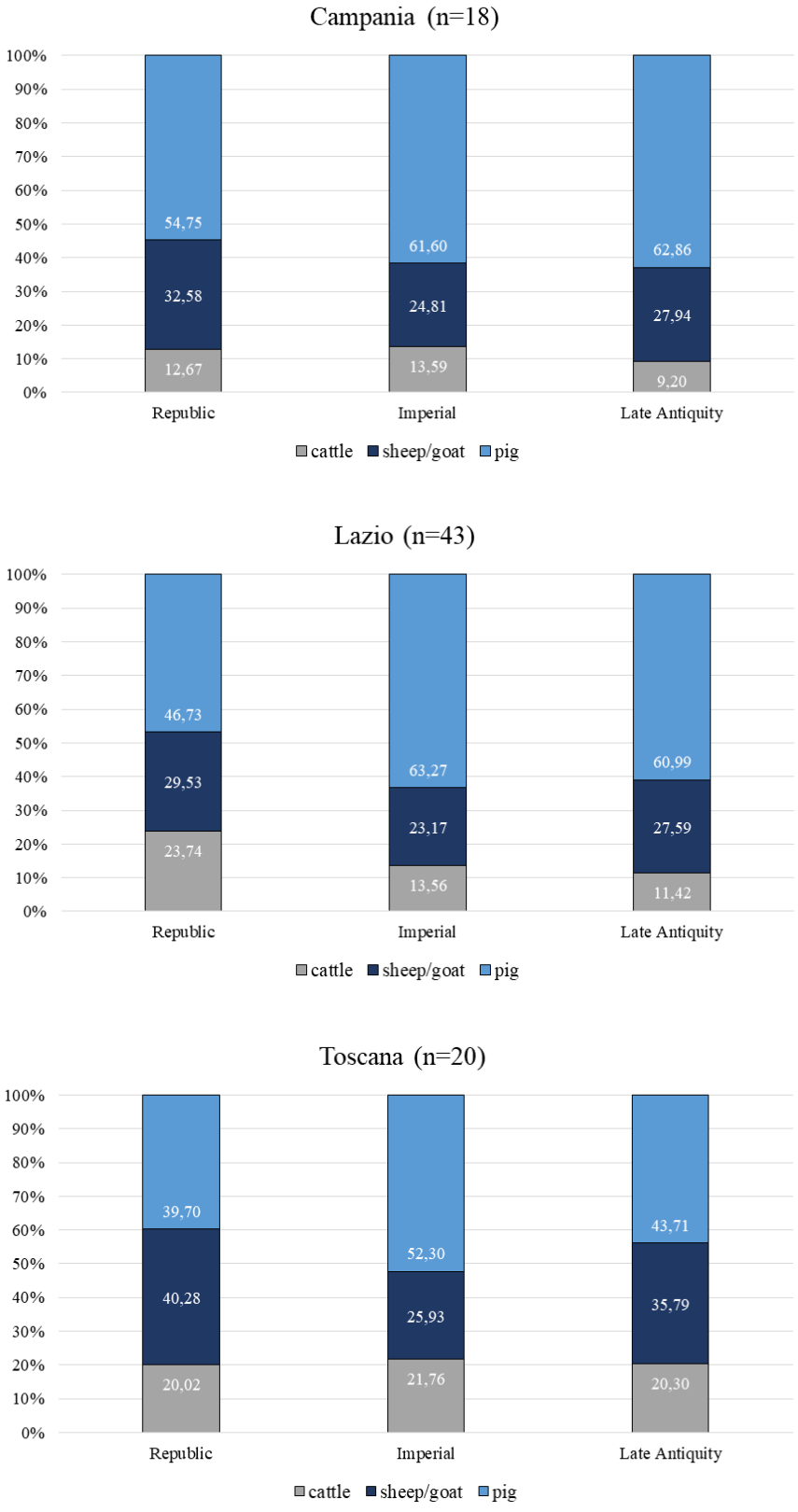


Fig. 25. Distribution of cattle, sheep/goat and pig throughout Roman times on sites located in Campania, Lazio en Toscana, based on NISP data from a total of 81 contexts.

Except for the percentages of pig, the same broad pattern of a decrease of cattle and an increase of sheep and goat in Late Antiquity is visible from the regional studies. A thorough regional analysis however, including more detailed analysis of the diverse trends for pig, does not yet seem fully possible at this point. First and foremost, there is an uneven division of the found and published archaeozoological contexts throughout Roman Italy. While some regions contain over 50 contexts, other have less than 5 or even none. The division of types of contexts in a specific region is similarly not equalled divided, especially in Lazio where 33 out of 56 contexts are grouped as urban 1, and out of these, 22 contexts are situated in Rome alone. An attempt to compare coastal and inland contexts proved equally unreliable, as there are often only a few coastal contexts available for a certain period or type of site, compared to double, triple or even six times the amount of inland sites. Italy is a land with diverse geographical and natural conditions (Arthur 2004, 103-105) of which the comparison in relation with the archaeozoological material could offer intriguing and interesting results, but at this moment more contexts are needed so that multiple regions can be reliably compared to one another.

As the focus of this study is on the transformations in the urban environment during Late Antiquity and the changes in the city compared to the Imperial period, a specific look at the percentages of cattle, sheep and goat, and pig in urban 1 contexts is required. The general pattern of an increase of sheep and goat and a decrease of cattle seems to hold true when all urban 1 contexts together are considered, as seen above (fig. 26), but it is the question if this remains true when cities are considered separately. It has been discussed in Chapter 2 that cities react in their own way to changing circumstances and that different sets of factors will cause different transformations within a single city (Liebeschuetz 1992, 16-17; Cameron 1993, 157-162; Wickham 2005, 10-13; Christie 2006, 185; Zavagno 2009, 15-16; 169-170; Dey 2015, 8-10). It is therefore to be expected that not every city will conform to this general pattern and that different developments might emerge when the data for single cities is analysed. To increase reliability and to ensure for a large enough sample, only contexts with a total NISP above 100 have been included in this analysis. Of 6 different cities contexts were available to allow for a comparison of the pig, sheep/goat and cattle remains from the Imperial period and Late Antiquity.

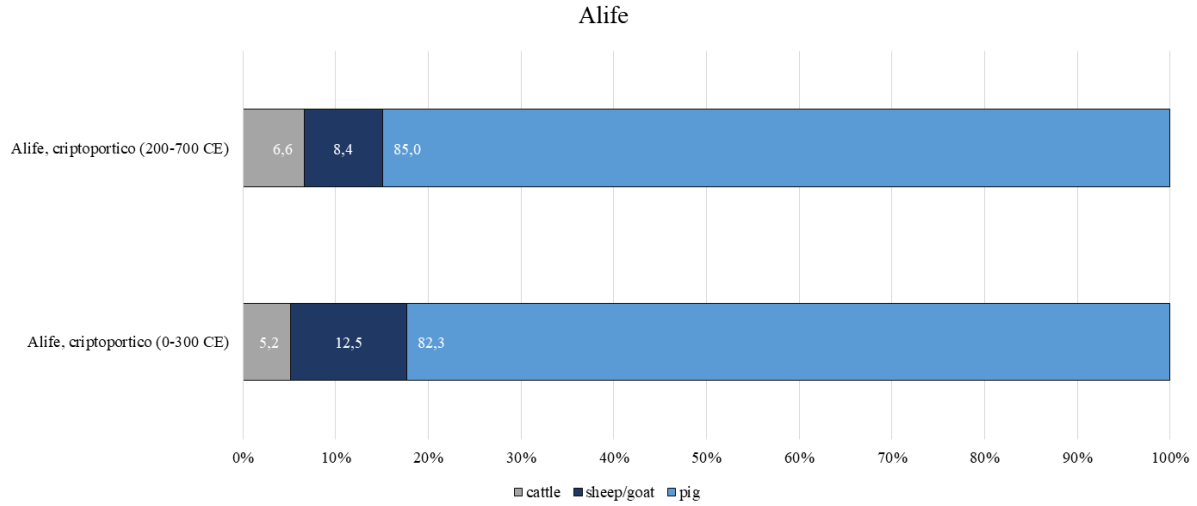


Fig. 26. Distribution of cattle, sheep/goat and pig from the Imperial period to Late Antiquity in the city of Alife, based on NISP data from 2 contexts

In the Campanian town of Alife, the data shows an increase of cattle, a decrease of sheep and goat and a slight increase of pig in Late Antiquity. This information is derived from a single site, the *cryptoportico*, of which the faunal remains could be divided into two contexts, one dating from the first to third century CE, the other from the third till the seventh century CE. Most prominent is the high percentage of pig, over 80% both in the Imperial period and in Late Antiquity. The other two groups show a contrasting pattern from what has been described above. It has however been noted by the original researcher of the site that the high percentage of cattle remains dated to the Late Antique period is due to the presence of a bone workshop in the *cryptoportico*, of which the waste products were mingled with consumption refuse (Carannante et al. 2012). The data might therefore not show the normal pattern of animal use (for consumption) in the Roman city. More contexts from Alife should be added to this data for a good analysis of the use of these three groups of animals in the Imperial and Late Antique city.

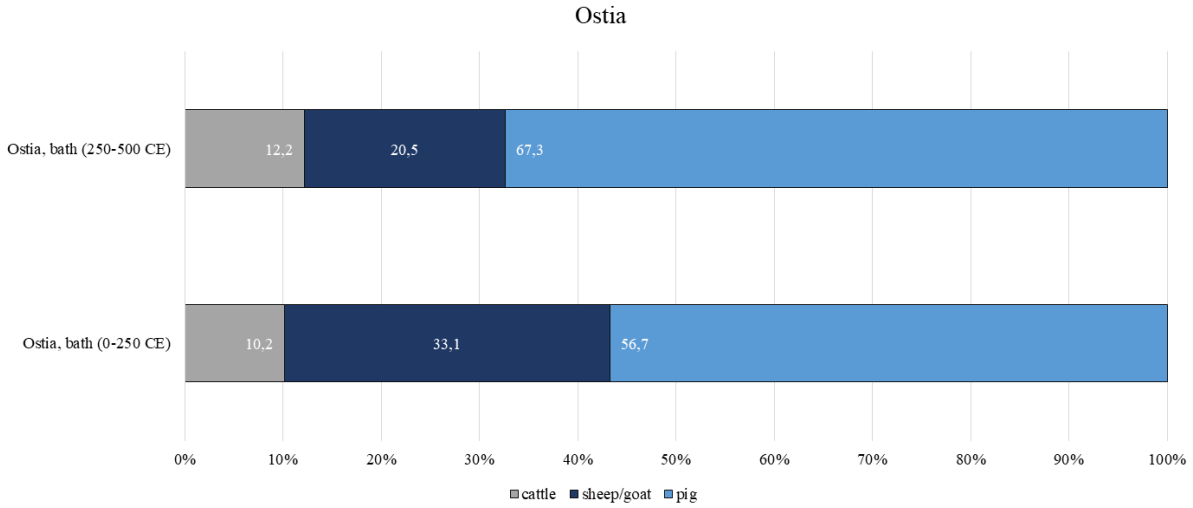


Fig. 27. Distribution of cattle, sheep/goat and pig from the Imperial period to Late Antiquity in the city of Ostia, based on NISP data from 2 contexts

A similar analysis has been made for two contexts from a single excavated site in Ostia. The animal remains excavated from the Roman baths show an increase of cattle and pig in Late Antiquity and a decrease in sheep and goat. It is the question, as with the contexts from Alife, if a single excavated spot in the city can give an indication of animal use throughout the entire settlement. The addition of multiple archaeozoological contexts and supplementary information of the evolution of the city in Late Antiquity might provide a clearer view of transformations in Late Antique Ostia.

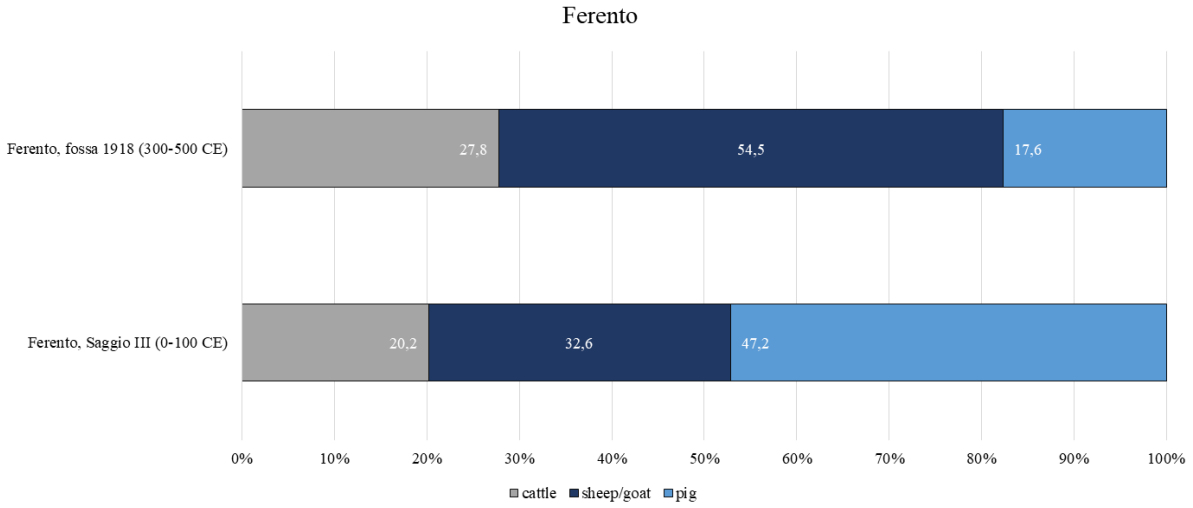


Fig. 28. Distribution of cattle, sheep/goat and pig from the Imperial period to Late Antiquity in the city of Ferento, based on NISP data from 2 contexts

Two contexts were available for the city of Ferento in Lazio, each context from a different part of the city. The Late Antique context shows an increase in both cattle and sheep/goat remains, while the percentage of pig is reduced drastically when compared to the Imperial period context. The researcher of these contexts has noted that the Late Antique context, fossa 1918, seems to deviate largely from previous Roman and later Medieval contexts on the site, and might be viewed as distinct from the other archaeozoological contexts (Alhaique, De Bernardis, Fortunato 2011). Again, a change can be seen from the Imperial Period to Late Antiquity, but more contexts should be added to gain a reliable analysis.

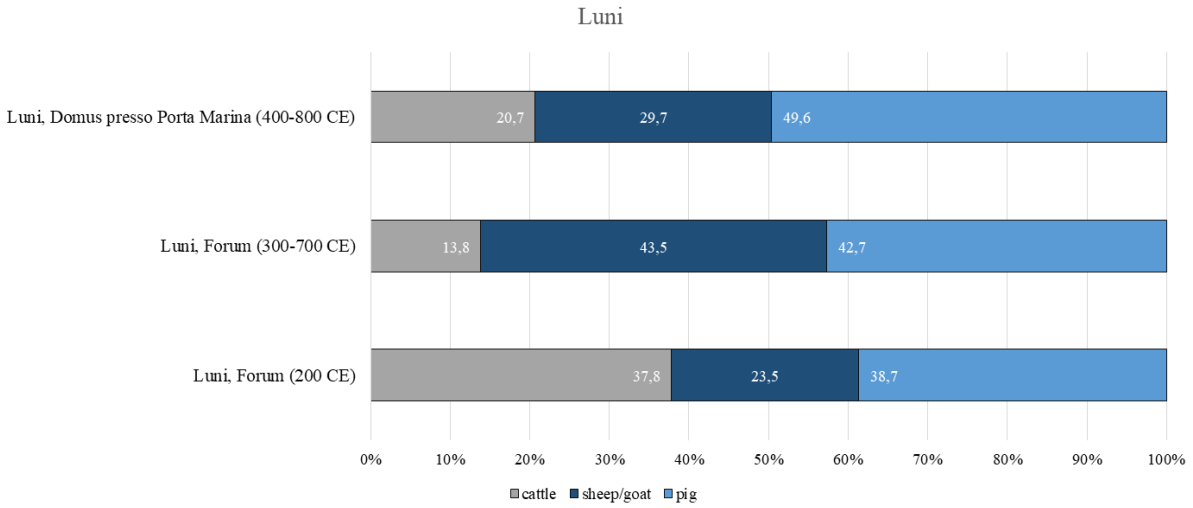


Fig. 29. Distribution of cattle, sheep/goat and pig from the Imperial period to Late Antiquity in the city of Luni, based on NISP data from 3 contexts

The contexts of Luni have been analysed before in Chapter 3. The three contexts conform to the general pattern and show an increase in pig, sheep and goat and a decrease in cattle throughout the centuries. As discussed before, this seems to be related to a process of ruralization in the city during Late Antiquity, when people turned to local resources due to the reduction of trade and financial shortage in the city compared to previous centuries, and when more open, uninhabited, areas seemed to have appeared in the city, probably used for cultivation of plants and animals (Ward-Perkins 1977; Ward-Perkins 1981a; Ward-Perkins 1981b; Delano Smith et al. 1986; Ward-Perkins 1997; Potter 1992, 211-219).

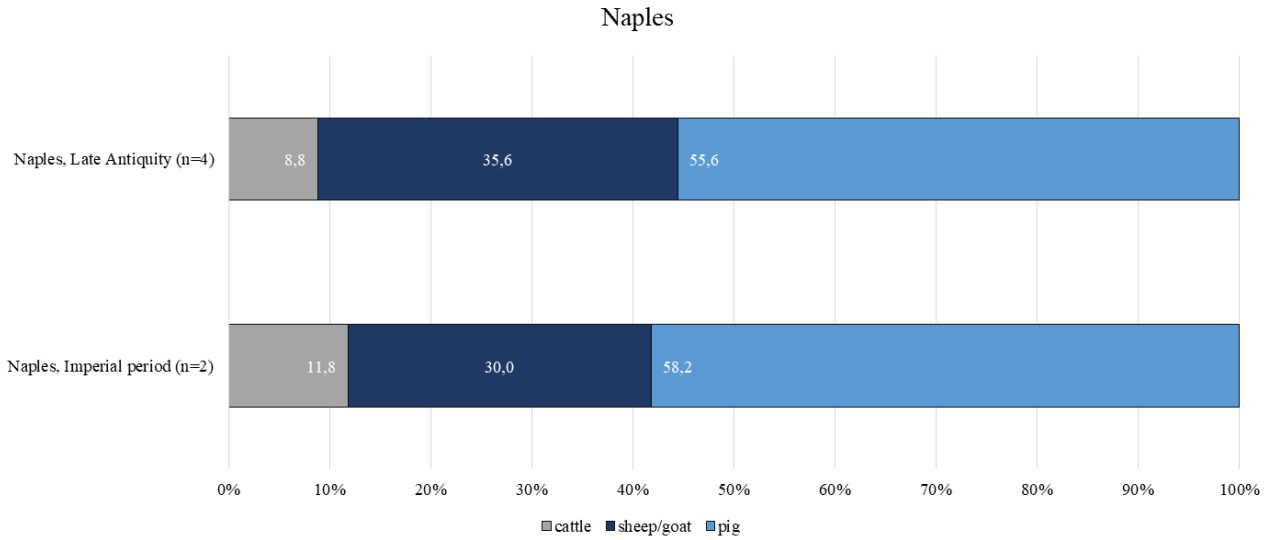


Fig. 30. Distribution of cattle, sheep/goat and pig from the Imperial period to Late Antiquity in the city of Naples, based on NISP data from 6 contexts

More contexts were available for the city of Naples. The data shown in fig. 32 is derived from 2 contexts[31] dated to the Imperial period and 4 contexts dated to Late Antiquity. It shows a decrease of cattle, an increase of sheep and goat and a decrease of pig, conforming to the general pattern seen in central Roman Italy. It is know from Early Medieval Naples (nine-tenth centuries CE) that open, probably cultivated, areas were present within the city walls, in some cases even clearly reserved and administered as vegetable gardens (Skinner 1994, 283). It is possible that these areas were already present in the previous centuries and that the sheep and goats might be kept nearby or even within the city walls.

[31] The context of Naples Santa Sofia only has a NISP of 46, but has none the less been added tot his analysis to create a bigger sample for period 2.

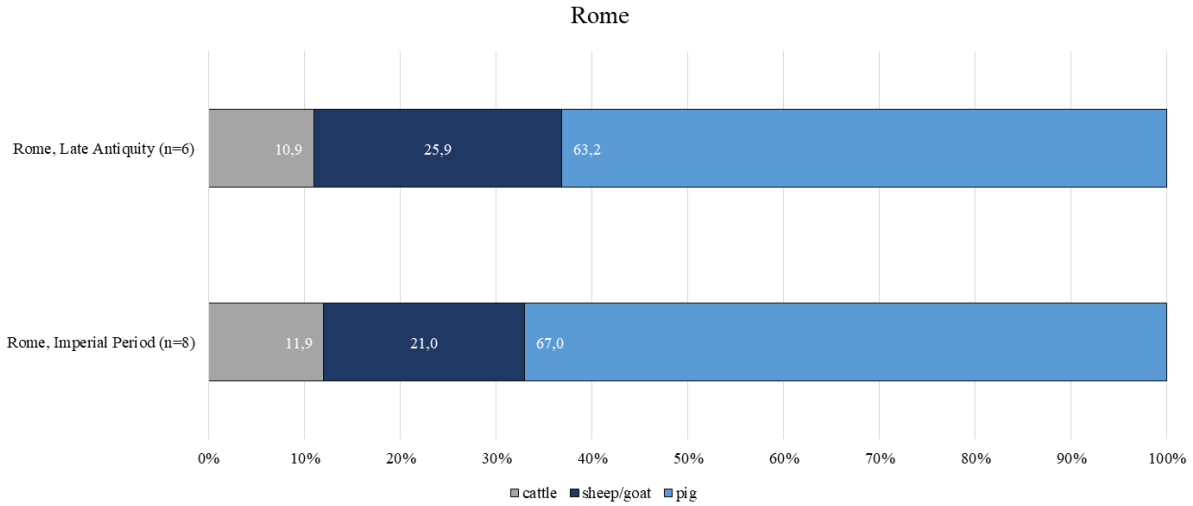


Fig. 31. Distribution of cattle, sheep/goat and pig from the Imperial period to Late Antiquity in the city of Rome, based on NISP data from 14 contexts

Most contexts were available for the city of Rome, in total 14 different contexts, 8 dated to the Imperial Period and 6 to Late Antiquity. The data from these contexts show that in Late Antiquity there was a decrease in the amount of pig and an increase in the amount of sheep and goat, while the amount of cattle found in the Roman capital stayed more or less the same (1% decrease). Like the previous two cities, and the general pattern of pig, sheep/goat and cattle in Central Roman Italy, there seems to be an increased use of sheep and goat. Not much clear information could be found on a possible ruralization of Rome during Late Antiquity, although it seems that by the tenth century many areas within the urban walls were abandoned and people lived primarily close by and along the banks of the Tiber (Hubert 1990, 81).

From the data analysed above it can be concluded that at least three of the studied cities seems to conform to the general pattern observed for Late Antiquity, namely an increase of sheep and goat and (in most cases) a decrease of cattle. The evolution of the amount of pig in Late Antiquity seems to be more variable, in some cities showing an increase while in others a decrease can be noted. In the regional analysis presented above this was similarly a group of animals that seems to show more variable patterns, so perhaps regional variations had more influence on the use and consumption of pig in Antiquity. This could provide for an interesting study subject when more archaeozoological data will become available in the future. The three other analysed cities showed contrasting patterns, with an increase of cattle and a decrease of sheep and goat. It should be taken into account that these

analyses are in all three cases based on only two contexts, sometimes derived from the same excavated site, and that factors like the location of the context or cultural and manufacturing practices other than consumption can have had an impact on the formation of the contexts, thereby creating an animal sample that might deviate from the general pattern of the whole city. Possibly the patterns shown above are a good reflection of animal use in these Late Antique cities, but without further information this cannot be concluded with certainty.

Interestingly, as ruralization seems to have happened in the city of Luni (Chapter 3) and possibly in the city of Naples (based on the nine-tenth century observations – Skinner 1994, 283)[32], it would seem that the general pattern of pig, sheep/goat and cattle use in Late Antiquity, to which these cities do conform, could possibly be related to a general process of ruralization in central Roman Italy, where the keeping of sheep and goat became more favoured above the keeping of cattle, as insecurities rose and people tended to turn to more reliable resources.

4.2.2. Mortality age of sheep and goat and secondary products

As mentioned before, sheep and goats were used for more than just their meat and could provide the people with products like wool and hair, milk and thereof cheese and other products. If sheep and goats were kept till an older, adult age, they could provide for wool, hair and milk, while animals slaughtered at a younger age (generally below 3 years) were kept solely for their meat. The mortality pattern of sheep and goat can therefore give an indication of the use of these animals for secondary products (Mackinnon 2004, 132; Groot 2010, 73-75; Baron, Reuter, Marković 2018, 9).

To see if any information about the ruralization of cities could be gained from the mortality pattern of ovicaprines, data from urban 1 contexts in central Roman Italy was compared (see Appendix 9). As some publications only gave information about the relative division of the sheep/goat population into different age categories (ranging from fetal to old) instead of more detailed fusion or dental data, it was chosen to group all available data into these age categories. The division between subadults and adults was put at 36 months, as conforming to ideas put forth by Payne and Hambleton (Payne 1973; Hambleton 1999; Greenfield, Arnold 2008, 838). The way in which the epiphyseal fusion data was represented in the publications, as a percentage of animals younger than a certain

[32] More information is needed for the city of Rome in order to include it to the list.

age or only as a number of bones that were fused on unfused (Mackinnon 2004, 134-145), was often unclear and rarely properly explained. In addition, the fusion data represents if a bone is older or younger than a certain amount of months, based on the fusion of the epiphyses (the ends of the long bones), but this is not always as specific as dental data. When an epiphysis fuses at an early age, for instance, it could either belong to a young animal, of which the epiphysis has just fused to the rest of bone, or to an older animal, of which the bones have been fused for several years (Reitz, Wing 2008, 173-174; 219-222; Groot 2010, 62-66). This phenomenon, in combination with the ambiguity of the published data, made it difficult to group the fusion data into the different age categories and therefore this data has been omitted from the analysis.

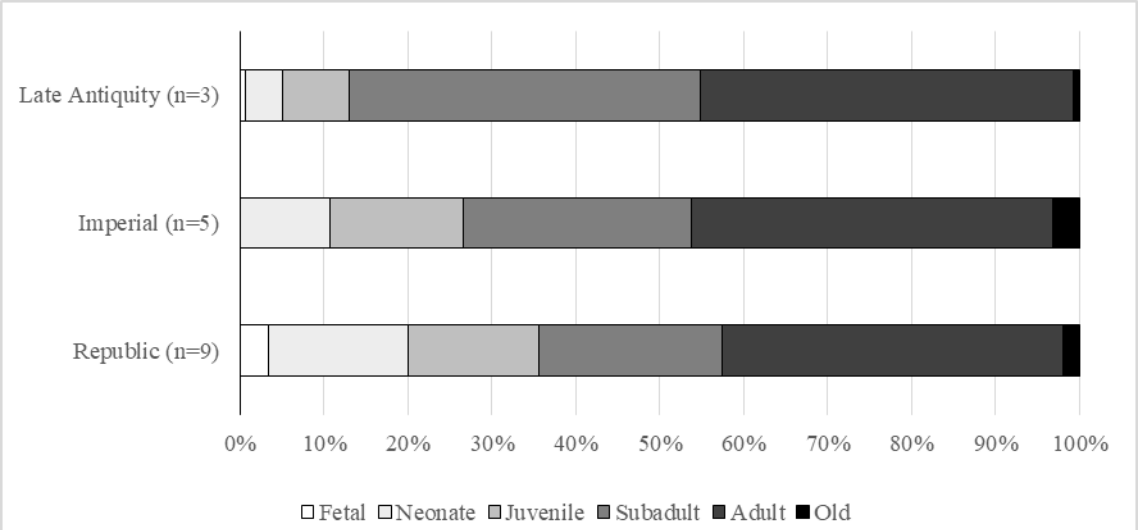


Fig. 32. Comparison of mortality data for sheep and goat for the Republic, Roman and Late Antique period, based on a total of 17 contexts

The mortality data for sheep and goat for contexts from central Roman Italy show that in the Late Antique period there was a reduction of animals killed at a younger age (fetal, neonate and juvenile animals, all under 1 year of age) compared to the previous two periods. This shows that there was a reduction of young animals used solely for their meat. It is known that lamb was commonly eaten in Roman times (Toynbee 1973, 164). Perhaps different circumstances in Late Antiquity caused the people to see greater advantage in keeping the animals till an older age, possibly for longer use of secondary resources. The data does show an increase of subadult animals, meaning that in Late Antiquity more sheep and goats were killed between the age of 1 and 3 than in the previous centuries. While these not yet fully adult animals probably were of little use for milk production, depending

on what age their first lamb would be born, they might have contributed to the amount of wool and hair obtainable from a herd.

Of course, this analysis is based on a sample of only 17 contexts, with only 3 dated to Late Antiquity, as not much information about age patterns was provided in the archaeozoological publications. This small sample is very restricted for giving clear results and the data presented above seems insufficient to see if the use of secondary products of sheep and goats had actually increased in Late Antiquity. A more detailed analysis, with a more specified look at the age pattern of single sites and perhaps an analysis of the amount of female and male ovicaprines, might give a better indication of this trend. Unfortunately, such an analysis falls outside of the scope of this study.

4.2.3. Presence of chicken on central Roman Italian sites

As discussed at the beginning of this Chapter (4.2) the NISP data for the contexts of central Roman Italy show that only a small percentage (7.4 %) of the total identified remains belonged to bird species (see fig. 22). No specific study of the distribution of bird species, as with the distribution of mammal species, has been undertaken, but it could be concluded from the analysis of the individual archaeozoological publications that chicken constitutes a large part of the excavated bird remains.

As chicken is another domesticated animal that was frequently consumed in Roman times, besides pig, cattle, sheep and goat (Mackinnon 2004, 244; Nicholson 2018, 997), it might prove interesting to see if a pattern is visible in the use of chicken throughout Roman times and especially from the Imperial period to Late Antiquity.

In Appendix 10 the contexts have been listed where the amount of chicken remains were published, with the total NISP of the animal finds and the NISP of the chicken remains. The percentages of chicken have been calculated in relation with the percentages of cattle, sheep/goat and pig, as in some publications this was the only manner in which the data of the chicken remains was published[33]. At those sites, no NISP is available for chicken, only a percentage.

[33] For instance in De Grossi Mazzorin, Minniti 2010, 53.

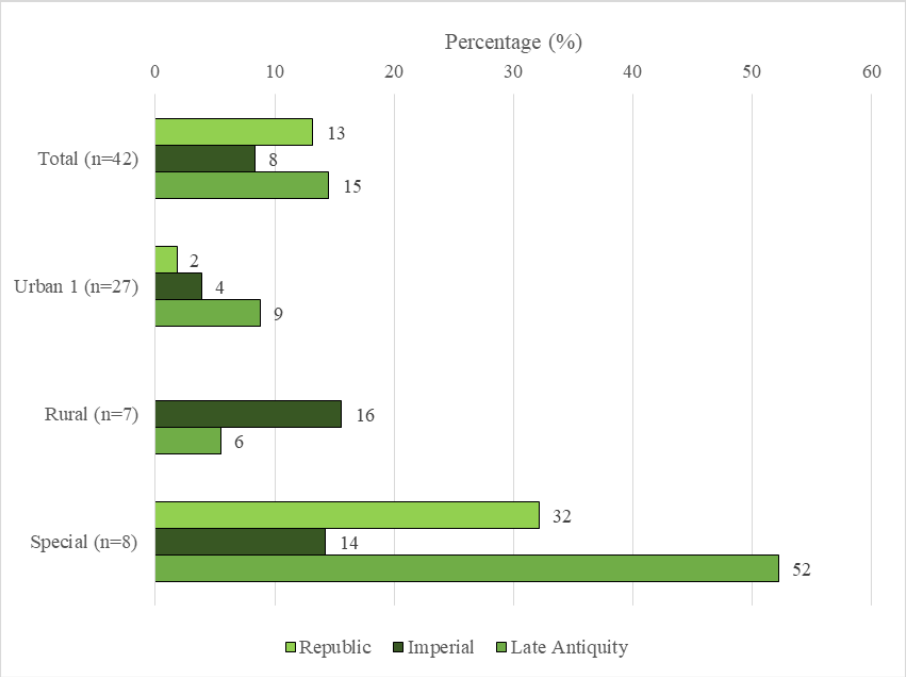


Fig. 33. Percentages of chicken on central Italian sites throughout Roman times. Percentages are calculated compared to the total NISP of cattle, sheep/goat, pig and chicken remains.

When the total remains are compared, an increase of chicken in Late Antiquity can be noted. However, if the contexts are divided per type, different patterns emerge. The urban 1 sites show an increase of chicken throughout the Roman period. For the rural sites, information was only available for the Imperial period and for Late Antiquity, and these data show a decrease of chicken. The special sites show a very high increase of chicken in Late Antiquity. There might be some influence here of specific cultural practices where the (ritual) use of chicken is attested, like the cult of Mithras (De Grossi Mazzorin 2005). One of the two special contexts from the Late Antique period is located in the Mitraeum of the Crypta Balbi in Rome, where chicken constituted 68.6% of the remains of the four groups of domestic animals. For the urban 2 sites there was no data for chicken remains. Overall, the results from these 42 contexts show that no general pattern in the use of chicken can be attested.

4.3. TRANSITION BETWEEN IMPERIAL TIMES AND LATE ANTIQUITY: ARCHAEOZOOLOGICAL EVIDENCE

Analysis of the animals remains from 127 different contexts from Central Roman Italy has provided insight in the animal use in this historical period. The relative percentages of ovicaprines, cattle and pig, the most abundant animals recovered in these contexts, were compared according to the different periods, different types of contexts and different regions. From this, a trend of the use of these three groups of domesticated animals in Late Antiquity could be recognized.

In general, it seems that in Late Antiquity there was a higher percentage of sheep and goat, and a lower percentage of cattle, compared to the previous periods. This high amount of sheep and goat in Late Antiquity had previously been recognized and was said to be related to a reduction of the population, an increase in areas of pasture that had in previous centuries been used for cultivation, and a ruralization of the urban environment (Arthur 2007, 16). This ruralization of the urban environment has already been discussed for the city of Luni, and for the cities of Sagalassos and Justiniana Prima. Archaeozoological research for Anglo-Saxon England seems to show a similar pattern, where sheep and goat seems to predominate in this Late Antique period and animals were primarily used for their secondary products and in small amounts for their meat (Rizzetto, Crabtree, Albarella 2017; Nicholson 2018, 997). Of course this was primarily a rural society (Nicholson 2018, 76), unequal to the more urban oriented world of Late Antique Italy (La Rocca 1992; Wickham 2005, 644-656; Dey 2015, 78), but it is interesting to see that a similar pattern, an increase in ovicaprine remains, can be seen in different parts of the former Roman Empire in Late Antiquity.

The increased use of these animals has in all cases been interpreted as a move away from the larger cattle, which were more costly to maintain, required more attention and whose meat was more difficult to distribute than that from the smaller ovicaprines, which could survive on lesser resources and needed less work to maintain (De Cupere 2001, 139-145; Degryse et al. 2004; Mackinnon 2004, 95-96; 121-123; Vanhaverbeke, Martens, Waelkens 2007; Rizzetto, Crabtree, Albarella 2017; Baron, Reuter, Marković 2018). Ovicaprines seemed to have been favoured and probably were more fitting to the circumstance in Late Antiquity. The use of pigs seems to have been more variably and a more detailed regional analysis, at yet not reliable possible, could give more insight in the use of this species in Late Antiquity.

The increase in ovicaprine remains could possibly be interpreted as a process towards a more rural environment. A detailed analysis of urban zooarchaeological contexts has shown this increase in both Luni and Naples, cities for which a ruralization in Late Antiquity can be assumed. For the identification of ruralization in the Late Antique city, the archaeozoological evidence does not yet seem fully reliable. It could provide an indication, but an incorporation of archaeological remains, including analysis of architectural remains and excavated stratigraphy for both Imperial and Late Antique periods, and possible information known from classical texts, seems necessary to make any conclusions about ruralization in the city. Specialized studies for individual cities, with detailed incorporation of the archaeozoological remains, could provide interesting results about their evolution in Late Antiquity.

The current dataset[34] has however provided for an interesting preliminary insight in the evolution of domesticated animals throughout antiquity. A trend has been established for Late Antiquity and a start has been made for further studies. The study as presented in this chapter could further be broadened to incorporate north- and south-Italian regions, to see changes from Late Antiquity into the Middle Ages (as has recently been attempted by Frank Salvadori (forthcoming)), to focus on specific species throughout time or in different regions, to incorporate other methods like ageing patterns (with bigger samples than the analysis presented above), or to study specific settlements.

[34] Larger than the dataset provided by Michael Mackinnon (Mackinnon 2004), whose work was an essential foundation for this work, and probably yet not as large as it could be in the nearby future with continuing excavations and hopefully increasing publications.

5. CONCLUSION

The city in Late Antiquity and its development compared to the previous Roman periods is a subject on which extensive research has been published by both archaeologists and historians. This study has attempted to explore the subject from a less viewed angle and to see in what ways archaeozoology can provide additional information and possible new insights about the city in the Late Antique period.

Analysis of current information on the Late Antique city has shown that multiple changes occurred in the classical Roman city over the course of Late Antiquity. Public buildings were abandoned, new simple structures were erected over former public areas and churches came to dominate the urban landscape. Various factors, including the influence of the *curia*, the church and of new occupiers, may have contributed to these changes and determined the way in which the cities were transformed. A number of these changes and factors have been identified in the city of Luni, an important case study in this thesis. Public structures on the forum were deserted and overbuilt by small houses in perishable materials. First century CE habitation in the south of the city was restructured and rebuilt for other purposes. The classical *curia* fell out of use, probably due to the disappearance of the curial class, and became the location of a new Christian cathedral. Habitation moved closer to the cathedral as the influence of the Church and the bishop in the city increased. Other factors that will have influenced transformations in the urban layout were the changing control over the city by the Romans, the Byzantines and the Lombards, possibly creating uncertain circumstances when tensions between these groups increased, and the diminishment of long distance trade, causing reduced prosperity of the city and its territory. The combination of these factors will have caused a process of transformation that, in the city of Luni, caused a ruralization of the urban environment. Areas in the city became uninhabited and were probably transformed into gardens for cultivation or plots for the pasture of animals.

Precisely this process of ruralization has been given specific attention in this study, because it is a process that might possibly be determined through the analysis of archaeozoological remains. Some previous studies outside of Roman Italy have shown that a strategy of smaller domesticated animals like sheep, goat and pig, which are kept in the vicinity of the city, can point to increasing ruralization in the city. Study of the archaeozoological remains excavated in Luni indeed show an abundance of pig, sheep and goat, with cattle present in lesser amounts (but with a high contribution to the meat

consumption). Compared to remains from the Imperial period, it seems like pig and especially sheep and goat have increased in importance while the amount of cattle seems to decrease.
A similar pattern has emerged from the analysis of archaeozoological contexts from central Roman Italy. In different kind of sites and different regions the contexts of Late Antiquity show an increased amount of sheep and goat and a lower amount of cattle compared to the previous centuries. This has been related to changing circumstances and an increased sense of insecurity in this later period, causing people to rely more on easier maintainable and moveable species. In general, this pattern has also been noted in the cities, although more information is needed for specialized analysis of individual cities as a variety of urban transformation existed in Late Antiquity and cities may have reacted to these changes in their own distinct way.

Analysis of zooarchaeological remains of Roman, and especially Late Antique, contexts in Central Italy, in the form of both a detailed study for a specific context and a broader comparison of a collection of contexts, has provided an insight in the use of animals in Late Antique Italy. Although mainly focused on the domesticated (consumed) mammals and based on a restricted amount of contexts, it does show that sheep and goat had gained an increased importance in this period, something that seems to be confirmed by studies from other regions in the former Roman Empire. As for the Late Antique city, archaeozoology has confirmed this pattern for some Central Italian cities, while others still require more data and a bigger archaeozoological sample. Clearest information seems to have derived from the city of Luni, where the detailed study of the zooarchaeological remains and the incorporation of other archaeological research allowed for a more comprehensive study and a better interpretation of the Late Antique city.
Although many limitations have been noted for the analysed contexts, including unequal regional and typological distribution of the uncovered remains and the availability and detail of the presented data, their study has shown that archaeozoology can provide information about the (changed) use of animals in the Late Antique city and its broader environment. In this study mostly general patterns have been presented, but detailed analysis of zooarchaeological contexts for specific cities will provide even more information and will help to understand a bit more about a particular period in the city's history. Further incorporation of other aspects of archaeological research will help to complete the picture and compare different situations.

The study of archaeozoological remains can provide information about general patterns of animal use in a certain region or in certain types of settlements or cultural contexts. Information may be gained about the consumption of certain animals, use of their secondary products and changing preferences throughout time. Regarding the Late Antique city, archaeozoology can similarly distinguish broad patterns and resemblances between different cities. More interestingly, it can provide information about the animal use and consumption in the Late Antique city, the differences compared to other periods and, in combination with other archaeological evidence, it might be able to give information about processes of ruralization inside the urban environment. "*Animals are just as likely to be made or modified by humans as would a ceramic vessel, a coin, or any other arguably typical artefact*" (Mackinnon 2007, 496). Archaeozoology is therefore just as valuable to studies of Late Antiquity as any other archaeological discipline.

BIBLIOGRAPHY

Abbot F.F., Johnson A.C., 1926. *Municipal Administration in the Roman Empire*, New York: Princeton University Press.

Albarella U., 1992. La fauna, in: Arthur P., (ed.), *L'Isola e il Santo, La chiesa di San Constanzo alla Marina Grande di Capri, scavi 1990*, Napoli: Editoriale Scientifica, 53-57.

Albarella U., Ceglia V., Roberts P., 1993. S. Giacomo Degli Schiavoni (Molise), An Early Fifth Century AD Deposit of Pottery and Animal Bones from Central Adriatic Italy, *Papers of the British School at Rome* 61, 157-230.

Alberti M.E., 2008. Murex Shells as Raw Material, The Purple-Dye Industry and its By-Products, Interpreting the Archaeological Record, in: *Kaskal, Rivista di storia, ambienti e culture del Vicino Oriente Antico* 5, 73-90.

Alhaique F., 2018. Zooarchaeological remains from the Tincu House at Gabii, in: Opitz R., Mogetta M., Terrenato N., (eds.), *A Mid-Republican House from Gabii*, Ann Arbor: University of Michigan Press, 137-160.

Alhaique F., De Bernardis D., Fortunato M.T., 2011. Attività produttive legate allo sfruttamento delle risorse animali tra età romana e medioevo, il caso di Ferento, in: De Minicis E., Pavolini C., (eds.), *Risorse naturali e attività produttive, Ferento a confronto con altre realtà, Atti del 2° Convegno di studi in memoria di Gabriella Maetzke, Viterbo, 27-28 aprile 2010*, Daidalos 12, Viterbo: DISBEC, 195-208.

Alhaique F., Fortunato M.T., 2015. Possible evidences for a dog sacrifice at Ferento (Viterbro) in the Late Antique Period, in: Thun Hohenstein U., Cangemi M., Fiore I., De Grossi Mazzorin J., *Atti del 7° Convegno Nazionale di Archeozoologia, Annali dell'Università degli Studi di Ferrara, Museologia Scientifica e Naturalistica* 11/2, 109-114.

Arthur P., 2004. From Vicus to Village, Italian Landscapes, AD 400-1000, in: Christie N., (ed.), *Landscapes of Change, Rural Evolutions in Late Antiquity and the Early Middle Ages*, Aldershot: Ashgate, 103-133.

Arthur P., 2007. Pots and Boundaries, On Cultural and Economic Areas between Late Antiquity and the Early Middle Ages, in: Bonifay M., Tréglia J.-C., (eds.), *LRCW 2, Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean, Archaeology and Archaeometry, Volume I*, British Archaeological Reports International Series 1662/1, Oxford: Archaeopress, 15-28.

Arthur P., 2012. Hierapolis of Phrygia, The Drawn-Out Demise of an Anatolian City, in: Christie N., Augenti A., (eds.), *Urbes Extinctae, Archaeologies of Abandoned Classical Towns*, Farnham: Ashgate, 275-305.

Augenti A., 2006. Ravenna e Classe, archeologia di due città tra la tarda Antichità e l'alto Medioevo, in: Augenti A., (ed.), *Le città italiane tra la tarda Antichità e l'alto Medioevo, Atti del convegno (Ravenna, 26-28 febbraio 2004)*, Firenze: Edizioni All'Insegna del Giglio, 185-217.

Augenti A., 2012. Classe, Archaeologies of a Lost City, in: Christie N., Augenti A., (eds.), *Urbes Extinctae, Archaeologies of Abandoned Classical Towns*, Farnham: Ashgate, 45-75.

Azzaroli A., 1979. Su alcuni resti di cavalli protostorici dell'Italia centrale, *Studi Etruschi* 47, 231-236.

Baeten J., Marinova E., De Laet V., Degryse P., De Vos D., Waelkens M., 2012. Faecal biomarker and archaeobotanical analyses of sediments from a public latrine shed new light on ruralisation in Sagalassos, Turkey, *Journal of Archaeological Science* 39, 1143-1159.

Banti L., 1937. *Luni*, Firenze: Instituto di Studi Etruschi.

Barker G., 1976. Animal husbandry at Narce, in: Potter T.W., (ed.), *A Faliscan town in South Etruria, Excavations at Narce 1966-1971*, London, 295-307.

Barker G., 1977. L'economia del bestiame a Luni, in: Frova A., (ed.), *Scavi di Luni II, Relazione delle campagne di scavo 1972-1973-1974*, Rome: Giorgio Bretschneider, 725-735.

Barker G., 1982. The animal bones, in: Whitehouse D., Barker G., Reece R., Reese D., (eds.), The Schola Praeconum I, The Coins, Pottery, Lamps and Fauna, *Papers of the British School at Rome* 50, 81-99.

Barker G., Clark G., 1995. The faunal data, in: Barker G., (ed.), *The Biferno valley survey, The Archaeological and Geomorphological Record*, London: Leicester University Press, 143-176.

Barone R., 1980. *Anatomia Comparata di Mammiferi Domestici, Vol. 1 Osteologia*, Bologna: Edizioni Agricole (Italian edition [1966]).

Bedini E., 1997. I resti faunistici, in: Bonghi Jovini M., Chiaramonte Treré C., (eds.), *Tarquinia, Testimonianze archeologiche e ricostruzione storica, Scavi sistematici nell'abitato (campagne 1982-1988)*, Rome: L'Erma di Bretschneider, 103-144.

Bierbrauer V., 1988. Situazione della Ricerca sugli Insediamenti nell'Italia Settentrionale in Epoca Tardo-Antica e nell'Alto Medioevo (V-VII sec.), Fonti, Metodo, Prospettive, *Archeologia Medievale* 15, 501-515.

Bini M., Chelli A., Durante A.M., Gervasini L., Pappalardo M., 2009. Geoarchaeological sea-level proxies from a silted up harbour, A case study of the Roman colony of Luni (northern Tyrrhenian Sea, Italy), *Quaternary International* 206, 147-157.

Bistolfi F., De Grossi Mazzorin J., 2005. I resti equini rinvenuti nello scavo condotto sul Celio a Piazza Celimontana (Roma), in: Fiore I., Malerba G., Chilardi S., (eds.), *Atti del 3° Convegno Nazionale di Archeozoologia (Siracusa, 3-5 novembre 2000)*, Roma: Istituto poligrafico e Zecca dello Stato, 449-458.

Blanc G.A., 1960. Elenco completo delle faune trovate negli strati della Sacra Via, in: Gjerstad E., (ed.), *Early Rome III, Fortifications, Domestic Architecture, Santuaries, Stratigraphic Excavations*, Skrifter utgivna av Svenska Institutet i Rome, Series in 4°, 17/3, Lund: C.W.K. Gleerup, 470-473.

Bogdani J., Giorgi E., 2010. La Conclusione degli Scavi nel Giardino della Domus, le Strutture Repubblicane, il Quartiere Termale, la Necropoli Tarda, in: Giorgi E., Lepore G., (eds.), *Archaeologia nella Valle del Cesano da Suasa a Santa Maria in Portuno, Atti del Convegno per i venti anni di ricerche dell'Università di Bologna (Castelleone di Suasa, Corinaldo, San Lorenzo in Camp 18-19 dicembre 2008)*, Bologna: Ante Quem, 335-352.

Bökönyi S., 1986. Animal remains from the Roman villa of San Potito-Pvindoli (L'Aquila) 1983-1984, *Acta Archaeological Academiae Scientiarum Hungaricae* 38, 89-91.

Bowden W., Hodges R., 2012. An 'Ice Age settling on the Roman Empire', Post-Roman Butrint between Strategy and Serendipity, in: Christie N., Augenti A., (eds.), *Urbes Extinctae, Archaeologies of Abandoned Classical Towns*, Farnham: Ashgate, 207-241.

Bowersock G.W., Brown P., Grabar O., 2000. *Late Antiquity, A Guide to the Postclassical World*, Cambridge: Belknap Press of Harvard University Press (second printing [1999]).

Brogiolo G.P., 1993. *Brescia Altomedievale, Urbanistica ed Edilizia dal IV al IX secolo*, Documenti di Archeologia 2, Mantova: Editrice Società Archeologica Padana.

Brogiolo G.P., 2000. Towns, Forts and the Countryside, Archaeological Models for Northern Italy in the Early Lombard Period (AD 568-650), in: Brogiolo G.P., Gauthier N., Christie N., (eds.), *Towns and their Territories between Late Antiquity and the Early Middle Ages*, The Transformation of the Roman World Volume 9, Leiden: Brill, 299-323.

Brown P., 1971. *The World of Late Antiquity, From Marcus Aurelius to Muhammad*, London: Thames and Hudson.

Cameron A., 1993. *The Mediterranean World in Late Antiquity, AD 395-600*, London: Routledge.

Cameron A., 2001. The uses and abuses of the concept of 'decline' in later Roman history, A response, in: Lavan L., (ed.), *Recent Research in Late-Antique Urbanism*, Journal of Roman Archaeology Supplementary Series 42, Portsmouth: Journal of Roman Archaeology, 238-239.

Carannante A., Chilardi S., Rebbecchi D., Vedovelli R., 2012. Ostriche, fagiani e cacciagione, Consumi d'élite e decadenza ad Alife (CE) tra il II ed l'XI secolo, in: De Grossi Mazzorin J., Saccà D., Tozzi C., (eds.), *Atti del 6° Convegno Nazionale di Archeozoologia, Centro visitatori del Parco dell'Orecchiella, 21-24 maggio 2009, San Romano in Garfagnana – Lucca*, Lecce: Associazione Italiana di Archeozoologia, 307-314.

Cerilli E., 2005. Consumi alimentary in una mansio romana, il caso del Mansio ad Vacanas (Valle di Baccano, Campagnano di Roma, Lazio, in: Fiore I., Malerba G., Chilardi S., (eds.), *Atti del 3° Convegno Nazionale di Archeozoologia*, Roma: Istituto Poligrafico e Zecca dello Stato, 433-441.

Chavarría Arnau A., 2004. Interpreting the Transformation of Late Roman Villas, The Case of Hispania, in: Christie N., (ed.), *Landscapes of Change, Rural Evolutions in Late Antiquity and the Early Middle Ages*, Aldershot: Ashgate, 67-102.

Christie N., 2004. Landscapes of Change in Late Antiquity and the Early Middle Ages, Themes, Directions and Problems, in: Christie N., (ed.), *Landscapes of Change, Rural Evolutions in Late Antiquity and the Early Middle Ages*, Aldershot: Ashgate, 1-37.

Christie N., 2006. *From Constantine to Charlemagne, An archaeology of Italy, AD 300-800*, Aldershot: Ashgate.

Christie N., 2012. Urbes Extinctae, Archaeologies of and Approaches to Abandoned Classical Cities, in: Christie N., Augenti A., (eds.), *Urbes Extinctae, Archaeologies of Abandoned Classical Towns*, Farnham: Ashgate, 1-44.

Cirelli E., 2013. La città dell'Italia del nord nell'epoca dei re (888-962 AD), in: Valenti M., Wickham C., (eds.), *Italia, 888-962, una svolta, IV Seminario Internazionale Cassero di Poggio Imperiale a Poggibonsi (SI), 4-6 dicembre 2009*, Turnhout: Brepols Publishers n.v., 131-168.

Cirelli E., 2014. La Ridefinizione degli Spazi Urbani nelle Città dell'Adriatico Centrale tra la Tarda Antichità e l'Alto Medioevo, *Hortus Artium Medievalium* 20/1, 39-47.

Clark G., 1999. The animal bones, in: Fulford M., Wallace-Hadrill A., (ed.), Towards a history of pre-Roman Pompeii, excavations beneath the House of Amarantus (I.9.11-12), 1995-8, *Papers of the British School at Rome* 67, 85-95, 128-138.

Costantini L., Giorgi J., 2009. The Faunal Remians form Rooms 49, 50 and 51, in: Scott R.T., (ed.), *Excavations in the Area Sacra of Vesta (1987-1996)*, Memoirs of the American Academy in Rome Supplementary Volumes 8, Michigan: University of Michigan Press, 143-144.

Curta F., 2001. Peasants as Makeshift Soldier for the Occasion, Sixth-Century Settlement Patterns in the Balkans, in: Bums S.T., Eadie J.W. (eds.), *Urban Centers and Rural Contexts in Late Antiquity*, East Lansing: Michigan State University Press, 199-218.

De Cupere B., 2001. *Animals at Ancient Sagalassos, Evidence of the Faunal Remains*, Studies in Eastern Mediterranean Archaeology 4, Turnhout: Brepols Publishers.

De Grossi Mazzorin J., 1985. Reperti faunistici dall'acropoli di Populonia, testimonianze di allevamento e caccia nel III secolo a.C., *Rassegna d'Archeologia* 5, 131-171.

De Grossi Mazzorin J., 1987. La Fauna, in: Ghini G., (ed.), La villa dei Quintili a Monteporzio, *Archeologia Laziale* 8, 234-235.

De Grossi Mazzorin J., 1989. Nota preliminare sulla fauna, in: Morselli C., Tortorici E., (eds.), *Curia, Forum Iulium, Forum Transitorium,* Lavori e studi di archeologia pubblicati dalla Soprintendenza archeologica di Roma 14/2, Roma: De Luca Edizioni d'Arte, 340-347.

De Grossi Mazzorin J., 1995a. La fauna rinvenuta nell'area della Meta Sudans nel quadro evolutivo degli animali domestici in Italia, in: Peretto R., (ed.), *Atti del 1° Convegno nazionale di archeozoologia (Rovigo, 5-7 marzo 1993)*, Padusa Quaderni 1, Pisa/Roma: Istituti editoriali e poligrafici, 309-318.

De Grossi Mazzorin J., 1995b. Appendice, Indizi di pratiche cultuali nel santuario di Pescorocchiano attraverso l'analisi dei resti faunistici, in: Alvino G, (ed.), Santuari, culti e paesaggio in un'area italica, il Cicolano, *Quaderni di Archeologia Etrusco-Italica* 24, 484-486.

De Grossi Mazzorin J., 1996. Resti faunistici, in: Volpe R., (ed.), *Aqua Marcia, lo scavo di un tratto urbano,* Firenze: Edizioni All'Insegna del Giglio, 203-214.

De Grossi Mazzorin J., 1997. La fauna della stipe del santuario di Schiavi d'Abruzzo e le testimonianze di pratiche cultuali connesse ai suini nell'antichità, in: Campanelli A., Faustoferri A., (eds.), *I luoghi degli dei, Sacro e natura nell'Abruzzo italico,* Sambuceto: Poligrafica Mancini, 126-127.

De Grossi Mazzorin J., 2001. L'uso dei cani nei riti funerari, Il caso della necropoli di età imperiale a Fidene, via Radicofani, in: Heinzelmann M., Ortalli J., Fasold P., Witteyer M., (eds.), *Römischer Bestattungsbrauch und Beigabensitten, in Rom, Norditalien und den Nordwestprovinzen von der späten Republik bis in die Kaiserzeit, Culto die morti e costumi funerari romani, Roma, Italia settentrionale e province nord-occidentali dalla tarda Repubblica all'età imperiale*, *Internationales Kolloquium, Rom 1.-3. April 1998,* Wiesbaden: Dr. Ludwig Reichert Verlag, 77-82.

De Grossi Mazzorin J., 2004a. I resti animali del mitreo della Crypta Babli, testimonianze di pratiche cultuali, in: Martens M., De Boe G., (eds.), *Roman Mithraism, the evidence of small finds*, Brussel: Vlaams Instituut voor het Onroerend Erfgoed, 179-181.

De Grossi Mazzorin J., 2004b. I resti animali della struttura ipogea di Centocelle, una testimonianza di pratiche cultuali, in: Gioia P., Volpe R., *Centocelle I, Roma S.D.O. le indagini archeologiche*, Roma: Rubbettino Editore, 323-329.

De Grossi Mazzorin J., 2005. Introduzione e diffusione del pollame in Italia ed evoluzione delle sue forme di allevamento fino al Medioevo, in: Fiore I., Malerba G., Chilardi S., (eds.), *Atti del 3° Convegno Nazionale di Archeozoologia*, Roma: Istituto Poligrafico e Zecca dello Stato, 351-361.

De Grossi Mazzorin J., 2014a. Gli Astragali della tomba 101 della necropoli di Varranone (Poggio Picenze – AQ), Elementi apotropaici per i vivi o per i morti, in: Bourdin S., D'Ercole D., (eds.), *I Vestini e il loro territorio dalla Preistoria al Medioevo*, Roma: École Française de Rome, 81-89.

De Grossi Mazzorin J., 2014b. Analisi faunistica dei resti osteologici provenienti dal pozzo B, in: Delfino A., (ed.), *Forum Iulium, L'area del Foro di Cesare alla luce delle campagne di scavo 2005-2008, Le*

fasi arcaica, repubblicana e cesariano-augustea, British Archaeological Reports International Series 2607, Oxford: British Archaeological Reports, 83-87.

De Grossi Mazzorin J., Coppola F., 2008. L'analisi dei resti faunistici nel quadro delle strategie di allevamento e alimentazione nella Roma imperiale, in: Filippi F., (ed.), *Horti et Sordes, Uno scavo alle falde del Gianicolo*, Roma: Edizioni Quasar, 410-419.

De Grossi Mazzorin J., Mascione C., 2010. Populonia, Acropoli, Un deposito rituale dalla cisterna pubblica, in: Di Giuseppe H., Serlorenzi M., (eds.), *I riti del costruire nelle acque violate, Atti del Convegno Internazionale, Roma, Palazzo Massimo, 12-14 giugno 2008,* Roma: Scienze e Lettere, 325-334.

De Grossi Mazzorin J., Minniti C., 2000. Le sepolture di cani della necropoli di età imperiale di Fidene, via Radicofani (Roma), Alcune considerazioni sul loro seppellimento nell'antichità, in: Malerba G., Cilli C., Giacobini G., (eds.), *Atti del 2° Convegno nazionale di archeozoologia (Asti, 14-16 novembre 1997),* Forli: Abaco Edizioni, 387-398.

De Grossi Mazzorin J., Minniti C., 2001a. Caratterizzazione archeozoologica, le sepoltre di cani, in: Di Manzano P., (ed.), *Ad Deverticulum, Scavi archeologici lungo la bretella Nomentana-GRA*, Roma: Generalvie S.P.A., 81-93.

De Grossi Mazzorin J., Minniti C., 2001b. L'allevamento e l'approvvigionamento alimentare di una comunità urbana, L'utilizzazione degli animali a Roma tra il VII e il X secolo, in: Arena M.S., Delogu P., Paroli L., Ricci M., Saguì L., Vendittelli L., (eds.), *Roma dall'antichità al medioevo, Archeologia e Storia nel Museo Nazionale Romano, Crypta Balbi*, Roma: Electa, 72-78.

De Grossi Mazzorin J., Minniti C., 2008. Resti faunistici dal saggio IX, in: Acconcia V., Rizzitelli C., (eds.), *Materiali per Populonia 7*, Pisa: ETS edizioni, 197-214.

De Grossi Mazzorin J., Minniti C., 2009. Esame dei resti faunistici, in: Romualdi A., Settesoldi R., (eds.), *Populonia, La necropoli delle grotte, Lo scavo nell'area della cava, 1997-98*, Pisa: ETS edizioni, 320-334.

De Grossi Mazzorin J., Minniti C., 2010a. L'utilizzazione degli animali nella documentazione archeozoologica a Roma e nel Lazio dalla preistoria recente all'età classica, in: Drago Troccoli L., (ed.), *Il Lazio dai Colli Albani ai Monti Lepini tra preistoria ed età moderna*, Roma: Edizioni Quasar, 39-67.

De Grossi Mazzorin J., Minniti C., 2010b. Populonia, analisi dei resti faunistici di un'abitazione di età romana, in: Tagliacozzo A., Fiore I., Marconi S., Tecchiati U., (eds.), *Atti del 5° Convegno Nazionale di Archeozoologia, Rovereto, 10-12 novembre 2006,* Rovereto: Edizioni Osiride, 243-246.

De Grossi Mazzorin J., Minniti C., 2015. Le Hostiae Animales dalla fossa rituale del saggio IV, in: Di Cola V., Pitzalis F., (eds.), *Materiali per Populonia 11*, Pisa: ETS edizioni, 139-158.

De Grossi Mazzorin J., Riedel A., Tagliacozzo A., 1998. Horse Remains in Italy from the Eneolithic to the Roman Period, in: Alhaique F., (ed.), *Proceedings of the XIII Congress of the International Union of Prehistoric and Protohistoric Sciences, Volume 6, Tome 1, Forli, Italia, 1996, 8-14 September*, Forli: A.B.A.C.O. Edizioni, 87-92.

Degryse P., Muchez P., De Cupere B., Van Neer W., Waelkens M., 2004. Special Treatment of Trace Element Data from Modern and Ancient Animal Bone, Evaluation of Roman and Byzantine Environmental Pollution, *Analytical Letters* 37/13, 2819-1834.

Delano Smith C., Gadd D., Mills N., Ward-Perkins B., 1986. Luni and the Ager Lunensis, the Rise and Fall of a Roman Town and Its Territory, *Papers of the British School at Rome* 54, 81-146.

Delogu P., 2010. *Le Origini del Medioevo, Studi sul settimo secolo*, Roma: Jouvence.

Destro M., 2004. L'abbandono delle città interne delle Marche settentrionali tra età romana e altomedioevo, in: Menestò E., (ed.), *Ascoli e le Marche tra Tardoantico e Altomedioevo, Atti del Convegno di studio svoltosi in occasione della sedicesima edizione del "Premio internazionale Ascoli Piceno", Ascoli Piceno, 5-7 dicembre 2002*, Spoleto: Fondazione Centro Italiano di Studi sull'Alto Medioevo, 101-122.

Dey H.W., 2015. *The Afterlife of the Roman City, Architecture and Ceremony in Late Antiquity and the Early Middle Ages*, New York: Cambridge University Press.

Díaz P.C., 2000. City and Territory in Hispania in Late Antiquity, in: Brogiolo G.P., Gauthier N., Christie N., (eds.), *Towns and their Territories between Late Antiquity and the Early Middle Ages*, The Transformation of the Roman World Volume 9, Leiden: Brill, 3-35.

Esmonde Cleary S., 2013. *The Roman West, AD 200-500, An Archaeological Study*, Cambridge: Cambridge University Press.

Faulkner N., 2000. Change and decline in late Romano-British towns, in: Slater T.R., (ed.), *Towns in Decline, AD 100-1600*, Aldershot: Ashgate, 25-50.

Fazzini P., Maffei M., 2000. The disappearance of the city of Luni, *Journal of Cultural Heritage* 1, 247-260.

Fiore M.G., Appetecchia A., Fusco I., Salari L., Passacantando D., 2012a. Subiaco, Rinvenimento di materiali ceramici e osteologici nella grotta in località Le Camere (Subiaco-Roma), in: Ghini G., Mari Z., (eds.), *Lazio e Sabina 8, Atti dell'Ottavo Incontro di Studi sul Lazio e la Sabina*, Roma: Edizione Quasar, 91-102.

Fortunato M.T., 2013. Analisi archeozoologiche ed interpretazioni cultuali dei resti faunistici, legami tra il mondo animale e le divinità, in: Braconi P., Coarelli F., Diosono F., Ghini G., (eds.), *Il Santuario di Diana a Nemi, Le terrazze e il ninfeo, Scavi 1989-2009*, Roma: L'Erma di Bretschneider, 597-608.

Frova A., 1973. *Scavi di Luni, Relazione preliminare delle champagne di scavo 1970-1971*, Roma: L'Erma di Bretschneider.

Frova A., 1977. *Scavi di Luni II, Relazione delle campagne di scavo 1972-1973-1974,* Roma: Giorgio Bretschneider.

Fulford M., 2012. Calleva Atrebatum (Silchester, Hampshire, UK), An Early Medieval Extinction, in: Christie N., Augenti A., (eds.), *Urbes Extinctae, Archaeologies of Abandoned Classical Towns*, Farnham: Ashgate, 331-351.

Gautier A., 1987. Taphonomic groups, How and Why, *Archaeozoologia ½*, 47-52.

Gibbon E., 1906. *The History of the Decline and Fall of the Roman Empire, vol. 1-12*, New York: Fred de Fau and Co., (reissued [1776]).

Giorgetti A., Campodoni G., 1985. La documentazione archeozoologica, in: Vannini G., (ed.), *L'antico palazzo de Vescovi a Pistoia 2/1, Indagini archeologiche***,** Arte e Archeologia, Studi e Documenti 22, 545-558.

Giorgi E., 2004. L'urbanistica di Ascoli Piceno dall'età romana all'altomedioevo, in: Menestò E., (ed.), *Ascoli e le Marche tra Tardoantico e Altomedioevo, Atti del Convegno di studio svoltosi in occasione della sedicesima edizione del "Premio internazionale Ascoli Piceno", Ascoli Piceno, 5-7 dicembre 2002*, Spoleto: Fondazione Centro Italiano di Studi sull'Alto Medioevo, 315-340.

Giorgi E., Lepore G., 2010. *Archeologia nella Valle del Cesano da Suasa a Santa Maria in Portuno, Atti del Convegno per i venti anni di ricerche dell'Università di Bologna (Castelleone di Suasa, Corinaldo, San Lorenzo in Camp 18-19 dicembre 2008),* Bologna: Ante Quem.

Giovinazzo R., 1998. I reperti faunistici, in: Giannichedda (ed.), *Filattiera-Sorano, L'insediamento di età romana e tardo antica scavi 1986-1995*, Firenze: All'Insegna del Giglio, 196-197.

Grant A., 1982. The use of tooth wear as a guide to the age of domestic ungulates, in: Wilson B., Grigson C., Payne S., (eds.), *Ageing and Sexing Animal bones from Archaeological Sites*, British Archaeological Reports British Series 109, Oxford: British Archaeological Reports, 91-108.

Greenfield H.J., Arnold E.R., 2008. Absolute age and tooth eruption and wear sequences in sheep and goat, determining age-at-death in zooarchaeology using a modern control sample, *Journal of Archaeological Science* 35, 836-849.

Groot M., 2010. *Handboek Zoöarcheologie*, Materiaal en Methoden 1, Amsterdam: Archeologisch Centrum van de Vrije Universiteit – Hendrik Brunsting Stichting.

Halsall G., 2007. *Barbarian Migrations and the Roman West, 376-568*, New York: Cambridge University Press.

Hambleton E., 1999. *Animal husbandry regimes in Iron Age Britain, a comparative study of faunal assemblages from British Iron Age sites*, British Archaeological Reports British Series 282, Oxford: British Archaeological Reports.

Harries J., 1992. Christianity and the city in Late Roman Gaul, in: Rich J., (ed.), *The City in Late Antiquity*, Leicester-Nottingham Studies in Ancient Society Volume 3, London: Routledge, 77-98.

Hesse B., Wapnish P., 1987. Faunal remains., in: McCann A.M. (ed.), *The Roman Port and Fishery of Cosa, A Center of Ancient Trade*, Princeton: Princeton University Press, 315-317.

Higham C.F.W., 1967. Stock Rearing as a Cultural Factor in Prehistoric Europe, *Proceedings of the Prehistoric Society* 33, 84-106.

Holum K.G., Raban A., Lehmann C.M., le Burrier D., Ziek R., Sachs S.F., 1992. Preliminary report on the 1989-1990 seasons, in: Vann R.L., (ed.), *Caesarea Papers, Straton's Tower, Herod's Harbour, and Roman and Byzantine Caesarea, Including the papers given at a Symposium held at the University of Maryland, The Smithsonian Institution, and the Jewish Community Center of Greater Washington on 25-28 March, 1988*, Journal of Roman Archaeology Supplementary Series Number 5, Ann Arbor: Journal of Roman Archaeology, 79-111.

Hubert É., 1990. *Espace urbain et habitat à Rome du Xe siécle à la fin du XIIIe siécle*, Collection de l'École française de Rome 135, Rome: École Française de Rome, 3-396.

Ioppolo G., 1972. I reperti ossei animali nell'area archeologica di S. Omobono (1962-1964), *Atti della Pontificia Accademia Romana di Archeologia 44*, 3-46.

Istituto di Paleontologia Umano, 1968. Reperti osteologici e malacologici, in: Carandini A., (ed.), *Ostia I*, Studi Miscellanei 13, Rome: De Luca Editore, 122-124.

Istituto di Paleontologia Umano, 1973. Reperti osteologici e malacologici, in: Carandini A., Panella C., (ed.), *Ostia III*, Studi Miscellanei 21, Rome: De Luca Editore, 649-650.

Istituto di Paleontologia Umano, 1977. Reperti osteologici e malacologici, in: Carandini A., Panella C., (eds.), Ostia IV, Studi Miscellanei 23, Rome: De Luca Editore, 273-275.

Jashemski W.F., 1973a. Large vineyard discovered in ancient Pompeii, *Science* 180, 821-830.

Jashemski W.F., 1973b. The Discovery of a Large Vineyard at Pompeii: University of Maryland Excavations, 1970, *American Journal of Archaeology* 77/1, 27-41.

Jashemski W.F., 1979. *The Gardens of Pompeii, Herculaneum and the Villas Destroyed by Vesuvius*, New Rochelle/New York: Caratzas Brothers.

Jashemski W.F., 1993. *The Gardens of Pompeii II, Appendices*, New Rochelle/New York: Caratzas Brothers.

Jones A.H.M., 1964. *The Later Roman Empire, 284-602, A social economic and administrative survey*, Volume I-III, Oxford: Basil Blackwell.

Kindstedt P.S., 2012. *Cheese and Culture, a History of Cheese and Its Place in Western Civilization*, White River Junction: Chelsea Green Publishing.

King A.C., 1985. I resti animali, in: Ricci A. (ed.), *Settefinestre, una villa schiavistia nell'Etruria romana 2,* 278-300.

King A.C., 1987. Le ossa, in Arthur P., (ed.), *Scavo in proprietà Carillo, Santa Maria Capua Vetere, Contributo per una conoscenza di Capua tardo-antico*, Archeologia Medievale 14, 532.

King A.C., 1994. Mammiferi, in: Arthur P., (ed.), *Il complesso archeologico di Carminiello ai Mannesi, Napoli (scavi 1983-1984)*, Galatina: Congedo Editore, 367-406.

King A.C., 1997. Mammal, Reptile and Amphibian Bones, in: Potter T.W., King A.C., (eds.), *Excavations at the Mola di Monte Gelato*, British School at Rome Archaeological Monograph 11, London: British School at Rome, 383-403.

King A.C., 1999. Diet in the Roman world, a regional inter-site comparison of the mammal bones, *Journal of Roman Archaeology* 12, 168-202.

King A.C., Rielly K., Thomas K.D., 1985. I resti animali, in: Ricci A. (ed.), *Settefinestre, una villa schiavistia nell'Etruria romana 3, La villa e i suoi reperti*, Modena: Panini, 278-305.

Kirilov C., 2007. The reduction of the fortified city area in late antiquity, some reflections on the end of the antique city in the hands of the Eastern Roman Empire, in: Henning J., (ed.), *Post-Roman Towns, Trade and Settlement in Europe and Byzantium vol. 2, Byzantium, Pliska, and the Balkans*, Berlin/New York: Walter de Gruyter, 3-24.

Kokabi M., 1982. Tierknochenfunde, in: Eschebach H., Die Casa di Ganimede in Pompeij VII 13,4, Ausgrabungen und Baugeschichte, *Mitteilungen des Deutschen Archaeologischen Instituts Roemische Abteilung* 89, *Bullettino dell'Instituto Archeologico Germanico Sezione Romana* 89, 397-425.

Kulikowski M., 2004. *Late Roman Spain and its Cities*, Baltimore: The Johns Hopkins University Press.

Kulikowski M., 2007. Plague in Spanish Late Antiquity, in: Little L.K., (ed.), *Plague and the End of Antiquity, The Pandemic of 541-750*, New York: Cambridge University Press, 150-170.

La Rocca C., 1992. Public buildings and urban change in northern Italy in the early mediaeval period, in: Rich J., (ed.), *The City in Late Antiquity*, Leicester-Nottingham Studies in Ancient Society Volume 3, London: Routledge, 161-180.

Lavan L., 2001a. The late-antique city, a bibliographic essay, in: Lavan L., (ed.), *Recent Research in Late-Antique Urbanism*, Journal of Roman Archaeology Supplementary Series 42, Portsmouth: Journal of Roman Archaeology, 9-26.

Lavan L., 2001b. The uses and abuses of the concept of 'decline' in later Roman history, A brief comment, in: Lavan L., (ed.), *Recent Research in Late-Antique Urbanism*, Journal of Roman Archaeology Supplementary Series 42, Portsmouth: Journal of Roman Archaeology, 243-245.

Lavan L., 2012. Public Space in Late Antique Ostia, Excavation and Survey in 2008-2011, *American Journal of Archaeology* 116/4, 649-691.

Lepelley C., 1992. The survival and fall of the classical city in Late Roman Africa, in: Rich J., (ed.), *The City in Late Antiquity*, Leicester-Nottingham Studies in Ancient Society Volume 3, London: Routledge, 50-76.

Lewit T., 2001. Changing concepts of Late Antiquity, The decline and fall of Gibbonism, *Bulletin de l'Antiquité Tardive* 10, 33-37.

Liebeschuetz J.H.W.G., 1992. The end of the ancient city, in: Rich J., (ed.), *The City in Late Antiquity*, Leicester-Nottingham Studies in Ancient Society Volume 3, London: Routledge, 1-49.

Liebeschuetz J.H.W.G., 2001a. *Decline and Fall of the Roman City*, Oxford: Oxford University Press.

Liebeschuetz J.H.W.G., 2001b. The uses and abuses of the concept of 'decline' in later Roman history, or, Was Gibbon politically incorrect, in: Lavan L., (ed.), *Recent Research in Late-Antique Urbanism*, Journal of Roman Archaeology Supplementary Series 42, Portsmouth: Journal of Roman Archaeology, 233-238.

Little L.K., 2007. *Plague and the End of Antiquity, The Pandemic of 541-750*, New York: Cambridge University Press.

MacKinnon M., 1999. The faunal remains, in Soren D.S., Soren N., (eds.), *A Roman villa and late Roman infant cemetery, Excavation at Poggio Gramignano (Lugnano in Teverina)*, Rome: L'Erma di Bretschneider, 533-594.

MacKinnon M., 2004. *Production and Consumption of Animals in Roman Italy, Integrating the Zooarchaeological and Textual Evidence*, Journal of Roman Archaeology Supplementary Series 54, Portsmouth: Journal of Roman Archaeology.

Mackinnon M., 2007. Osteological Research in Classical Archaeology, *American Journal of Archaeology* 111/3, 473-504.

MacKinnon M., 2011. Faunal Remains, in: Ghisleni M., Vaccaro E., Bowes K., Arnoldus A., MacKinnon M., Marani F., (eds.), Excavating the Roman Peasant I, Excavations at Pievina (GR), *Papers of the British School at Rome* 79, 120-128.

Mannoni T., 1983. Insediamenti poveri nella Liguria di età romana e bizantina, *Rivista di Studi Liguri* 49/1-4, 254-264.

Martínez Jiménez J., 2013. Crisis or Crises, The End of Roman Towns in Iberia, Between the Late Roman and Early Umayyad Periods, in: van der Wilt E.M., Martínez Jiménez J., (eds.), *Tough Times, The Archaeology of Crisis and Recovery, Proceedings of the Graduate Archaeology at Oxford conferences in 2010 and 2011*, British Archaeological Reports International Series 2478, Oxford: Archaeopress, 77-90.

May E., 1985. Wideristhöhe und Langknochenmasse bei Pferden, Ein immer noch aktuelles Problem, *Zeitschrift für Säugetierkunde* 50, 368-382.

Meadow R.H., 1999. The use of size index scaling techniques for research on archaeozoological collections from the Middle East, in: Becker C., Manhart H., Peters J., Schibler J., (eds.), *Historia Animalium Ex Ossibus, Beiträge zur Paläoanatomie, Archäologie, Ägyptologie, Ehtnologie und Geschichte der Tiermedizin, Festschrift für Angela von den Driesch*, Rahden/Westf.: Verlag Marie Leidorf GmbH, 285-300.

Menchelli S., Sangriso P., Genovesi S., 2016. Luni, le campagne 2014-2015 nel settore sud-orientale della città, in: Lusuardi Siena S., Legrottaglie G. (eds.), *Dall'Appennino a Luni tra Età Romana e Medioevo, Atti della giornata di studi, Berceto, 26 settembre 2016, Quaderni Centro Studi Lunensi* 10, 101-124.

Menchelli S., Sangriso P., Genovesi S., Maccari A., Marcheschi R., Marini S., forthcoming(a). Casa e bottega, un nuovo quartiere presso porta Marina, *Quaderni Centro Studi Lunensi 2018*.

Menchelli S., Capelli C., Genovesi S., Maccari A., Cabella R., forthcoming(b). Luni, le domus presso Porta Marina, Ceramiche da fuoco, comuni ed anfore dalle stratigrafie tardoantiche, in: *LRCW 6, Late Roman Coarse Wares.*

Milinković M., 2007. Stadt oder „Stadt", Frühbyzantinische Siedlungsstrukturen im nördlichen Illyricum, in: Henning J., (ed.), *Post-Roman towns, Trade and Settlement in Europe and Byzantium Volume 2, Byzantium, Pliska, and the Balkans,* Millennium-Studien zu Kultur und Geschichte des ersten Jahrtausends n.Chr. 5/2, Berlin: Walter de Gruyter, 159-191.

Minniti C., 2005. Analisi dei resti faunistici provenienti da tre pozzi (nn. 6, 7, 11) della Tenuta di Vallerano (Roman, I-II secolo d.C.), in: Fiore I., Malerba G., Chilardi S., (eds.), *Atti del 3° Convegno Nazionale di Archeozoologia*, Roma: Istituto Poligrafico e Zecca dello Stato, 419-432.

Nicholas D., 1997. *The Growth of the Medieval City, From Late Antiquity to the Early Fourteenth Century*, New York: Addison Wesley Longman Inc.

Nicholson O., 2018. *The Oxford Dictionary of Late Antiquity, Volume 1-2*, Oxford: Oxford University Press.

Niewöhner P., 2017. Urbanism, in: Niewöhner P., (ed.), *The Archaeology of Byzantine Anatolia, From the End of Late Antiquity until the Coming of the Turks*, Oxford: Oxford University Press, 39-59.

Ostrogorsky G., 1959. Byzantine cities in the Early Middle Ages, *Dumbarton Oaks Papers* 13, 45-66.

Payne S., 1973. Kill-off patterns in sheep and goats, the mandibles from Aşvan Kale, *Anatolian Studies* 23, 281-303.

Payne S., Bull G., 1988. Components of variation in measurements of pig bones and teeth, and the use of measurements to distinguish wild from domestic pig remains, *Archaeozoologia* 2/1,2, 27-66.

Potter T.W., 1992. *Roman Italy*, London: British Museum Press [Second impression (1987)].

Poulter A.G., 2007. The Transition to Late Antiquity, in: Poulter A.G., (ed.), *The Transition to Late Antiquity, On the Danube and Beyond*, Proceedings of the British Academy 141, Oxford: Oxford University Press, 1-50.

Prummel W., Bouma J.W., 1997. Animal Offerings at Borgo Le Ferriere (Latium, Italy), *Anthropozoologica* 25, 531-537.

Raimondo C., 2006. Le città dei Bruttii tra tarda Antichità e Altomedioevo, nuove osservazioni sulla base delle fonti archeologiche, in: Augenti A., (ed.), *Le città italiane tra la tarda Antichità e l'alto Medioevo, Atti del convegno (Ravenna, 26-28 febbraio 2004)*, Firenze: Edizioni All'Insegna del Giglio, 519-558.

Reece R., 1992. The end of the city in Roman Britain, in: Rich J., (ed.), *The City in Late Antiquity*, Leicester-Nottingham Studies in Ancient Society Volume 3, London: Routledge, 136-144.

Reese D.S., 2002. Marine Invertebrates, Freshwater Shells, and Land Snails, Evidence from Specimens, Mosaics, Wall Paintings, Sculpture, Jewelry, and Roman Authors, in: Jashemski W.F., Meyer F.G., (eds.), *The Natural History of Pompeii*, Cambridge: Cambridge University Press, 292-314.

Reitz E.J., Wing E.S., 2008. *Zooarchaeology, Second Edition*, Cambridge: Cambridge University Press.

Rhodes P., 1994. Pesci, in: Arthur P., (ed.), *Il complesso archeologico di Carminiello ai Mannesi, Napoli (scavi 1983-1984)*, Galatina: Congedo Editore, 421-422.

Richardson J., 1995. Faunal remains, in: Bon S.E., Jones R., Kurchin B., Robinson D., (eds.), *Anglo-American research at Pompeii 1995, Preliminary report*, Bradford: Bradford Archaeological Sciences Research, 27-29.

Richardson J., Thompson G., Genovese A., 1997. New directions in economic and environmental research at Pompeii, in: Bon S.E., Jones R., (eds.), Sequence and space in Pompeii, Oxford, 88-101.

Rielly K., 1994. Uccelli, in: Arthur P., (ed.), *Il complesso archeologico di Carminiello ai Mannesi, Napoli (scavi 1983-1984)*, Galatina: Congedo Editore, 405-419.

Rizzetto M., Crabtree P.J., Albarella U., 2017. Livestock Changes at the Beginning and End of the Roman Period in Britain, Issues of Acculturation, Adaptation and Improvement, *European Journal of Archaeology 20/3, Animal Husbandry in the Western Roman Empire, A Zooarchaeological Perspective*, 535-556.

Rizzo F., Fortunato M.T., Pavolini C., 2013. Una deposizione rituale nell'area della domus ad atrio di Ferento, *Journal of Fasti Online* 293, 1-27, consulted on July 10 2018 on http://www.fastionline.org/docs/FOLDER-it-2013-293.pdf.

Robertson W., 1769. *The History of the Reign of the Emperor Charles V, With a View of the Progress of Society in Europe, from the Subversion of the Roman Empire, to the Beginning of the Sixteenth Century*, London: W. and W. Strahan.

Rostovtzeff M., 1926. *The Social and Economic History of the Roman Empire*, Oxford: Clarendon Press.

Salvadori F., forthcoming. The transition from late antiquity to early Middle Ages in Italy, A zooarchaeological perspective, *Quaternary International 2018*.

Santini F., 2013. Il santuario di S. Angelo di Civitella (Pescorocchiano, Rieti), pratiche cultuali, in: Ghini G., Mari Z., (eds), *Lazio e Sabina 9, Atti del Convegno, Nono Incontro di Studi sul Lazio e la Sabina, Roma, 27-29 marzo 2012*, Roma: Edizioni Quasar, 155-160.

Saradi H.G., 2006. *The Byzantine City in the Sixth Century, Literary Images and Historical Reality*, Athens: Socity of Messenian Archaeological Studies.

Scali S., 1987. I resti animali, in: Barbieri G., (ed.), *L'alimentazione nel mondo antico, Gli Etruschi*, Rome: Istituto poligrafico e Zecca dello Stato, 87.

Scali S., 1993a. Appendix 1, I Resti Faunistici Proveniente dalle Case Romane di Cosa (Ansedonia), in: Bruno V.J., Scott R.T., (eds.), Cosa IV, The houses, *Memoirs of the American Academy in Rome* 38, 193-200.

Scali S., 1993b. Animal bones from Forum SW/SE cistern, in: Brown F.E., Richardson E.H., Richardson L., (eds.), Cosa III, The buildings of the forum, *Memoirs of the American Academy in Rome* 37, 296-298.

Silver I.A., 1963. The Ageing of Domestic Animals, in: Brothwell D., Higgs E., (eds.), *Science in Archaeology, A Comprehensive Survey of Progress and Research*, Bristol: Thames and Hudson, 250-268.

Skinner P., 1994. Urban Communities in Naples, 900-1050, *Papers of the British School at Rome* 62, 279-299.

Sorrentino C., 1981a. La fauna, in: Berggren E., Berggren K., (eds.), *San Giovenale, Excavations in Area B 1957-1960*, Skrifter utgivna av Svenska Institutet i Rom, Series prima in 4°, 26, Volume 2/2, Lund: C.W.K. Gleerup, 58-64.

Sorrentino C., 1981b. La fauna, in: Olinder B., Pohl I., (eds.), *San Giovenale, The semisubterranean building in Area B*, Skrifter utgivna av Svenska Institutet i Rom, Series prima in 4o, 26, Volume 2/4, Lund: C.W.K. Gleerup, 85-89.

Sorrentino C., 1989. Il Sus scrofa L. come offerta funebre, la sua distribuzione nelle tombe della necropoli romana del 'Cantone' a Collelongo (L'Aquila, Abruzzo, Italia), in: Meniel P., (ed.), *Animal et pratiques religieuses, les manifestations matérielles*, Anthropozoologica 3, Paris: CNRS, 119-126.

Sorrentino C., Giuseppe Z., Manzi F., 2000. Materiale osteologico animale, in: Bruni S., (ed.), *Le navi antiche di Pisa, Ad un anno dell'inizio delle ricerche, The Ancient ships of Pisa, after a year of work*, Florence: Polistampa, 329-349.

Tagliacozzo A., 1989. L'analisi dei resti faunistici dell'area sacra di S. Omobono, in: *Il viver quotidiano in Roma arcaica, Materiali degli scavi del Tempio Arcaico nell'area sacra di S. Omobono*, Rome: Procom, 65-69.

Tagliacozzo A., 1990. I resti ossei faunistici di Musarna, *Mélanges de l'Ecole française de Rome, Antiquité* 102, 479-480.

Tagliacozzo A., 1993. I reperti faunistici, in: Pavolini C., (ed.), *Caput Africae I*, Rome: Istituto Poligrafico e Zecca dello Stato, 252-278.

Tagliacozzo A., 1995. I resti ossei faunistici, in: Santrot M.-H., Santrot J., (eds.), *Fouilles de l'École Française de Rome à Bolsena (Poggio Moscini) VII, La citerne 5 et son mobilier*, Mélanges d'Archéologie et d'Histoire Supplement 6, Rome: École Françasie de Rome, 323-347.

Toynbee J.M.C., 1973. *Animals in Roman Life and Art*, London: Thames and Hudson.

Vaccaro E., MacKinnon M.., 2013. Changes in the economic locale, ceramic and faunal evidence, in: Vaccaro E., Ghisleni M., Arnoldus-Huyzendveld A., Grey C., Bowes K., (eds.), Excavating the Roman Peasant II, Excavations at Case Nuove, Cinigiano (GR), *Papers of the British School at Rome* 81, 145-154.

Vanhaverbeke H., Martens F., Waelkens M., Poblome J., 2004. Late Antiquity in the Territory of Sagalassos (Pisidia, SW Turkey), in: Bowden W., Lavan L., Machado C., (eds.), *Recent Research on the Late Antique Countryside*, Late Antique Archaeology 2, Leiden/Boston: Brill, 247-279.

Vanhaverbeke H., Martens F., Waelkens M., 2007. Another View on Late Antiquity, Sagalassos (SW Anatolia), its Suburbium and its Countryside in Late Antiquity, in: Poulter A.G., (ed.), *The Transition to Late Antiquity, On the Danube and Beyond*, Proceedings of the British Academy 141, Oxford: Oxford University Press, 611-648.

Vermeulen F.M.R., 2012. Potentia, A Lost New Town, in: Christie N., Augenti A., (eds.), *Urbes Extinctae, Archaeologies of Abandoned Classical Towns*, Farnham: Ashgate, 77-95.

Verslype L., Brulet R., 2004. *Terres Noires, Dark Earth, Actes de la table-ronde international tenue à Louvain-la-Neuve, les 09 et 10 novembre 2001*, Louvain-la-Neuve: Universitè Catholique de Louvain.

Volpe G., 2006. Città apule fra destrutturazione e trasformazione, i casi di Canusium ed Herdonia, in: Augenti A., (ed.), *Le città italiane tra la tarda Antichità e l'alto Medioevo, Atti del convegno (Ravenna, 26-28 febbraio 2004)*, Firenze: Edizioni All'Insegna del Giglio, 587-559

Von den Driesch A., 1976. *A guide to the Measurement of Animal Bones from Archaeological Sites*, Peabody Museum Bulletins 1, Cambridge: Harvard University.

Von den Driesch A., Boessneck J., 1974. Kritische Anmerkungen zur Widerristhöhenberechnung aus Längenmassen vor- und frühgeschichtlicher Tierknochen, *Säugetierkundliche Mitteilungen* 22, 325-348.

Wacher J., 1975. *The Towns of Roman Britain*, London: B.T. Batsford LTD.

Walmsley A., 1996. Byzantine Palestine and Arabia, Urban Prosperity in Late Antiquity, in: Christie N., Loseby S.T., (eds.), *Towns in Transition, Urban Evolution in Late Antiquity and the Early Middle Ages*, Aldershot: Scolar Press, 126-158.

Ward-Perkins B., 1977. Lo scavo nella zona nord del Foro (CS), in: Frova A., (ed.), *Scavi di Luni II, Relazione delle campagne di scavo 1972-1973-1974*, Roma: Giorgio Bretschneider, 633-638.

Ward-Perkins B., 1981a. Luni, The Prosperity of the town and its territory, in: Barker G., Hodges R., (eds.), *Archaeology and Italian Society, Prehistoric, Roman and Medieval Studies*, Papers in Italian Archaeology II, British Archaeological Reports International Series 102, Oxford: British Archaeological Series, 179-190.

Ward-Perkins B., 1981b. Two Byzantine Houses at Luni, *Papers of the British School at Rome* 49, 91-98.

Ward-Perkins B., 1996. Urban Continuity, in: Christie N., Loseby S.T., (eds.), *Towns in Transition, Urban Evolution in Late Antiquity and the Early Middle Ages*, Aldershot: Scolar Press, 4-17.

Ward-Perkins B., 1997. Continuitists, Catastrophists, and the Towns of Post-Roman Northern Italy, *Papers of the British School at Rome* 65, 157-176.

Ward-Perkins B., 2001. The uses and abuses of the concept of 'decline' in later Roman history, A brief comment, in: Lavan L., (ed.), *Recent Research in Late-Antique Urbanism*, Journal of Roman Archaeology Supplementary Series 42, Portsmouth: Journal of Roman Archaeology, 239-241.

Ward-Perkins B., 2005. *The Fall of roman and the End of Civilization*, Oxford: Oxford University Press.

Whittow M., 1990. Ruling the Late Roman and Early Byzantine City, A Continuous History, *Past and Present* 129, 3-29.

Whittow M., 1996. *The Making of Orthodox Byzantium, 600-1025*, London: MacMillan.

Whittow M., 2001. The uses and abuses of the concept of 'decline' in later Roman history, Was Gibbon politically incorrect, or just wrong, in: Lavan L., (ed.), *Recent Research in Late-Antique Urbanism*, Journal of Roman Archaeology Supplementary Series 42, Portsmouth: Journal of Roman Archaeology, 241-243.

Wickham C., 1981. *Early Medieval Italy, Central Power and Local Society 400-100*, London: Routledge.

Wickham C., 1988. La Città Altomedievale, Una Nota sul Dibattito in Corso, *Archeologia Medievale* 15, 649-651.

Wickham C., 2005. *Framing the Early Middle Ages, Europe and the Mediterranean 400-800*, Oxford: Oxford University Press.

Wilkens B., 1991. I resti faunistici, in: Ciampoltrini G., Rendini P., Wilkens B., (eds.), L'alimentazione nell'abitato etrusco di Montecatino in Val Freddana (Lucca), *Studi Etruschi* 56, 275-284.

Zavagno L., 2009. *Cities in Transition, Urbanism in Byzantium between Late Antiquity and the Early Middle Ages (AD 500-900),* British Archaeological Reports International Series 2030, Oxford: Archaeopress.

INTERNETSOURCES

Baron H., Reuter A.E., Marković N., 2018. Rethinking ruralization in terms of resilience, Subsistence strategies in sixth-century Caričin Grad in the light of plant and animal bone finds, *Quaternary International*, 1-17, consulted on July 9 2018 on https://www.sciencedirect.com/science/article/pii/S1040618217302707.

Giudice A., 2013. Il tardoantico, decline o trasformazione, *Frankfurter elektronische Rundschau zur Altertumskunde* 21, 1-19, consulted on June 13 2018 op http://www.fera-journal.eu/index.php/ojs-fera/article/view/150.

Widrig W., 2002. The Via Gabina villas sites 10, 11 and 12, consulted on July 10 2018 on http://viagabina.rice.edu/index.html.

MacKinnon M., 2010. Pievina, Preliminary Zooarchaeological Report, *The Roman Peasant Project, Data and Preliminary Reports*, 1-22, consulted on July 10 2018 on https://www.sas.upenn.edu/romanpeasants/reports.html.

Clark G., 1990. The Via Gabina villas sites 10, 11 and 13, Faunal Remains, consulted on July 10 2018 http://viagabina.rice.edu/bones/index.html.

ANTIQUE SOURCES

Libanius, *Orations*: Norman A.F., (ed.), 1969. *Selected Orations, Volume I, Julianic Orations*, Loeb Classical Library 451, Cambridge: Harvard University Press.

Pliny the elder, *Naturalis Historia* 3-7: Rackham H., (ed.), 1942. *Natural History, Volume II, Books 3-7*, Loeb Classical Library 352, Cambridge: Harvard University Press.

Pliny the elder, *Naturalis Historia* 8-11: Rackham H., (ed.), 1940. *Natural History, Volume III, Books 8-11*, Loeb Classical Library 353, Cambridge: Harvard University Press.

Pliny the elder, *Naturalis Historia* 12-16: Rackham H., (ed.), 1945. *Natural History, Volume IV, Books 12-16*, Loeb Classical Library 370, Cambridge: Harvard University Press.

Martial, *Epigrammaton Libri* 11-14: Shackleton Bailey D.R., (ed.), 1993. *Epigrams, Volume III, Books 11-14*, Loeb Classical Library 480, Cambridge: Harvard University Press.

Strabo, *Geographika 3-5*: Jones H.L., (ed.), 1923. *Geography, Volume II, Books 3-5*, Loeb Classical Library 50, Cambridge: Harvard University Press.

APPENDIX 1. CATALOGUE OF STUDIED MATERIAL

In the following table the specific information per identified specimen is presented. Per specimen, information is given about identified animal and identified skeletal elements. Under the category *Bone element*, information is given about the part of the bone that is preserved. Meaning of the abbreviations: com.=complete, frag.=fragment, pr.=proximal part of the bone, dis.=distal part, P.E.=proximal epiphysis, D.E.=distal epiphysis, I=incisor teeth, C=canine teeth, P=premolar teeth, M=molar teeth, s=superior/upper teeth, i=inferior/lower teeth. Furthermore is indicated if the bone was situated at the left or right side of the body, how much percentage of the bone was still conserved, the weight of the specimen, and taken measurements. These were taken according to criteria from Von den Driesch 1976 and use the abbreviations from this work. Epiphyseal fusion is indicated and dental age is represented based on Silver 1963, Higham 1967 and Grant 1982. In the notes additional information about marks or in some instances identified sex of the specimen is represented.

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age ()	Notes
1135 1	*Sus domesticus*	pig	phalanx 1.	com.	left	90	2	Glpe=33 Bp=16 SD=12 Bd=14	fused		
1135 2	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	right	95-100	3	Glpe=42 Bp=13 SD=1- Bd=12	fused		
1135 3	*Bos taurus*	cattle	metatarsus	pr. frag. with P.E.	right	10	49	-	fused		
1135 4	*Sus domesticus*	pig	tibia	body frag.	right	25	10	-			
1135 5	*Ovis aries/ Capra hircus*	sheep/goat	tibia	body frag.	right	40-45	11	-			
1135 6	*Ovis aries/ Capra hircus*	sheep/goat	costa	pr. frag.	left	-	4	-			
1135 7	*Bos taurus*	cattle	costa	pr. frag.	-	-	24	-			
1135 8	*Sus domesticus*	pig	teeth	C1i	right	-	2	-			
1135 9	*Gallus gallus domesticus*	chicken	humerus	frag. with P.E.	right	30	<1	Bp=19			
1135 10	*Rodentia*	rodent (mouse)	femur	frag. with P.E.frag. without D.E.	-	80	<1	Bp=6 SC=3			
1135 11	*Sus domesticus*	pig	fibula	body frag.	-	40	1	-	fused		
1135 12	*Sus domesticus*	pig	teeth	I1s	left	<10	<1	-	unfused		
1194 1	*Sus domesticus*	pig	costa	pr. frag.	right	-	4	-			
1194 2	*Sus domesticus*	pig	astragalus	frag.	right	90	7	GL1=35 GLm=32			
1194 3	Sus domesticus	pig	teeth	C frag.	-	-	<1	-			
1194 4		fish	vertebra	com.	-	95-100	<1	GL=11 SD=8			
1194 5		fish	vertebra	com.	-	95-100	<1	GL=16 SD=11			
1156 1	*Sus domesticus*	pig	astragalus	com.	right	95-100	12	GL1=44 GLm=40			
1156 2	*Bos taurus*	cattle	tarsalia (scafo-cuboide)	frag.	left	30-40	21	-			
1156 3	*Sus domesticus*	pig	metatarsus 2.	com.	left	95-100	1	GL=58	fused		
1156 4	*Sus domesticus*	pig	metatarsus 5.	com.	left	95-100	2	GL=62	fused		
1156 5	*Bos taurus*	cattle	metatarsus	frag. with P.E.	left	40	113	Bp=53 Dp=47	fused		
1156 6	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	frag. with P.E.	left	60	12	Bp=19 Dp=19	fused		
1156 7	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	body frag.	-	30	4	-			

1156 8	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	body frag.	-	40	7	-			
1156 9	*Bos taurus*	cattle	femur	dis. frag.	right	10-15	39	-			
1156 10	*Bos taurus*	cattle	femur	dis. frag.	right	20	76	-			
1156 11	*Bos taurus*	cattle	femur	P.E. frag.	left	5	33	-			
1156 12	*Bos taurus*	cattle	femur	P.E. frag.	-	5	22	-			possible gnawing marks
1156 13	*Sus domesticus*	pig	pelvis	frag.	left	20	25	LAR=30	Fused		
1156 14	*Sus domesticus*	pig	pelvis	frag.	left	20	32	LAR=31	Fused		
1156 15	*Sus domesticus*	pig	pelvis	frag.	right	20	24	LAR=27	Fused		
1156 16	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	right	10	6	-			
1156 17	*Sus domesticus*	pig	pelvis	frag.	right	5	5	-			
1156 18	*Sus domesticus*	pig	pelvis	frag.	left	5	6	-			
1156 19	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	right	2-5	2	-			
1156 20	-	medium mammal	vertebra thoracales	frag.	-	-	4	-			
1156 21	*Sus domesticus*	pig	vertebra cervicales	frag.	-	25-30	9	-			
1156 22	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag. with P.E.	right	5-10	<1	-			
1156 23	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag.	-	5-10	<1	-			
1156 24	*Bos taurus*	cattle	costa	frag.	-	5-10	4	-			
1156 25	*Bos taurus*	cattle	costa	pr. frag.	-	1	22	-			
1156 26	*Sus domesticus*	pig	cranium	frag.	left	5-10	22	-			
1156 27	*Dama Dama*	fallow deer	cranium	frag.	-	5	5	-			
1156 28	*Bos taurus*	cattle	phalanx 1.	com.	right (front)	95-100	28	GLpe=57 Bp=35 SD=28 Bd=32	fused		
1156 29	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	left	95-100	2	GL=38 Bp=14 Bd=13	fused		
1156 30	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	left	95-100	4	GL=41 Bp=16 Bd=16	fused		
1156 31	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag. with P.E.	right	30	8	Bp=24 Dp=17	fused		
1156 32	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag. with D.E.	left	35	6	Bd=25 Db=17	fused		
1156 33	*Sus domesticus*	pig	metacarpus	frag. with D.E.	-	30	4	Bd=17 Dd=18	fused		
1156 34	*Sus domesticus*	pig	metacarpus 4.	frag. with P.E.	left	40	2	Bp=15 Dp=16	fused		
1156 35	*Sus domesticus*	pig	metacarpus 4.	frag. with P.E.	right	40	2	Bp=15 Dp=16	fused		
1156 36	*Sus domesticus*	pig	radius	frag. with P.E.	right	30	8	Bp=29	fused		
1156 37	*Sus domesticus*	pig	radius	frag.	right	20	9	-			
1156 38	*Ovis aries/ Capra hircus*	sheep/goat	radius	body frag.	left	70	11	-			
1156 39	*Ovis aries/ Capra hircus*	sheep/goat	radius	frag. with ulna frag.	left	45	12	-			
1156 40	*Equus caballus*	horse	radius	frag. with D.E.	right	15-20	82	Bd=72 BFd=64 Dd=42	fused		
1156 41	*Bos taurus*	cattle	radius	frag. with D.E. with ulna frag.	left	25	122	Bd=69 Dd=49	fused		
1156 42	*Sus domesticus*	pig	ulna	pr. frag.	right	40	12	BPC=21			
1156 43	*Sus domesticus*	pig	ulna	pr. frag.	right	40	10	DPA=28 BPC=19			
1156 44	*Sus domesticus*	pig	ulna	pr. frag.	right	30	17	DPA=35 BPC=19			cut marks
1156 45	*Sus domesticus*	pig	ulna	pr. frag.	right	30	10	DPA=34 BPC=20			
1156 46	*Ovis aries/ Capra hircus*	sheep/goat	ulna	pr. frag.	right	20	2	BPC=15			

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
115647	*Ovis aries/ Capra hircus*	sheep/goat	ulna	pr. frag.	right	50	3	BPC=17			
115648	*Sus domesticus*	pig	metatarsus 4.	frag. with P.E.	right	30	3	BP=15 Dp=22	fused		
115649	*Bos taurus*	cattle	pelvis	frag.	left	10	76	-			
115650	*Ovis aries/ Capra hircus*	sheep/goat	humerus	frag. with D.E.	left	20	12	Bd=31 Dd=26	fused		
115651	*Ovis aries/ Capra hircus*	sheep/goat	humerus	frag. with D.E.	left	35-40	29	Bd=35 Dd=29	fused		
115652	*Sus domesticus*	pig	humerus	dis. frag.	left	35	10	-	fused		
115653	*Sus domesticus*	pig	humerus	dis. frag.	right	30	30	-	fused		
115654	*Sus domesticus*	pig	humerus	frag. with D.E.	right	20	21	Bd=47 Dd=35	fused		
115655	*Ovis aries/ Capra hircus*	sheep/goat	scapula	frag. with D.E.	left	30	8	SLC=19 GLP=30 LG=23 BG=20	fused		
115656	*Sus domesticus*	pig	scapula	frag. with D.E.	left	30	14	LG=29 BG=27	fused		
115657	*Sus domesticus*	pig	scapula	dis. frag.	right	20	6	-			
115658	*Sus domesticus*	pig	scapula	dis. frag.	left	10	20	-			
115659	*Sus domesticus*	pig	scapula	frag. with D.E.	right	30-40	17	SLC=23 GLP=33 LG=27 BG=23	fused		
115660	*Sus domesticus*	pig	mandibula, teeth	frag. with M2i, M3i	right	10	39	M3- L=27 B=15		7-14 m, subadult (e+a)	
115661	*Sus domesticus*	pig	cranium, teeth	frag. with Pm3s, Pm4s	left	10	18	-			
115662	*Sus domesticus*	pig	teeth	C1s frag.	-	-	4	-			male
115663	*Sus domesticus*	pig	teeth	C1i frag.	left	-	4	-			male
115664	*Sus domesticus*	pig	teeth	C1i frag.	left	-	7	-			male
115665	*Bos taurus*	cattle	mandibula, teeth	frag. with P2i, P3i	right	10	11	-		30-33 m, eruption P2s, P3s	
115666	*Bos taurus*	cattle	mandibula, teeth	frag. with P2i, P3i	left	15	30	-			
115667	*Bos taurus*	cattle	mandibula, teeth	frag. with P2i, P3i	left	15	38	-			
115668	*Bos taurus*	cattle	teeth	I	-	100	2	-			
115669	*Bos taurus*	cattle	mandibula, teeth	frag. with M3i	left	-	90	M3- L=37 B=15			
115670	*Bos taurus*	cattle	mandibula, teeth	frag. with Pm4i	-	-	12	-		5-6 y	
115671	*Bos taurus*	cattle	cranium, teeth	frag. with Pm4s, M1s	left	-	38	-			
115672	*Bos taurus*	cattle	mandibula, teeth	frag. with M2i	-	-	34	M2- L(crown)=36 B=26		5-6 y	
115673	*Bos taurus*	cattle	teeth	M3i	-	-	37	M3- L(crown)=39 B=28		5-6 y	
115674	*Bos taurus*	cattle	cranium, teeth	frag. with M1s	-	-	18	-			
115675	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M3s	-	-	6	-			
115676	*Sus domesticus*	pig	metapode	frag. without D.E.	-	20	2	-	unfused		
115677	*Gallus gallus domesticus*	chicken	femur	com.	left	95-100	2	GL=80 LM=76 Bp=16 Dp=12 Sc=7 Bd=16 Dd=14	fused		
115678	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E. with D.E.frag.	right	80-90	1	Bp=13 SC=7	fused		
115679	*Gallus gallus domesticus*	chicken	femur	body frag.	left	80-90	2	SC=8	fused		
115680	*Galliformes sp.*	galliforms	femur	frag. with D.E.	right	70-80	<1	-	fused		
115681	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with D.E.	right	30	<1	Bd=10 Dd=11	fused		
115682	-	bird	tibiatarsus	frag. with D.E.	left	60-80	<1	Bd=5 Dd=5 SC=2	fused		smaller than chicken

115683	*Galliformes sp.*	galliforms	ulna	frag. with D.E.	left	30	<1	Did=9	fused		
115684	*Gallus gallus domesticus*	chicken	coracoid	com.	right	95-100	<1	GL=50 Lm=48 Bb=13 BF=10	fused		
115685	*Galliformes sp.*	galliforms	tibia	frag. with P.E.	right	10-20	<1	Dip=18	fused		
11241	*Equus caballus*	horse	pelvis	frag.	right	20-25	154	LAR=59	Fused		
11242	*Equus caballus*	horse	tibia	pr. frag.	left	15-20	91	-			
11243	*Equus caballus*	horse	femur	dis. frag.	right	5-10	40	-			
11244	*Equus caballus*	horse	calcaneum	frag. without P.E.	left	80-90	63	-	Unfused		Same individual as *
11245	*Equus caballus*	horse	metacarpus	com.	right	95-100	220	GL=230 GL1=227 L1=222 Bp=54 Dp=35 SD=35,5 CD=104 DD=24 Bd=52 Dd=38	Fused		
11246	*Equus caballus*	horse	metacarpus	com.	right	95-100	151	GL=213 GL1=209 L1=205 Bp=48 Dp=32 SD=34 CD=191 DD=193 Bp=47 Dd=33,5	Fused		
11247	*Equus caballus*	horse	metacarpus	body frag.	-	70-75	102	SD=30 DD=21,5			
11248	*Equus caballus*	horse	metapode	frag. with D.E.	-	20-25	34	BD=48 Dd=36,5	Fused		
11249	*Equus caballus*	horse	metapode	frag. with D.E.	-	40	63	Bd=46 Dd=36	Fused		
112410	*Equus caballus*	horse	metatarsus	frag. with P.E.	right	40-50	88	Bp=47 Dp=44	Fused		
112411	*Equus caballus*	horse	metatarsus	frag. with P.E. with D.E. frag.	left	90	239	GL=272 GL1=270 L1=265 Bp=53 Dp=45 SD=32 CD=119 DD=28 Dd=40			*
112412	*Equus caballus*	horse	metacarpale lateral	pr. frag.	right	40-50	9	-			
112413	*Equus caballus*	horse	metacarpale medial	pr. frag.	right	50-60	10	-			
112414	*Equus caballus*	horse	metacarpale medial	pr. frag.	right	50	6	-			
112415	*Equus caballus*	horse	metatarsale medial	pr. frag.	right	90	17	-			
112416	*Equus caballus*	horse	metatarsale lateral	pr. frag.	left	90	14	-			*
112417	*Equus caballus*	horse	phalanx 1.	com.	left	95-100	67	GL=82 Bp=56 BFp=49 Dp=36 SD=34 Bd=46 BFd=42	Fused		
112418	*Equus caballus*	horse	phalanx 1.	com.	right	95-100	58	GL=86 Bp=52 BFp=47 Dp=38 SD=32 Bd=43,5 BFd=41	Fused		
112419	*Equus caballus*	horse	phalanx 1.	com.	left	95-100	52	GL=83 Bp=56 BFp=49 Dp=39 SD=34 Bd=46 BFd=44	Fused		
112420	*Equus caballus*	horse	astragalus	com.	left	95-100	80	GH=62 GB=60 BFd=52 LmT=61			*
112421	*Equus caballus*	horse	tarsalia (scafoide)	com.	left	90-95	10	GB=22			*
112422	*Equus caballus*	horse	astragalus	com.	right	95-100	68	GH=58 GB=60 BFd=50 LmT=58			
112423	*Equus caballus*	horse	metacarpus	pr. frag.	-	15	25	-			
112424	*Equus caballus*	horse	tarsalia (scafoide, b. cuneiforme, s. cuneiforme)	com.	left	90	47	GB=57	Fused		*. 3 tarsalia fused together

1124 25	*Equus caballus*	horse	femur	P.E. frag.	right	5	47	DC=54			
US nr.	**Taxon**	**Animal**	**Skeletal element**	**Bone element**	**Body side**	**conservation (%)**	**weight (g)**	**Measurements (mm)**	**Epiphyseal fusion**	**Dental Age**	**Notes**
1124 26	*Bos taurus*	cattle	phalanx 3.	com.	left	85-90	3	DLS=93 Ld=64 MBS=24			
1124 27	*Bos taurus*	cattle	phalanx 2.	com.	right (front)	95-100	10	Glpe=35 Bp=24 SD=20 BD=19,5	Fused		
1124 28	*Bos taurus*	cattle	phalanx 2.	com.	left (hind)	95-100	23	Glpe=46 Bp=25 SD=27,5 Bd=29	Fused		
1124 29	*Bos taurus*	cattle	phalanx 1.	frag.	left	80	15	SD=22 Bd=23	Fused		
1124 30	*Bos taurus*	cattle	phalanx 1.	com.	right (hind)	95-100	26	Glpe=59 Bp=32 SD=28 Bd=30	Fused		cutmarks (pr.)
1124 31	*Bos taurus*	cattle	phalanx 1.	com.	right (hind)	95-100	27	Glpe=60 Bp=29 SD=26,5 Bd=28	Fused		cutmark
1124 32	*Bos taurus*	cattle	phalanx 1.	frag.	left (front)	95	23	Glpe=58 Bp=28 SD=25	Fused		
1124 33	*Sus domesticus*	pig	phalanx 3.	com.	left	100	3	DLS=33 Ld=33 MBS=12			
1124 34	*Sus domesticus*	pig	phalanx 3.	com.	left	95-100	2	DLS=30 Ld=28,5 MBS=16			
1124 35	*Sus domesticus*	pig	phalanx 2.	com.	right (front)	95	2	GL=22 Bp=14 SD=12 Bd=12	Fused		
1124 36	*Sus domesticus*	pig	phalanx 1.	com.	right	100	5	Glpe=34 Bp=16 SD=14 Bd=15	Fused		
1124 37	*Sus domesticus*	pig	phalanx 1.	com.	left	95-100	6	Glpe=39 Bp=17,5 SD=14 Bd=17	Fused		
1124 38	*Sus domesticus*	pig	phalanx 1.	com.	right	95-100	5	Glpe=35 Bp=17 SD=14 Bd=17	Fused		
1124 39	*Sus domesticus*	pig	phalanx 1.	com.	left	90	3	Glpe=32,5 Bp=13 SD=10 Bd=11	Fused		
1124 40	*Sus domesticus*	pig	phalanx 1.	com.	right	100	4	Glpe=37 Bp=17 SD=13 Bd=16	Fused		
1124 41	*Sus domesticus*	pig	phalanx 1.	frag. with P.E. with D.E. frag.	right	70-75	4	Glpe=39 Bp=17,5 SD=14 Bd=17	Fused		
1124 42	*Sus domesticus*	pig	phalanx 1.	com.	right	95-100	2	Glpe=23 Bp=11 SD=7,5 Bd=8,5	In fusion (pr.)		
1124 43	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 3.	frag.	left	90	2	Ld=6			
1124 44	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	left	100	2	Glpe=33 Bp=13 SD=10 Bd=11	Fused		
1124 45	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	right	95	4	Glpe=38 Bp=12,5 SD=11 BD=12	Fused		
1124 46	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	right	90-95	3	Glpe=32 Bp=11 SD=9 Bd=10	In fusion		
1124 47	*Ovis aries/ Capra hircus*	sheep/goat	phalanx 1.	com.	left	90-95	3	Glpe=34 Bp=11 SD=8,5 BD=10,5	Fused		
1124 48	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag. with P.E.	right	70-80	12	Bp=20,5 Dp=14	Fused		cutmark/chopmark
1124 49	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag. with P.E.frag.	right	15-20	6	-			
1124 50	*Bos taurus*	cattle	metacarpus	D.E.frag.	-	30	64	Bd=68 Dd=34,5	Fused		
1124 51	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag. with. P.E.frag.	right	40	11	-	Fused		
1124 52	*Sus domesticus*	pig	metacarpus 3.	frag. with. P.E.frag. without D.E.	left	80	2	[GL]no E.D.=36 Bp=12 B=8,5	Unfused (dis.)		
1124 53	*Sus domesticus*	pig	metacarpus 3.	frag. with P.E. without D.E.	left	80	7	[GL]=60 Bp=20 B=14	Unfused (dis.)		
1124 54	*Sus domesticus*	pig	metacarpus 3.	com.	right	95-100	13	GL=72 Bp=21,5 B=15 Bd=17	Fused		
1124 55	*Sus domesticus*	pig	metacarpus 3.	frag. without D.E.	right	80	9	[GL]=62 Bp=21 B=15	Unfused (dis.)		

112456	*Sus domesticus*	pig	metacarpus 4.	com.	right	95-100	11	GL=76 LeP=73 BP=15 B=12,5 Bd=17	In fusion (dis.)		
112457	*Sus domesticus*	pig	metacarpus 4.	frag. without D.E.	left	80	7	[GL]=61 [LeP]=58 Bp=15 B=12	Unfused (dis.)		
112458	*Sus domesticus*	pig	metatarsus 3.	frag. with P.E.	left	20	3	Bp=15,5			
112459	*Sus domesticus*	pig	metatarsus 3.	frag. with P.E.	right	30-40	6	Bp=14,5	Fused		
112460	*Sus domesticus*	pig	metatarsus 3.	com.	right	95	11	GL=77 LeP=76 Bp=17 B=14 Bd=16	Fused		
112461	*Sus domesticus*	pig	metatarsus 3.	frag. with P.E.	left	30-40	6	Bp=16	Fused		
112462	*Sus domesticus*	pig	metatarsus 4.	frag. with P.E.	right	40-50	5	Bp=12,5			
112463	*Sus domesticus*	pig	metatarsus 4.	com.	left	95	10	GL=85 LeP=82 Bp=14 B=11 Bd=15	Fused		
112464	*Sus domesticus*	pig	metapode	D.E.	-	15-20	3	Bd=17	Unfused		
112465	*Sus domesticus*	pig	metacarpus	frag. with D.E.	right	60-70	10	Bd=17	Fused		
112466	*Sus domesticus*	pig	metatarsus 5.	frag. without D.E.	left	80	3	[GL]no E.D.=55	Unfused (dis.)		
112467	*Sus domesticus*	pig	metatarsus 5.	frag. without D.E.	left	80	3	[GL]no E.D.=53	Unfused (dis.)		
112468	*Sus domesticus*	pig	metatarsus 2.	com.	left	95-100	4	GL=63	Fused		
112469	*Sus domesticus*	pig	metatarsus 2.	frag. with P.E.	left	45-50	2	-	Fused		
112470	*Bos taurus*	cattle	radius	frag. with P.E.frag.	left	5-10	32	-			
112471	*Bos taurus*	cattle	radius	frag. with ulna frag.	left	45-50	111	-			
112472	*Bos taurus*	cattle	radius	frag. with P.E.frag.	right	15-20	51	-	Fused		cutmark
112473	*Ovis aries/ Capra hircus*	sheep/goat	radius	body frag.	left	30-40	13	-			cutmark
112474	*Ovis aries/ Capra hircus*	sheep/goat	radius	frag. with P.E. frag.	left	30-40	10	Bp=31 BFp=28	Fused		chopmark
112475	*Ovis aries/ Capra hircus*	sheep/goat	radius	dis. Body frag.	right	50	15	-			
112476	*Ovis aries/ Capra hircus*	sheep/goat	radius	dis. Body frag.	left	30-35	8	-			
112477	*Sus domesticus*	pig	radius	frag. with P.E.	left	50-60	19	Bp=29	Fused		
112478	*Sus domesticus*	pig	radius	frag. with P.E.	right	50	21	Bp=31	Fused		
112479	*Sus domesticus*	pig	radius	frag. with P.E.	right	40	15	Bp=30	Fused		
112480	*Sus domesticus*	pig	radius	body frag.	left	25-30	10	-			
112481	*Sus domesticus*	pig	radius	body frag.	right	30	6	-			Black colour
112482	*Sus domesticus*	pig	metapode	frag. without D.E.	-	30-40	2	-	Unfused (dis.)		
112483	*Bos taurus*	cattle	ulna	pr. Body frag.	left	70-80	45	DPA=57 BPC=41			cutmarks
112484	*Sus domesticus*	pig	ulna	body frag.	left	40-50	22	BPC=22			
112485	*Sus domesticus*	pig	ulna	body frag.	right	20-30	14	-			
112486	*Sus domesticus*	pig	ulna	pr. frag. without P.E.	right	20-30	13	DPA=37	Unfused (pr.)		cutmarks
112487	*Sus domesticus*	pig	ulna	body frag.	left	50-60	19	DPA=37 BPC=20			
112488	*Sus domesticus*	pig	ulna	body frag.	right	20-30	10	-			
112490	*Sus domesticus*	pig	ulna	pr. Body frag.	right	15-20	9	-			gnawing marks
112491	*Ovis aries/ Capra hircus*	sheep/goat	ulna	pr. Body frag.	left	40-50	5	DPA=23 BPC=16			
112492	*Ovis aries/ Capra hircus*	sheep/goat	ulna	body frag.	left	20	3	BPC=18			
112493	*Bos taurus*	cattle	humerus	frag. with D.E.frag.	left	20	139		Fused		
112494	*Bos taurus*	cattle	humerus	D.E.frag.	right	20-30	124	Bd=74	Fused		

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1124 95	*Bos taurus*	cattle	humerus	dis. frag.	left	5-10	30	-			
1124 96	*Bos taurus*	cattle	humerus	dis. frag. with D.E.frag.	left	10	44	-	In fusion		
1124 97	*Bos taurus*	cattle	humerus	D.E.frag.	left	10	36	-			chopmark
1124 98	*Bos taurus*	cattle	humerus	D.E.frag.	left	10	30	-			
1124 99	*Sus domesticus*	pig	humerus	dis. frag.	left	40-50	39	-			
1124 100	*Sus domesticus*	pig	humerus	dis. frag.	right	30-40	27	-			
1124 101	*Sus domesticus*	pig	humerus	dis. frag.	left	40	28	-			
1124 102	*Sus domesticus*	pig	humerus	frag. with D.E.frag.	left	30-35	25	-	Fused		
1124 103	*Sus domesticus*	pig	humerus	dis. frag.	right	30-40	27	-			chopmark
1124 104	*Sus domesticus*	pig	humerus	dis. frag.	left	20-30	17	-			
1124 105	*Sus domesticus*	pig	humerus	frag. with D.E.frag.	right	60	54	Bd=41	Fused		
1124 106	*Sus domesticus*	pig	humerus	dis. frag.	left	40-50	24	-			
1124 107	*Sus domesticus*	pig	humerus	dis. frag.	left	15-20	8	-			
1124 108	*Sus domesticus*	pig	humerus	dis. frag.	right	20	11	-			
1124 109	*Sus domesticus*	pig	humerus	dis. frag. with D.E.	left	15-20	22	Bd=37	Unfused (dis.)		
1124 110	*Sus domesticus*	pig	humerus	pr. frag. without P.E.	right	40-50	10	-	Unfused (pr.)		
1124 111	*Ovis aries/ Capra hircus*	sheep/goat	humerus	frag. with D.E.	right	20-25	13	Bd=29 BT=29	Fused		
1124 112	*Ovis aries/ Capra hircus*	sheep/goat	humerus	frag. with D.E.	left	40-50	28	Bd=32 BT=32	Fused		cutmark/chopmark
1124 113	*Ovis aries/ Capra hircus*	sheep/goat	humerus	pr. frag. without P.E.	left	20-30	10	-	Unfused (pr.)		
1124 114	*Sus domesticus*	pig	humerus	dis. Body frag.	right	70-80	2	-			young animal
1124 115	*Bos taurus*	cattle	humerus	D.E.frag.	left	5-10	26	-			
1124 116	*Bos taurus*	cattle	femur	D.E.frag.	left	5-10	33	-	Fused		
1124 117	*Bos taurus*	cattle	femur	P.E. frag.	-	5-10	19	DC=40,5	Unfused (pr.)		
1124 118	*Bos taurus*	cattle	femur	P.E. frag.	-	5-10	18	-	Unfused (pr.)		
1124 119	*Sus domesticus*	pig	femur	pr. frag. without P.E.	left	20-30	17	-	Unfused (pr.)		
1124 120	*Sus domesticus*	pig	femur	frag. with P.E.frag.	left	20-30	21	-	In fusion (pr.)		
1124 121	*Sus domesticus*	pig	femur	D.E.frag.	left	10	26	-	Unfused (dis.)		
1124 122	*Sus domesticus*	pig	femur	pr. Body frag.	left	10-20	19	-			
1124 123	*Sus domesticus*	pig	femur	pr. Body frag.	left	10-20	15	-			
1124 124	*Sus domesticus*	pig	femur	body frag.	right	20	21	-			
1124 125	*Sus domesticus*	pig	femur	dis. frag.	right	10-15	6	-			
1124 126	*Sus domesticus*	pig	femur	body frag.	left	30-40	41	-			
1124 127	*Sus domesticus*	pig	humerus	frag. with D.E.	right	20	27	-	Fused		chopped through (E.D.)
1124 128	*Ovis aries/ Capra hircus*	sheep/goat	humerus	dis. frag.	right	30-40	13	-			chopped through (E.D.)
1124 129	*Ovis aries/ Capra hircus*	sheep/goat	humerus	frag. with D.E.	right	30-40	20	-	Fused		cutmark; chopped through (E.D.)
1124 130	*Ovis aries/ Capra hircus*	sheep/goat	femur	frag. with D.E.	right	40	26	Bd=33	Fused		
1124 131	*Ovis aries/ Capra hircus*	sheep/goat	femur	pr. frag. without P.E.	left	15-20	9	-	Unfused (pr.)		
1124 132	*Ovis aries/ Capra hircus*	sheep/goat	femur	body frag.	-	15	6	-			
1124 133	*Ovis aries/ Capra hircus*	sheep/goat	femur	P.E.	-	5-10	2	DC=20	Unfused (pr.)		

1124 134	*Ovis aries/ Capra hircus*	sheep/goat	femur	frag. with P.E.	left	30-40	21	BP=45 DC=20	In fusion		
1124 135	*Ovis aries/ Capra hircus*	sheep/goat	femur	frag. with P.E.	left	25	21	BP=41 DC=18	In fusion (pr.)		
1124 136	*Felis catus*	cat	femur	frag. with P.E.	right	40	4	BP=20 DC=9	In fusion		
1124 137	*Felis catus*	cat	tibia	com.	right	100	8	GL=116 Bp=20 SD=7 Bd=15	In fusion		
1124 138	*Bos taurus*	cattle	tibia	frag. with D.E.	right	45-50	146	Bd=60	Fused		
1124 139	*Bos taurus*	cattle	tibia	frag. with D.E.	left	15-20	51	Bd=65	Fused		
1124 140	*Sus domesticus*	pig	tibia	pr. Body frag.	left	25-30	24	-			
1124 141	*Sus domesticus*	pig	tibia	frag. with D.E.	left	45-50	27	Bd=27	Fused		
1124 142	*Sus domesticus*	pig	tibia	pr. Body frag.	left	20-25	13	-			
1124 143	*Sus domesticus*	pig	tibia	body frag.	right	15-20	6	-			
1124 144	*Ovis aries/ Capra hircus*	sheep/goat	tibia	pr. Body frag.	right	20-25	14	-			
1124 145	*Ovis aries/ Capra hircus*	sheep/goat	tibia	frag. with D.E.	right	40	13	Bd=25	Fused		
1124 146	*Ovis aries/ Capra hircus*	sheep/goat	tibia	body frag.	right	50	12	-			
1124 147	*Ovis aries/ Capra hircus*	sheep/goat	tibia	frag. with D.E.frag.	left	30-40	14	Bd=26	Fused		
1124 148	*Ovis aries/ Capra hircus*	sheep/goat	tibia	D.E.frag.	right	20-25	13	Bd=26	Fused		
1124 149	*Ovis aries/ Capra hircus*	sheep/goat	tibia	dis. Body frag.	-	25-30	11	-			
1124 150	*Ovis aries/ Capra hircus*	sheep/goat	tibia	body frag.	right	50	19	-			
1124 151	*Ovis aries/ Capra hircus*	sheep/goat	tibia	frag. with D.E.	left	55-60	30	Bd=24 Sd=15	Fused		
1124 152	*Ovis aries/ Capra hircus*	sheep/goat	tibia	pr. frag.	left	20	17	-			
1124 153	*Ovis aries/ Capra hircus*	sheep/goat	tibia	body frag.	-	25-30	6	-			
1124 154	*Ovis aries/ Capra hircus*	sheep/goat	tibia	D.E.	left	5-10	5	Bd=28	Unfused (dis.)		
1124 155	*Sus domesticus*	pig	fibula	frag.	left	20-25	1	-			
1124 156	*Ovis aries/ Capra hircus*	sheep/goat	ulna	Pr. frag. with P.E.	right	45-50	7	DPA=25	Fused		
1124 157	*Sus domesticus*	pig	calcaneum	pr. frag. without P.E.	left	60-70	8	-	Unfused (pr.)		
1124 158	*Sus domesticus*	pig	calcaneum	frag. without P.E.	left	80	13	[GL]no E.P.=71 GB=23	Unfused (pr.)		
1124 159	*Sus domesticus*	pig	calcaneum	dis. frag.	right	70-75	11	-			
1124 160	*Sus domesticus*	pig	calcaneum	frag. without P.E.	right	80	10	[GL]no E.P.=65 GB=22	Unfused (pr.)		
1124 161	*Sus domesticus*	pig	calcaneum	frag. without P.E.	right	75-80	4	-	Unfused (pr.)		
1124 162	*Bos taurus*	cattle	patella	frag.	left	80-90	33	GL=67			
1124 163	*Bos taurus*	cattle	patella	frag.	right	80-90	27	GL=61			chopmark
1124 164	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	frag. with P.E.frag.	left	10-15	6	-	Fused		
1124 165	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	frag. with P.E.	left	75-80	12	Bp=19,5 Dp=19,5	Fused		
1124 166	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	frag. with P.E.frag.	right	10-15	4	-	Fused		
1124 167	*Ovis aries/ Capra hircus*	sheep/goat	metatarsus	frag. with P.E.	right	20	7	Bp=20 Dp=19			
1124 168	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag.	-	15-20	5	-			
1124 169	*Ovis aries/ Capra hircus*	sheep/goat	metacarpus	frag. with P.E.frag.	right	60	12	-			
1124 170	*Bos taurus*	cattle	metacarpus	P.E.frag.	right	5-10	31	-			burnmarks (black stains)
1124 171	*Bos taurus*	cattle	metatarsus	frag. with D.E.	-	25-35	66	Bd=60 Dd=32	Fused		

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1124 172	*Bos taurus*	cattle	metatarsus	frag. with P.E.	left	30-35	60	Bp=44 Dp=38,5	Fused		
1124 173	*Bos taurus*	cattle	metacarpus	frag. with P.E.frag.	left	20-25	43	-	Fused		
1124 174	*Bos taurus*	cattle	metacarpus	frag. with P.E.frag.	left	20-25	51	-	Fused		
1124 175	*Bos taurus*	cattle	astragalus	frag.	left	75	34	GLm=57 Bd=39			
1124 176	*Bos taurus*	cattle	carpalia (semilunare)	com.	-	95-100	17	-			
1124 177	*Bos taurus*	cattle	sesamoidea	com.	-	95-100	3	-			
1124 178	*Bos taurus*	cattle	carpalia (semilunare)	com.	-	95	10	-			
1124 179	*Sus domesticus*	pig	tarsalia (scafoide)	com.	-	95-100	4	-			
1124 180	*Ovis aries/ Capra hircus*	sheep/goat	carpalia (piramidale)	com.	-	95-100	2	-			
1124 181	*Bos taurus*	cattle	pelvis	frag.	left	15-20	153	LA=70 LAR=55	Fused		
1124 182	*Bos taurus*	cattle	pelvis	frag.	left	<5	22	-			
1124 183	*Bos taurus*	cattle	pelvis	frag.	right	<5	12	-			
1124 184	*Bos taurus*	cattle	pelvis	frag.	right	5	39	-			
1124 185	*Bos taurus*	cattle	pelvis	frag.	left	-	25	-			
1124 186	*Sus domesticus*	pig	pelvis	frag.	right	30-35	44	SH=25 SB=14	Fused		Chopmark
1124 187	*Sus domesticus*	pig	pelvis	frag.	left	5-10	20	LAR=31 LA=35	Fused		
1124 188	*Sus domesticus*	pig	pelvis	frag.	left	20	35	SH=28 SB=13	Fused		
1124 189	*Sus domesticus*	pig	pelvis	frag.	right	10	16	-			Cutmarks
1124 190	*Sus domesticus*	pig	pelvis	frag.	left	5-10	10	-			Cut/chopmark
1124 191	*Sus domesticus*	pig	pelvis	frag.	right	10	9	-			
1124 192	*Sus domesticus*	pig	pelvis	frag.	right	10	12	-			Chopped through
1124 193	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	left	10	10	-			
1124 194	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	left	5-10	6	-			
1124 195	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	left	<5	3	-			
1124 196	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	left	5-10	7	-			
1124 197	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	left	5-10	6	-			
1124 198	*Ovis aries/ Capra hircus*	sheep/goat	pelvis	frag.	right	10-15	12	-			cutmark/chopmark
1124 199	*Sus domesticus*	pig	pelvis	frag.	-	-	2	-			cutmark; young animal
1124 200	*Bos taurus*	cattle	scapula	frag. with D.E.	left	20	72	SLC=45 GLP=60 LG=53 BG=44	Fused		
1124 201	*Bos taurus*	cattle	scapula	frag. with D.E.	right	20	70	SLC=53 GLP=66 LG=56 BG=45	Fused		
1124 202	*Bos taurus*	cattle	scapula	frag. with D.E.frag.	left	10-15	46	-			
1124 203	*Bos taurus*	cattle	scapula	D.E.frag.	right	5-10	27	-			Chopped through (both sides)
1124 204	*Bos taurus*	cattle	scapula	dis. Body frag.	right	10	34	-			
1124 205	*Sus domesticus*	pig	scapula	frag. with D.E.	right	10	12	SLC=22 GLP=33 LG=27 BG=23	Fused		
1124 206	*Sus domesticus*	pig	scapula	frag. with D.E.	right	10	13	SLC=23 GLP=32 LG=25	Fused		
1124 207	*Sus domesticus*	pig	scapula	frag. with D.E.	left	10	12	SLC=23 GLP=33 LG= 25 BG=24	Fused		Chopmark; Chopped through
1124 208	*Sus domesticus*	pig	scapula	frag. with D.E.	left	10	11	SLC=22 GLP=32 BG=24	Fused		Chopped through

1124 209	*Sus domesticus*	pig	scapula	frag. with D.E.	left	10	19	SLC=25 GLP=40 LG=30 BG=27	Fused		
1124 210	*Sus domesticus*	pig	scapula	frag. with D.E.frag.	right	20	20	SLC=21			
1124 211	*Sus domesticus*	pig	scapula	frag. with D.E.frag.	left	20	20	SLC=21			
1124 212	*Sus domesticus*	pig	scapula	dis. frag.	left	15	9	-			
1124 213	*Sus domesticus*	pig	scapula	dis. Body frag.	right	5-10	8	-			
1124 214	*Sus domesticus*	pig	scapula	dis. frag.	left	10-15	8	-			gnawing marks
1124 215	*Sus domesticus*	pig	scapula	dis. frag.	right	10-15	8	-			
1124 216	*Sus domesticus*	pig	scapula	body frag.	right	10	7	-			
1124 217	*Sus domesticus*	pig	scapula	body frag.	right	10	10	-			
1124 218	*Sus domesticus*	pig	scapula	body frag.	right	10-15	13	-			
1124 219	*Sus domesticus*	pig	scapula	dis. Body frag.	right	10-15	10	-			
1124 220	*Ovis aries/ Capra hircus*	sheep/goat	scapula	dis. Body frag.	right	10	5	-			
1124 221	*Ovis aries/ Capra hircus*	sheep/goat	scapula	dis. frag.	left	10	2	-			
1124 222	*Ovis aries/ Capra hircus*	sheep/goat	scapula	frag. with D.E.frag.	right	10	6	-			
1124 223	*Ovis aries/ Capra hircus*	sheep/goat	scapula	frag. with D.E.	left	10	6	SLC=17 GLP=29 LG=21 BG=19	Fused		
1124 224	*Ovis aries/ Capra hircus*	sheep/goat	scapula	frag. with D.E.	left	10	8	SLC=17 GLP=29 LG=13 BG=19	Fused		
1124 225	*Bos taurus*	cattle	mandibula	frag.	right	<5	23	-			
1124 226	*Bos taurus*	cattle	cranium	frag.	left	<5	11	-			
1124 227	*Bos taurus*	cattle	cranium	frag.	-	<5	33	-			
1124 228	*Bos taurus*	cattle	mandibula	frag.	-	<5	9	-			
1124 229	*Bos taurus*	cattle	cranium	frag.	right	<5	30	-			
1124 230	*Bos taurus*	cattle	cranium	frag.	left	<5	14	-			
1124 231	*Bos taurus*	cattle	cranium	frag.	right	<5	26	-			
1124 232	*Ovis aries/ Capra hircus*	sheep/goat	cranium	frag.	-	<5	13	-			
1124 233	*Ovis aries/ Capra hircus*	sheep/goat	cranium	frag.	right	<5	24	-			
1124 234	*Ovis aries/ Capra hircus*	sheep/goat	cranium	frag.	-	-	4	-			
1124 235	*Ovis aries/ Capra hircus*	sheep/goat	cranium	frag.	left	<5	2	-			
1124 236	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	right	-	4	-			
1124 237	*Canis familiaris*	dog	mandibula	frag.	right	-	20	-			
1124 238	*Sus domesticus*	pig	tibia	body frag.	left	35-40	19	-			chopmark
1124 239	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	left	5-10	5	-			
1124 240	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	left	10	12	-			
1124 241	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	left	5	4	-			
1124 242	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	right	10-15	9	-			
1124 243	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	-	<5	2	-			
1124 244	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	-	5	4	-			
1124 245	*Bos taurus*	cattle	cranium	frag.	-	5-10	24	-			
1124 246	*Sus domesticus*	pig	cranium	frag.	left	5-10	11	-			
1124 247	*Sus domesticus*	pig	cranium	frag.	right	5-10	10	-			

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1124 248	*Sus domesticus*	pig	cranium	frag.	left	5-10	5	-			
1124 249	*Sus domesticus*	pig	mandibula	frag.	left	5-10	6	-			
1124 250	*Bos taurus*	cattle	cranium	frag.	-	-	42	-			
1124 251	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	-	5-10	9	-			
1124 252	*Ovis aries/ Capra hircus*	sheep/goat	mandibula	frag.	right	10	8	-			
1124 253	*Bos taurus*	cattle	mandibula	frag.	right	5-10	22	-			cutmark
1124 254	*Ovis aries/ Capra hircus*	sheep/goat	cranium	frag.	-	-	20	-			
1124 256	*Sus domesticus*	pig	axis	frag.	-	60	11	-			
1124 257	*Sus domesticus*	pig	vertebra thoracales	frag.	-	30-40	6	-			
1124 258	*Sus domesticus*	pig	vertebra lumbales	frag.	-	30	2	-			
1124 259	*Sus domesticus*	pig	vertebra thoracales	frag.	-	30-40	7	-			chopped through
1124 260	*Sus domesticus*	pig	vertebra lumbales	frag.	-	20	4	-			
1124 261	*Sus domesticus*	pig	vertebra lumbales	frag.	-	25-30	7	-			chopped through
1124 262	*Sus domesticus*	pig	vertebra lumbales	frag.	-	45-50	10	-			
1124 263	*Sus domesticus*	pig	vertebra thoracales	frag.	-	-	6	-			
1124 264	*Sus domesticus*	pig	vertebra lumbales	frag.	-	95-100	15	-			
1124 265	*Sus domesticus*	pig	vertebra lumbales	frag.	-	30-40	4	-			
1124 266	*Sus domesticus*	pig	vertebra thoracales	frag.	-	50	8	-			
1124 267	*Sus domesticus*	pig	vertebra	frag.	-	-	2	-			chopped through
1124 268	*Sus domesticus*	pig	vertebra thoracales	frag.	-	10-15	3	-			chopped through
1124 269	*Sus domesticus*	pig	vertebra lumbales	frag.	-	10-15	3	-			chopped through
1124 270	*Sus domesticus*	pig	vertebra cervicales	frag.	-	20-25	6	-			
1124 271	*Sus domesticus*	pig	vertebra lumbales	frag.	-	40	4	-			chopped through
1124 272	*Ovis aries/ Capra hircus*	sheep/goat	vertebra	frag.	-	-	4	-			chopped through
1124 273	*Ovis aries/ Capra hircus*	sheep/goat	vertebra cervicales	frag.	-	50	10	-			chopped through
1124 274	*Ovis aries/ Capra hircus*	sheep/goat	vertebra cervicales	frag.	-	45-50	7	-			
1124 275	*Ovis aries/ Capra hircus*	sheep/goat	vertebra lumbales	frag.	-	40-45	7	-			
1124 276	*Ovis aries/ Capra hircus*	sheep/goat	vertebra lumbales	frag.	-	25-30	3	-			
1124 277	*Ovis aries/ Capra hircus*	sheep/goat	axis	frag.	-	25-30	8	-			
1124 278	*Ovis aries/ Capra hircus*	sheep/goat	axis	frag.	-	25-30	7	-			
1124 279	*Ovis aries/ Capra hircus*	sheep/goat	atlas	frag.	-	80-90	17	-			chopmark
1124 280	*Ovis aries/ Capra hircus*	sheep/goat	axis	frag.	-	75-80	12	-			
1124 281	*Ovis aries/ Capra hircus*	sheep/goat	axis	frag.	-	70-75	15	-			
1124 282	*Bos taurus*	cattle	vertebra thoracales	frag.	-	70-80	32	-			
1124 283	*Bos taurus*	cattle	vertebra lumbales	frag.	-	30	17	-			
1124 284	*Bos taurus*	cattle	vertebra	frag.	-	30	28	-			
1124 285	*Bos taurus*	cattle	vertebra thoracales	frag.	-	40-50	27	-			
1124 286	*Bos taurus*	cattle	vertebra lumbales	frag.	-	20-30	21	-			

1124 287	*Bos taurus*	cattle	vertebra cervicales	frag.	-	20-30	23	-			
1124 288	*Bos taurus*	cattle	vertebra	frag.	-	10-20	12	-			
1124 289	*Bos taurus*	cattle	vertebra lumbales	frag.	-	10-20	10	-			
1124 290	*Ovis aries/ Capra hircus*	sheep/goat	vertebra lumbales	frag.	-	30-40	16	-			
1124 291	*Ovis aries/ Capra hircus*	sheep/goat	axis	frag.	-	30-40	14	-			chopped through
1124 292	*Bos taurus*	cattle	vertebra thoracales	frag.	-	80	36	-			
1124 293	*Bos taurus*	cattle	vertebra	frag.	-	-	17	-			
1124 294	*Bos taurus*	cattle	axis	frag.	-	10-15	19	-			
1124 295	*Bos taurus*	cattle	mandibula	frag.	-	-	12	-			
1124 296	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag. with P.E.	left	-	3	-			
1124 297	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag. with P.E.	left	-	5	-			
1124 298	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag. with P.E.	left	-	4	-			
1124 299	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag. with P.E.	left	-	2	-			
1124 300	*Ovis aries/ Capra hircus*	sheep/goat	costa	frag. with P.E.	right	-	3	-			
1124 301	*Ovis aries/ Capra hircus*	sheep/goat	costa	pr. frag.	right	-	1	-			
1124 302	*Sus domesticus*	pig	costa	pr. frag.	left	-	2	-			
1124 303	*Sus domesticus*	pig	costa	frag. with P.E.	left	-	4	-			
1124 304	*Sus domesticus*	pig	costa	frag. with P.E.	left	-	5	-			
1124 305	*Sus domesticus*	pig	costa	frag. with P.E.	right	-	1	-			
1124 306	*Bos taurus*	cattle	costa	frag. with P.E.	left	-	9	-			
1124 307	*Bos taurus*	cattle	costa	P.E.frag.	right	-	5	-			
1124 308	*Bos taurus*	cattle	costa	P.E.frag.	right	-	7	-			
1124 309	*Bos taurus*	cattle	costa	frag.	-	-	6	-			
1124 310	*Capra hircus*	goat	horn	frag.	right	-	80	-			
1124 311	*Ovis aries*	sheep	horn	frag.	left	-	50	-			
1124 312	*Ovis aries*	sheep	horn	frag.	left	-	29	-			
1124 313	*Ovis aries*	sheep	horn	frag. with cranium frag.	left	-	8	-			
1124 314	*Capra hircus*	goat	horn	frag.	right	-	48	-			
1124 315	*Bos taurus*	cattle	mandibula, teeth	frag. with M2i, M1i	left	-	124	-		30 m, subadult (f,g)	
1124 316	*Bos taurus*	cattle	teeth	M1i frag.	-	80-90	12	-		(k)	
1124 317	*Bos taurus*	cattle	teeth	Pm3i frag.	-	90	9	-		(g)	
1124 318	*Bos taurus*	cattle	teeth	Pm3i frag.	-	70	7	-		(h)	
1124 319	*Bos taurus*	cattle	teeth	M3i frag.	left	70-80	19	-		(k)	
1124 320	*Bos taurus*	cattle	teeth	M3s frag.	right	80-90	40	-		(j-k)	
1124 321	*Bos taurus*	cattle	teeth	M3s frag.	right	70-80	28	-		(k-l)	
1124 322	*Bos taurus*	cattle	teeth	M3s frag.	right	80-90	26	-		(k-l)	
1124 323	*Bos taurus*	cattle	teeth	M1s frag.	right	80-90	41	-		(k-l)	
1124 324	*Bos taurus*	cattle	teeth	M1s frag.	right	50-60	11	-		(j-k)	
1124 325	*Bos taurus*	cattle	teeth	M3s frag.	left	60	29	-		(g)	
1124 326	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with M3i, Pm4i, Pm3i	right	45-50	38	-		4-6 y (g,k,j,wear)	

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1124 327	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with M3i	left	10-15	18	-		24 m (b-c)	
1124 328	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with dPm4i, dPm3i	left	25	7	-		3-12 m (g, wear)	
1124 329	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with Pm4i, dP3i	right	<10	7	-		18 m	
1124 330	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with M3i, M1i, Pm4i, Pm3i, Pm2i	right		36	-		36-48 m	
1124 331	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with M3i, M2i, M1i	left	15-20	33	-		24-36 m (d-e, g, g)	
1124 332	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with dPm2i	left	-	2	-		3-12 m, milkteeth, eruption Pm2	
1124 333	*Ovis aries/ Capra hircus*	sheep/goat	mandibula, teeth	frag. with M3i	left	10	8	-			
1124 334	*Ovis aries/ Capra hircus*	sheep/goat	cranium, teeth	frag. with M2s, M1s, Pm4s, Pm3s	right	-	19	-		24-36 m (h, h, wear, wear)	
1124 335	*Ovis aries/ Capra hircus*	sheep/goat	cranium, teeth	frag. with M2s, M1s, Pm4s, Pm3s, Pm2s	right	-	32	-		24-36 m (h, g, wear)	
1124 336	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M2i frag.	left	90	7	-		(g-h)	
1124 337	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M3i frag.	left	80-90	8	-		(b)	
1124 338	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M1i frag.	right	90	4	-		(g-h)	
1124 339	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M1i frag.	left	90	3	-		(g)	
1124 340	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M2i frag.	left	80-90	5	-		(f)	
1124 341	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M1i frag.	right	90	3	-		(g-h)	
1124 342	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M1i frag.	right	90	2	-		(g)	
1124 343	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M2i frag.	right	80	5	-		(g)	
1124 344	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M3i frag.	left	60	2	-			
1124 345	*Ovis aries/ Capra hircus*	sheep/goat	teeth	Pm4i frag.	right	90	2	-		(g)	
1124 346	*Ovis aries/ Capra hircus*	sheep/goat	teeth	dPm3i frag.	left	80-90	<1	-			
1124 347	*Ovis aries/ Capra hircus*	sheep/goat	teeth	dP4 frag.	left	70-80	2	-		(g)	
1124 348	*Ovis aries/ Capra hircus*	sheep/goat	teeth	I.i frag.	left	90	1	-			
1124 349	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M1s frag.	left	80-90	4	-		(g-h)	
1124 350	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M2s frag.	right	80-90	6	-		(d-e)	
1124 351	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M2s frag.	right	80	5	-		(g-h)	
1124 352	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M2s frag.	left	70-80	5	-		(g-h)	
1124 353	*Ovis aries/ Capra hircus*	sheep/goat	teeth	M1s frag.	left	80-90	4	-		(g-h)	
1124 354	*Ovis aries/ Capra hircus*	sheep/goat	teeth	Pm4s frag.	left	80	2	-		(g-h)	
1124 355	*Ovis aries/ Capra hircus*	sheep/goat	teeth	Pm4s frag.	left	80	1	-			
1124 356	*Equus caballus*	horse	teeth	frag. S.	left	80-90	55	-			
1124 357	*Equus asinus*	donkey	teeth	M3i frag.	left	90	17	-			
1124 358	*Equus asinus*	donkey	teeth	M2i frag.	left	90	17	-			
1124 359	*Equus caballus*	horse	teeth	I.i frag.	left	-	14	-			
1124 360	*Felis catus*	cat	mandibula, teeth	frag. with M1i, Pm4i, Pm3i, Ci	right	45-50	5	-		adult	
1124 361	*Sus domesticus*	pig	mandibula, teeth	frag. with (M3i), M2i, M1i, Pm4i	right	-	32	-		7-14 m (V, a, e, a)	

1124 362	*Sus domesticus*	pig	mandibula, teeth	frag. with M3i	right	-	16	-		subadult/adult (a)	
1124 363	*Sus domesticus*	pig	mandibula, teeth	frag. with M3i, M2i	left	-	34	-		16-24 m, subadult (1/2 U, a)	
1124 364	*Sus domesticus*	pig	mandibula, teeth	frag. with M3i, M2i, M1i	right	-	36	-		14-21 m (a-b, d-e, f)	
1124 365	*Sus domesticus*	pig	mandibula, teeth	frag. with M3i	left	-	23	-		old (j-k)	
1124 366	*Sus domesticus*	pig	mandibula, teeth	frag. with M3i	right	70-80	29	-		adult (c)	
1124 367	*Sus domesticus*	pig	mandibula, teeth	frag. with M2i, M1i	right	-	5	-		12-16 m (a-b, e)	
1124 368	*Sus domesticus*	pig	mandibula, teeth	frag. with M2i, M1i	left	-	19	-		12-16 m (a,e)	
1124 369	*Sus domesticus*	pig	mandibula, teeth	frag. with C1i	right	-	41	-			female
1124 370	*Sus domesticus*	pig	mandibula, teeth	frag. with I1i(right), I1i(left), I2i(left)	-	-	24	-			
1124 371	*Sus domesticus*	pig	mandibula, teeth	frag. with I1i, I2i	right	-	17	-		14-18 m	
1124 372	*Sus domesticus*	pig	cranium, teeth	frag. with I1s	right	-	9	-			
1124 373	*Sus domesticus*	pig	cranium, teeth	frag. with M2s, M1s, Pm4s, Pm3s	right	-	30	-		>24 m	
1124 374	*Sus domesticus*	pig	cranium, teeth	frag. with M3s	left	-	18	-		adult (b-c)	
1124 375	*Sus domesticus*	pig	cranium, teeth	frag. with M2s, M1s, Pm4s, Pm3s	left	-	31	-		>5 y (h-j, k-l, wear)	
1124 376	*Sus domesticus*	pig	cranium, teeth	frag. with M3s, M2s	right	-		-		>5 y (g-h, l)	
1124 377	*Sus domesticus*	pig	cranium, teeth	frag. with M2s, M1s, Pm4s	right	-	16	-		24 m (d-e, j,)	
1124 378	*Sus domesticus*	pig	teeth	frag. with M3s	right	80	10	-		(a)	
1124 379	*Sus domesticus*	pig	cranium, teeth	frag. with M2s, M1s, Pm4s, Pm3s	right	-	21	-		24 m (b-c, k,)	belongs with 1124.380
1124 380	*Sus domesticus*	pig	teeth	M3s frag.	right	70-80	8	-		(a)	belongs with 1124.379
1124 381	*Sus domesticus*	pig	cranium, teeth	frag. with M3s, M2s	left	-	29	-		21-27 m (c-d, e)	
1124 382	*Sus domesticus*	pig	cranium, teeth	frag. with M3s	right	-	10	-		>5 Y (h-j)	
1124 383	*Sus domesticus*	pig	teeth	M1i frag.	left	80	4	-		(f)	
1124 384	*Sus domesticus*	pig	teeth	Pm4i frag.	right	95	2	-		(a)	
1124 385	*Sus domesticus*	pig	teeth	frag.	-	10-20	<1	-			
1124 386	*Sus domesticus*	pig	teeth	I2i frag.	left	90	4	-			
1124 387	*Sus domesticus*	pig	teeth	I frag.	-	40-50	2	-			
1124 388	*Sus domesticus*	pig	teeth	I2i frag.	right	80	3	-			
1124 389	*Sus domesticus*	pig	teeth	I2i frag.	right	-	4	-			
1124 390	*Sus domesticus*	pig	teeth	I frag.	-	50	2	-			
1124 391	*Sus domesticus*	pig	teeth	I3i frag.	right	80-90	2	-			
1124 392	*Sus domesticus*	pig	teeth	I1i frag.	left	90	2	-			
1124 393	*Sus domesticus*	pig	teeth	I1i frag.	right	70	2	-			
1124 394	*Sus domesticus*	pig	teeth	I2i frag.	right	-	1	-		not yet erupted	
1124 395	*Sus domesticus*	pig	teeth	I1s. frag.	right	60	1	-			
1124 396	*Sus domesticus*	pig	teeth	I1s. frag.	left	90-100	2	-			
1124 397	*Equus caballus*	horse	teeth	I.i frag.	-	-	4	-			
1124 398	*Sus domesticus*	pig	teeth	C1s frag.	left	-	6	-			male

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1124 399	*Sus domesticus*	pig	teeth	C1s frag.	right	-	6	-			male
1124 400	*Sus domesticus*	pig	teeth	C1i frag.	right	-	12	-			male
1124 401	*Sus domesticus*	pig	teeth	C1i frag.	right	-	12	-			male
1124 402	*Sus domesticus*	pig	teeth	C1i frag.	right	-	4	-			male
1124 403	*Sus domesticus*	pig	teeth	C1i frag.	right	-	3	-			male
1124 404	*Sus domesticus*	pig	teeth	C1i frag.	right	-	4	-			male
1124 405	*Sus domesticus*	pig	teeth	C1i frag.	right	-	6	-			male
1124 406	*Sus domesticus*	pig	teeth	C1i frag.	right	-	8	-			male
1124 407	*Sus domesticus*	pig	teeth	C1i frag.	left	-	2	-			male
1124 408	*Sus domesticus*	pig	teeth	C1i frag.	left	-	13	-			male
1124 409	*Sus domesticus*	pig	teeth	C1i frag.	left	-	6	-			male
1124 410	*Sus domesticus*	pig	teeth	Ci frag.	-	-	2	-			female
1124 411	*Gallus gallus domesticus*	chicken	humerus	com.	right	100	2	GL=62,5 Bp=17 SC=6 Bd=13			
1124 412	*Gallus gallus domesticus*	chicken	humerus	com.	right	95-100	3	GL=72 BP=18 SC=6 Bd=15			
1124 413	*Gallus gallus domesticus*	chicken	humerus	frag. with D.E.	left	30-35	<1	Bd=14			
1124 414	*Gallus gallus domesticus*	chicken	ulna	frag. with P.E.	left	50-55	1	Dip=10 Bp=7			
1124 415	*Gallus gallus domesticus*	chicken	ulna	frag. with P.E.	left	60-70	1	Dip=11 Bp=7			
1124 416	*Gallus gallus domesticus*	chicken	ulna	com.	left	100	2	GL=70 Dip=12 Bp=9 SC=5 Did=8,5			
1124 417	*Gallus gallus domesticus*	chicken	ulna	frag. with P.E.	right	60-70	1	Dip=11 Bp=7			
1124 418	*Gallus gallus domesticus*	chicken	ulna	frag. with D.E.	left	60	2	Did=7			
1124 419	*Galliformes sp.*	galliforms	radius	frag. with D.E.	-	25	<1	Bd=4			
1124 420	*Gallus gallus domesticus*	chicken	vertebra (lumbales, sacrum)	frag.	-	40-45	1	-			
1124 421	*Gallus gallus domesticus*	chicken	femur	frag. with P.E.frag. with D.E.frag.	left	80-90	3	SC=6			
1124 422	*Gallus gallus domesticus*	chicken	femur	frag. with P.E.frag.	right	70-75	4	-			
1124 423	*Gallus gallus domesticus*	chicken	femur	frag. with D.E.	left	50-55	2	Bd=13 Dd=10,5			
1124 424	*Gallus gallus domesticus*	chicken	tibiotarsus	frag. with P.E.frag.	right	50-60	2	-			
1124 425	*Gallus gallus domesticus*	chicken	tibiotarsus	frag. with D.E.	right	30-35	1	Bd=12 Dd=11			
1124 426	*Gallus gallus domesticus*	chicken	tibiotarsus	frag. with D.E.frag.	left	70-80	3	-			
1124 427	*Gallus gallus domesticus*	chicken	tibiotarsus	frag. with D.E.frag.	right	60-70	4	-			
1124 428	*Gallus gallus domesticus*	chicken	tarsometatarsus	com.	left	95-100	2	GL=65 Bp=11 SC=6 Bd=12			
1124 429	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E.	right	70-80	1	Bp=11			
1124 430	*Gallus gallus domesticus*	chicken	carpometacarpus	com.	right	95-100	1	GL=34 Bp=9 Did=7			
1124 431		bird	costa	frag.	-	-	2	-			
1124 432		bird	costa	frag.	-	-	<1	-			
1124 433		bird	phalanx	frag.	-	-	<1	-			
1124 434		bird	metacarpus	frag.	-	-	1	-			
1006 1	*Bos taurus*	cattle	humerus	frag. with D.E.frag.	left	70-80	283	Bd=85	Fused		

1006 2	*Sus domesticus*	pig/boar	humerus	D.E.frag.	left	20	28	-	Fused		
1006 3	*Ovis aries/Capra hircus*	sheep/goat	humerus	D.E.frag.	right	20-25	12	-	Fused		
1006 4	*Ovis aries/Capra hircus*	sheep/goat	humerus	D.E.frag.	right	25	17	-			cutmark
1006 5	*Sus domesticus*	pig	humerus	D.E.frag.	left	15-20	20	-			
1006 6	*Sus domesticus*	pig	humerus	D.E.frag.	left	15-20	12	Bd=35	Fused		
1006 7	*Sus domesticus*	pig	humerus	D.E.frag.	left	30-40	38	-			
1006 8	*Sus domesticus*	pig	humerus	D.E.frag.	left	40	26	-			
1006 9	*Sus domesticus*	pig	humerus	D.E.frag.	left	30	22	-			
1006 10	*Sus domesticus*	pig	humerus	D.E.frag.	left	15-20	11	-			
1006 11	*Sus domesticus*	pig	humerus	D.E.frag.	left	10-15	8	-			
1006 12	*Bos taurus*	cattle	metatarsus	frag. with P.E.frag.	right	15-20	26	-	Fused		
1006 13	*Sus domesticus*	pig	radius	frag. with P.E.	left	25	12	Bp=28 Dp=22	Fused		
1006 14	*Ovis aries/Capra hircus*	sheep/goat	radius	frag. with P.E.	left	10-15	5	Bp=28 Dp=15	Fused		
1006 15	*Ovis aries/Capra hircus*	sheep/goat	radius	P.E.frag.	right	5-10	3	-	Fused		
1006 16	*Ovis aries/Capra hircus*	sheep/goat	radius	P.E.frag.	left	10	5	-	Fused		
1006 17	*Ovis aries/Capra hircus*	sheep/goat	radius	dis. body frag. with ulna frag.	right	20	8	-	Fused		
1006 18	*Ovis aries/Capra hircus*	sheep/goat	radius	dis. frag.	right	15-20	10	Bd=29,5	Unfused		
1006 19	*Ovis aries/Capra hircus*	sheep/goat	radius	frag. with D.E. with ulna frag.	left	40	15	-	Fused		
1006 20	*Ovis aries/Capra hircus*	sheep/goat	radius	body frag.	left	50-55	18	-			
1006 21	*Ovis aries/Capra hircus*	sheep/goat	radius	frag. with P.E.frag.	right	5-10	4	-			
1006 22	*Sus domesticus*	pig	radius	frag. with D.E.	left	30	16	Bd=35	Fused		
1006 23	*Ovis aries/Capra hircus*	sheep/goat	radius	D.E.	left	10	2	Bd=25	Unfused		
1006 24	*Bos taurus*	cattle	radius	frag. with P.E.frag.	right	5-10	63	-	Fused		
1006 25	*Sus domesticus*	pig	radius	frag. with P.E.	left	45-50	27	Bp=32	Fused		
1006 26	*Bos taurus*	cattle	radius	D.E.frag. with ulna frag.	left	0-5	16	-	fused		
1006 27	*Sus domesticus*	pig	humerus	pr. frag.	left	20-25	42	-	Unfused		
1006 28	*Sus domesticus*	pig	ulna	pr. frag.	left	10-15	8	-			
1006 29	*Sus domesticus*	pig	ulna	pr. frag.	right	30	22	BPC=22			cutmark
1006 30	*Sus domesticus*	pig	ulna	body frag.	left	30	20	-			
1006 31	*Bos taurus*	cattle	metacarpus	dis. frag.	left	20	26	-			
1006 32	*Ovis aries/Capra hircus*	sheep/goat	metacarpus	frag. with P.E.	left	50-60	13	Bp=24 Dp=17	Fused		
1006 33	*Ovis aries/Capra hircus*	sheep/goat	metacarpus	frag. with P.E.frag.	right	25	6	-	Fused		
1006 34	*Ovis aries/Capra hircus*	sheep/goat	metacarpus	frag. with D.E.	left	25	8	Bd=29 Dd=16	Fused		gnawing marks

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1006 35	*Ovis aries/Capra hircus*	sheep/goat	metacarpus	body frag.	-	15-20	4	-			
1006 36	*Ovis aries/Capra hircus*	sheep/goat	metacarpus	body frag.	-	20-25	5	-			
1006 37	*Bos taurus*	cattle	metapode	D.E.frag.	-	5	14	-			
1006 38	*Bos taurus*	cattle	metapode	D.E.frag.	-	5	12	-			
1006 39	*Sus domesticus*	pig	metapode	D.E.frag.	-	15-20	4	Bd=19	Fused		
1006 40	*Sus domesticus*	pig	metacarpus 3.	frag. with P.E.	right	30	5	Bp=16,5	Fused		
1006 41	*Sus domesticus*	pig	metatarsus 4.	frag. with P.E. without D.E.	right	90	10	Bp=15,5 B=14 [GL]no E.D.=78	Unfused (dis.)		
1006 42	*Sus domesticus*	pig	metacarpus 1.	com.	right	95-100	8	Gl = 68,5 Bp=14 B=11,5 Bd=14 [GL]no E.D.=57	In fusion (dis.)		
1006 43	*Sus domesticus*	pig	metatarsus 3.	frag. with P.E. without D.E.	right	85-90	8	Bp=13 B=11 [GL]no E.D.=59	Unfused (dis.)		burning marks
1006 44	*Sus domesticus*	pig	metatarsus 4.	frag. with P.E.frag.	right	70	10	Bp=15	Fused		
1006 45	*Sus domesticus*	pig	metacarpus 4.	frag. with P.E.	left	50	7	Bp=16,5	Fused		
1006 46	*Sus domesticus*	pig	metatarsus 4.	frag. with P.E.frag.	right	10-15	2	-	Fused		
1006 47	*Sus domesticus*	pig	metacarpus 4.	frag. with P.E.	left	50	7	Bp=17	Fused		
1006 48	*Sus domesticus*	pig	metatarsus 2.	com.	left	95-100	5	GL=68 [GL]no E.D.=57	Fused		cutmark/chopmark
1006 49	*Sus domesticus*	pig	metatarsus 2.	frag. without D.E.	left	80-90	2	[GL]no E.D.=48	Unfused (dis.)		
1006 50	*Sus domesticus*	pig	metatarsus 5.	frag. without D.E.	-	80-90	3	[GL]no E.D.=50	Unfused (dis.)		
1006 51	*Canis familiaris*	dog	metatarsus 5.	frag. with P.E.frag.	right	75-80	2	Bd=80	Fused		
1006 52	*Sus domesticus*	pig	metacarpus 2.	frag. without D.E.	left	80-90	2	[GL]no E.D.=47	Unfused (dis.)		
1006 53	*Sus domesticus*	pig	metacarpus 2.	frag. with P.E.frag.	right	50	2	-	Fused		
1006 54	*Sus domesticus*	pig	metapode	frag. with P.E. without D.E.	-	80-90	3	[GL]no E.D.=80	Unfused (dis.)		
1006 55	*Bos taurus*	cattle	phalanx 1.	com.	right (front)	95-100	24	Glpe=56 Bp=27 SD=23 Bd=26	Fused		chopmarks
1006 56	*Bos taurus*	cattle	phalanx 1.	com.	right (hind)	95-100	24	Glpe=61 Bp=31 SD=26 Bd=27	Fused		
1006 57	*Bos taurus*	cattle	phalanx 1.	frag. with D.E.	left	5	4	-			burning marks
1006 58	*Bos taurus*	cattle	phalanx 1.	frag. with D.E.	left	10	8	-			
1006 59	*Sus domesticus*	pig	phalanx 1.	com.	left	95-100	7	Glpe=35 Bp=18 SD=16 Bd=18 [Glpe]no E.P.=27	Fused		
1006 60	*Sus domesticus*	pig	phalanx 1.	com.	left	95	7	Glpe=40 Bp=19 SD=15 Bd=16 [Glpe]=31	In fusion (pr.)		
1006 61	*Sus domesticus*	pig	phalanx 1.	frag. without P.E.	right	80-90	3	[Glpe]no E.P.=27 SD=11 Bd=13	Unfused (pr.)		
1006 62	*Sus domesticus*	pig	phalanx 1.	com.	right	95-100	4	Glpe=36 [Glpe]no E.P.=29 Bp=15 SD=11 Bd=14	Fused		burning mark
1006 63	*Sus domesticus*	pig	phalanx 1.	com.	right	100	5	Glpe=36 [Glpe]no E.P.=29 Bp=15 SD=12 Bd=14	Fused		
1006 64	*Sus domesticus*	pig	phalanx 1.	com.	right	100	4	Glpe=36 [Glpe]=28 Bp=15 SD=12 Bd=15	Fused		

100665	*Ovis aries/Capra hircus*	sheep/goat	phalanx 1.	dis. frag.	left	60	2	Bd=10	Fused		
100666	*Ovis aries/Capra hircus*	sheep/goat	phalanx 2.	com.	left	100	2	Glpe=23 Bp=11 SD=8 Bd=9	Fused		
100667	*Capreolus capreolus*	Roe deer	phalanx 2.	com.	right	100	2	GL=26 Bp=11 SD=7 Bd=8	Fused		
100668	*Bos taurus*	cattle	phalanx 2.	com.	right	95-100	12	GLpe=48 Bp=27 SD=22 Bd=23	Fused		
100669	*Bos taurus*	cattle	phalanx 2.	com.	left	95-100	15	Glpe=38 Bp=28 SD=22 Bd=23,5	Fused		
100670	*Bos taurus*	cattle	astragalus	com.	right	90	48	GL1=65 GLm=57 D1=33 Dm=33 Bd=40			
100671	*Sus domesticus*	pig	astragalus	com.	left	90-95	12	GL1=43 GLm=40			
100672	*Bos taurus*	cattle	carpalia (semilunare)	com.	right	95-100	10	GB=38,5			
100673	*Bos taurus*	cattle	carpalia (scafoide)	com.	right	95-100	8	GB=38			
100674	*Ovis aries/Capra hircus*	sheep/goat	metatarsus	body frag.	-	15-20	5	-			
100675	*Ovis aries/Capra hircus*	sheep/goat	metatarsus	body frag.	-	20-25	5	-			
100676	*Ovis aries/Capra hircus*	sheep/goat	metatarsus	frag. with P.E.frag.	right	40-50	14	-	Fused		
100677	*Sus domesticus*	pig	femur	dis. frag.	right	20-25	22	-			Cutmarks
100678	*Sus domesticus*	pig	calcaneum	frag. without P.E.	right	90	12	[GL]no E.P.=64 GB=22	Unfused (pr.)		
100679	*Sus domesticus*	pig	calcaneum	frag. without P.E.	left	90	10	[GL]no E.P.=71 GB=23	Unfused (pr.)		
100680	*Ovis aries/Capra hircus*	sheep/goat	calcaneum	com.	left	95-100	8	GL=55 GB=20	In fusion (pr.)		
100681	*Ovis aries/Capra hircus*	sheep/goat	calcaneum	com.	right	95-100	10	GL=62 GB=19	Fused		
100682	*Sus domesticus*	pig	tibia	D.E.	right	5	3	Bd=25 Dd=22	Unfused (dis.)		
100683	*Sus domesticus*	pig	tibia	frag. with D.E.	right	5-10	12	Bd=30 Dd=26	In fusion		
100684	*Sus domesticus*	pig	tibia	frag. with D.E.frag.	right	10-20	12	-	Fused		
100685	*Sus domesticus*	pig	tibia	frag. with D.E.	right	40	32	Bd=30 Dd=25	Fused		chopmarks
100686	*Sus domesticus*	pig	tibia	frag. with D.E.	left	25-30	18	Bd=27 Dd=24,5	Fused		
100687	*Bos taurus*	cattle	tibia	frag. with D.E.	left	5	25	-			
100688	*Ovis aries/Capra hircus*	sheep/goat	tibia	frag. with D.E.	right	45-50	28	Bd=27 Dd=21	Fused		
100689	*Sus domesticus*	pig	tibia	body frag.	left	40	26	-			
100690	*Sus domesticus*	pig	fibula	frag. with D.E.	right	20	3	-	Fused		
100691	*Sus domesticus*	pig	fibula	pr. frag. without P.E.	left	20-30	2	-	Unfused		
100692	*Ovis aries/Capra hircus*	sheep/goat	femur	frag. Con P.E.frag.	right	20-25	12	-	Fused		cutmark/chopmark
100693	*Ovis aries/Capra hircus*	sheep/goat	femur	frag. Con P.E.frag.	right	25	12	DC=18	Fused		
100694	*Sus domesticus*	pig	femur	frag. Con P.E.frag.	right	20-25	22	-	Fused		
100695	*Bos taurus*	cattle	humerus	P.E.frag.	left	10-20	62	-	Fused		
100696	*Ovis aries/Capra hircus*	sheep/goat	tibia	pr. frag.	right	10	5	-			

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1006 97	*Ovis aries/Capra hircus*	sheep/goat	tibia	pr. frag.	left	25	13	-			
1006 98	*Sus domesticus*	pig	metacarpus 4.	frag. with P.E.frag. without D.E.	right	80-90	2	[GL]no E.D.=33	Unfused		
1006 99	*Sus domesticus*	pig	scapula	dis. frag.	left	25-30	22	SLC=23			burning marks
1006 100	*Sus domesticus*	pig	scapula	dis. frag.	left	20	23	-			
1006 101	*Sus domesticus*	pig	scapula	D.E.frag.	left	5-10	8	GLP=34 LG=26 BG=26			dark colour (burnt)
1006 102	*Ovis aries/Capra hircus*	sheep/goat	scapula	D.E.frag.	left	10	6	GLP=34 LG=24 BG=23,5	Fused		
1006 103	*Ovis aries/Capra hircus*	sheep/goat	scapula	frag. with D.E.frag.	right	10-20	8	SLC=19 LG=24 BG=22	Fused		
1006 104	*Sus domesticus*	pig	scapula	frag. with D.E.frag.	right	20	18	SLC=22 BG=22	Fused		cutmarks
1006 105	*Sus domesticus*	pig	scapula	dis. frag.	left	15-20	14	-			
1006 106	*Bos taurus*	cattle	scapula	body frag.	-	10	20	-			
1006 107	*Bos taurus*	cattle	scapula	body frag.	-	15	26	-			
1006 108	*Ovis aries/Capra hircus*	sheep/goat	pelvis	frag.	right	5-10	6	SH=8 SB=14			
1006 109	*Ovis aries/Capra hircus*	sheep/goat	pelvis	frag.	right	10	4	-			gnawing marks
1006 110	*Sus domesticus*	pig	pelvis	frag.	left	15-20	20	-			cutmark/chopmark
1006 111	*Ovis aries/Capra hircus*	sheep/goat	pelvis	frag.	right	10-20	8	-			
1006 112	*Ovis aries/Capra hircus*	sheep/goat	pelvis	frag.	right	5-10	7	-			
1006 113	*Ovis aries/Capra hircus*	sheep/goat	pelvis	frag.	right	5-10	8	-			
1006 114	*Canis familiaris*	dog	pelvis	frag.	left	20	12	LAR=22	Fused		
1006 115	*Sus domesticus*	pig	radius	frag. without D.E. without P.E.	-	80	2	[GL]no E.D. e E.P=38 SD=7	Unfused - 1-2 m		
1006 116	*Bos taurus*	cattle	mandibula	frag.	right	20	140	-			
1006 117	*Sus domesticus*	pig	fibula	dis. frag.	left	45-50	4	-			
1006 118	*Sus domesticus*	pig	mandibula	frag.	-	5-10	14	-			
1006 119	*Sus domesticus*	pig	cranium	frag.	right	5-10	8	-			
1006 120	*Bos taurus*	cattle	pelvis	frag.	right	5-10	30	-			
1006 121	*Sus domesticus*	pig	ulna	body frag.	left	30	18	-			chopmarks
1006 122	*Sus domesticus*	pig	scapula	frag.	right	15-20	8	-			
1006 123	*Ovis aries/Capra hircus*	sheep/goat	cranium	frag.	right	<5	5	-			
1006 124	*Bos taurus*	cattle	cranium	frag.	right	<5	10	-			
1006 125	*Bos taurus*	cattle	humerus	D.E.frag.	left	5-10	37	-			
1006 126	*Sus domesticus*	pig	mandibula	frag.	right	5	8	-			
1006 127	*Sus domesticus*	pig	mandibula	frag.	right	2-5	7	-			
1006 128	*Bos taurus*	cattle	costa	frag.	-	-	20	-			
1006 129	*Bos taurus*	cattle	costa	pr. frag.	-	-	18	-			

1006 130	*Bos taurus*	cattle	costa	frag.	-	-	14	-			
1006 131	*Bos taurus*	cattle	costa	dis. frag.	-	-	6	-			
1006 132	*Bos taurus*	cattle	costa	frag.	-	-	8	-			
1006 133	*Bos taurus*	cattle	costa	pr. frag.	right	-	19	-			cutmark/chopmark
1006 134	*Bos taurus*	cattle	costa	frag. with P.E.	left	-	12	-	In fusion		
1006 135	*Sus domesticus*	pig	costa	pr. frag.	left	-	4	-			
1006 136	*Sus domesticus*	pig	costa	pr. frag.	left	-	5	-			cutmarks
1006 137	*Sus domesticus*	pig	costa	pr. frag. with P.E.frag.	right	-	2	-			
1006 138	*Sus domesticus*	pig	costa	frag. with P.E.frag.	right	-	3	-			cutmark/chopmark
1006 139	*Sus domesticus*	pig	costa	frag. with P.E.frag.	right	-	5	-			
1006 140	*Sus domesticus*	pig	costa	frag. with P.E.frag.	left	-	8	-			
1006 141	*Sus domesticus*	pig	costa	frag. with P.E.frag.	right	-	4	-			
1006 142	*Sus domesticus*	pig	costa	frag. with P.E.frag.	left	-	3	-			
1006 143	*Sus domesticus*	pig	costa	frag. with P.E.frag.	right	-	6	-			
1006 144	*Sus domesticus*	pig	costa	frag. with P.E.frag.	right	-	2	-			
1006 145	*Sus domesticus*	pig	costa	frag. with P.E.frag.	left	-	2	-			
1006 146	*Sus domesticus*	pig	costa	frag. with P.E.frag.	left	-	6	-			
1006 147	*Sus domesticus*	pig	costa	frag. without P.E.	left	-	6	-	Unfused		
1006 148	*Sus domesticus*	pig	costa	frag. without P.E.	right	-	7	-	Unfused		
1006 149	*Sus domesticus*	pig	costa	pr. frag.	left	-	3	-			
1006 150	*Ovis aries/Capra hircus*	sheep/goat	costa	pr. frag.	right	-	2	-			
1006 151	*Ovis aries/Capra hircus*	sheep/goat	costa	frag. with P.E.frag.	right	-	4	-			
1006 152	*Sus domesticus*	pig	sacrum	frag.	-	40	13	-			chopmark
1006 153	*Sus domesticus*	pig	axis	frag.	-	80-90	16	LCDe=37 LAPa=41 BFcr=45 Bpacd=37 BFcd=28,5			
1006 154	*Sus domesticus*	pig	vertebra thoracales	frag.	-	40-50	13	BFcd=27			
1006 155	*Sus domesticus*	pig	axis	frag.	-	70-80	14	LCDe=31 BFcr=47 Bpacd=34 BFcd=29			
1006 156	*Sus domesticus*	pig	vertebra thoracales	frag.	-	30	8	PL=32			
1006 157	*Ovis aries/Capra hircus*	sheep/goat	vertebra cervicales	frag.	-	20-30	12	-			
1006 158	*Ovis aries/Capra hircus*	sheep/goat	vertebra thoracales	frag.	-	25-30	4	-			
1006 159	*Ovis aries/Capra hircus*	sheep/goat	vertebra thoracales	frag.	-	25-30	1	-			
1006 160	*Sus domesticus*	pig	vertebra thoracales	frag.	-	10	2	-			
1006 161	*Sus domesticus*	pig	vertebra thoracales	frag.	-	15-20	2	-			
1006 162	*Sus domesticus*	pig	vertebra thoracales	frag.	-	20	4	-			
1006 163	*Ovis aries/Capra hircus*	sheep/goat	vertebra thoracales	frag.	-	20	2	-			

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1006 164	*Sus domesticus*	pig	vertebra lumbales	frag.	-	25-30	3	-			
1006 165	*Sus domesticus*	pig	vertebra lumbales	frag.	-	30	4	-			
1006 166	*Ovis aries/Capra hircus*	sheep/goat	sacrum	frag.	-	5-10	3	-			
1006 167	*Sus domesticus*	pig	vertebra lumbales	frag.	-	10-20	4	-			
1006 168	*Sus domesticus*	pig	vertebra cervicales	frag.	-	20-25	5	-			
1006 169	*Sus domesticus*	pig	vertebra thoracales	frag.	-	15-20	4	PL=24			
1006 170	*Sus domesticus*	pig	vertebra lumbales	frag.	-	20-30	5	-			
1006 171	*Sus domesticus*	pig	vertebra lumbales	frag.	-	10-15	2	-			
1006 172	*Sus domesticus*	pig	vertebra lumbales	frag.	-	20-25	6	-			
1006 173	*Bos taurus*	cattle	vertebra thoracales	frag.	-	50-55	26	BFcr=39 HFcr=30			
1006 174	*Bos taurus*	cattle	vertebra	frag.	-	30-40	47	PL=67			burnmark
1006 175	*Bos taurus*	cattle	vertebra	frag.	-	-	19	-			
1006 176	*Ovis aries/Capra hircus*	sheep/goat	atlas	frag.	-	20	7	-			
1006 177	*Bos taurus*	cattle	vertebra cervicales	frag.	-	30-40	19	-			
1006 178	*Bos taurus*	cattle	atlas	frag.	-	25-30	55	-			
1006 179	*Sus domesticus*	pig	atlas	frag.	-	20	5	-			
1006 180	*Sus domesticus*	pig	fibula	body frag.	right	25-30	3	-			
1006 181	*Sus domesticus*	pig	metatarsus 2.	frag. without D.E.	right	-	2	[GL]no E.D.=41	Unfused		
1006 182	*Sus domesticus*	pig	radius	body frag.	-	70-80	2	SD=8	fetus		
1006 183	*Sus domesticus*	pig	metacarpus	frag. without D.E.	-	80	2	[GL]no E.D.=27 SD=7	fetus		
1006 184	*Felis catus*	cat	humerus	frag. with D.E.	right	-	3	Bd=16,5	Fused		
1006 185	*Sus domesticus*	pig	fibula	body frag.	left	-	2	-			
1006 186	*Felis catus*	cat	radius	frag. with P.E.	right	30-40	1	BP=11	Fused		
1006 187	*Sus domesticus*	pig	costa	frag.	-	-	5	-			chopmark
1006 188		medium mammal	vertebra	frag.	-	-	7	-			
1006 189		medium mammal	vertebra	frag.	-	-	3	-			
1006 190	*Bos taurus*	cattle	cranium	frag.	left	<5	12	-			
1006 191	*Sus domesticus*	pig	pelvis	frag.	-	-	1	-			
1006 192	*Ovis aries/Capra hircus*	sheep/goat	metatarsus	frag. with P.E.frag.	left	15-20	15	-	Fused		
1006 193	*Ovis aries/Capra hircus*	sheep/goat	metatarsus	body frag.	-	30-40	3	-			
1006 194	*Sus domesticus*	pig	tarsalia (cuboide)	frag.	-	60-70	8	-			
1006 195	*Sus domesticus*	pig	mandibula	frag.	left	5-10	10	-			
1006 196	*Ovis aries/Capra hircus*	sheep/goat	tibia	body frag.	-	25	8	-			
1006 197	*Ovis aries/Capra hircus*	sheep/goat	tibia	body frag.	-	30-40	9	-			
1006 198	*Ovis aries/Capra hircus*	sheep/goat	femur	body frag.	-	20-25	5	-			cutmark

1006 199	*Bos taurus*	cattle	metapode	dis. frag.	-	<5	<1	-			burnmarks
1006 200	*Sus domesticus*	pig	radius	body frag.	-	80	<1	SD=5,5	Fetus		
1006 201	*Sus domesticus*	pig	metapode 2 or 5	frag. without D.E.	-	80	<1	[GL]no E.D.=29	Young		
1006 202	*Sus domesticus*	pig	metapode	dis. frag. without D.E.	left	40	<1	-	Young		
1006 203	*Sus domesticus*	pig	metapode	dis. frag. without D.E.	left	40	<1	-			
1006 204	*Ovis aries/Capra hircus*	sheep/goat	humerus	dis. frag.	left	25	2	-			
1006 205	*Ovis aries/Capra hircus*	sheep/goat	metacarpus	dis. frag.	right	40		-			
1006 206	*Ovis aries/Capra hircus*	sheep/goat	scapula	dis. frag.	left	20-25		-			
1006 207	*Ovis aries/Capra hircus*	sheep/goat	tibia	body frag.	-	20-25		-			
1006 208	*Ovis aries/Capra hircus*	sheep/goat	tibia	body frag.	-	20		-			
1006 209	*Dama Dama*	Fallow Deer	tibia	P.E.frag.	left	5-10	21	-			
1006 210	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	38	-			
1006 211	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	47	-			
1006 212	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	48	-			
1006 213	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	5	-			
1006 214	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	9	-			
1006 215	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	3	-			
1006 216	*Ovis aries/Capra hircus*	sheep/goat	horn	frag.	-	-	10	-			
1006 217	*Sus domesticus*	pig	cranium, teeth	frag. with M2s, M1s	right	-	19	-		(c, e)	
1006 218	*Sus domesticus*	pig	cranium, teeth	frag. with M2s	-	-	6	-		(k)	
1006 219	*Sus domesticus*	pig	teeth	M3s frag.	right	40	6	-		(a)	
1006 220	*Sus domesticus*	pig	teeth	M2 frag.	-	60	5	-		(a)	
1006 221	*Sus domesticus*	pig	cranium, teeth	frag. with M2s	-	-	7	-		(d)	
1006 222	*Sus domesticus*	pig	teeth	M3 frag.	-	50	8	-		(c,)	
1006 223	*Sus domesticus*	pig	teeth	frag.	-	-	3	-			
1006 224	*Sus domesticus*	pig/boar	teeth	C1i frag.	right	-	12	-			male
1006 225	*Sus domesticus*	pig/boar	teeth	C1i frag.	right	-	10	-			male
1006 226	*Sus domesticus*	pig/boar	teeth	C1s frag.	-	-	11	-			male
1006 227	*Sus domesticus*	pig/boar	teeth	C1i frag.	s	-	18	-			male
1006 228	*Sus domesticus*	pig	mandibula, teeth	frag. with M1i	right	-	17	-		(f/g)	
1006 229	*Sus domesticus*	pig/boar	teeth	C1i frag.	left	-	8	-			male
1006 230	*Sus domesticus*	pig/boar	teeth	C1i frag.	left	-	4	-			male
1006 231	*Sus domesticus*	pig/boar	teeth	C frag.	-	-	3	-			male

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1006 232	*Canis familiaris*	dog	teeth	C frag.	-	-	3	-			
1006 233	*Bos taurus*	cattle	teeth	M1s or M2s frag.	-	80-90	29	-		(b)	
1006 234	*Bos taurus*	cattle	teeth	M3i frag.	left	70	22	-			
1006 235	*Bos taurus*	cattle	mandibula, teeth	frag. with M1i, Pm4i	-	-	40	-		(f-g)	
1006 236	*Bos taurus*	cattle	teeth	M1i or M2i frag.	-	80-90	17	-			
1006 237	*Bos taurus*	cattle	teeth	M1s frag.	-	80-90	24	-		(h)	
1006 238	*Ovis aries/Capra hircus*	sheep/goat	mandibula, teeth	frag. with M3i, M2i, M1i, Pm4i, Pm3i, Pm2i	right	-	44	-		8-10 y, (g, m, m/n, l)	
1006 239	*Sus domesticus*	pig	mandibula, teeth	frag. with M3i, M2i, M1i, Pm4i	left	-	38	M3: L=27 B=13		14-21 m (u, b, h, a)	
1006 240	*Ovis aries/Capra hircus*	sheep/goat	teeth	M1s or M2s frag.	left	80-90	6	-		(f-g)	
1006 241	*Ovis aries/Capra hircus*	sheep/goat	teeth	M2s frag.	left	80-90	8	-		(h-j)	
1006 242	*Ovis aries/Capra hircus*	sheep/goat	teeth	M3s frag.	right	80	8	-		(h-j)	
1006 243	*Bos taurus*	cattle	teeth	Pmi frag.	-	40-50	5	-			
1006 244	*Ovis aries/Capra hircus*	sheep/goat	teeth	M3s frag.	right	70-80	6	M3:L=17 B=10,5		(a)	
1006 245	*Ovis aries/Capra hircus*	sheep/goat	teeth	M3s frag.	left	80-90	8	M3: L=16 B=11		(c,)	
1006 246	*Ovis aries/Capra hircus*	sheep/goat	teeth	M2s or M1s frag.	left	80	6	-		(b)	
1006 247	*Ovis aries/Capra hircus*	sheep/goat	teeth	M2s or M1s frag.	-	80-90	5	-		(f)	
1006 248	*Ovis aries/Capra hircus*	sheep/goat	teeth	Mi frag.	-	40	5	-			
1006 249	*Ovis aries/Capra hircus*	sheep/goat	teeth	M3i frag.	left	60-70	8	-		(f-g)	
1006 250	*Sus domesticus*	pig	cranium, teeth	frag. with M3s, M2s, M1s	right	-	30	M3: L=24 B=15		24 m; (1/2-u, c, d-e)	
1006 251	*Ovis aries/Capra hircus*	sheep/goat	teeth	M1i frag.	right	80-90	4	-		(f-g)	
1006 252	*Ovis aries/Capra hircus*	sheep/goat	teeth	M1i frag.	left	60	3	-		(h)	
1006 253	*Bos taurus*	cattle	teeth	Pm4i frag.	left	-	8	-		(h)	
1006 254	*Bos taurus*	cattle	teeth	I frag.	right	-	4	-			
1006 255	*Ovis aries/Capra hircus*	sheep/goat	mandibula, teeth	frag. with Pm4i	left	-	26	-		(g)	
1006 256	*Sus domesticus*	pig	mandibula, teeth	frag. with I1i, I2i	left	-	14	-			
1006 257	*Sus domesticus*	pig	teeth	I frag.	left	80-90	3	-			
1006 258	*Sus domesticus*	pig	teeth	I frag.	right	80-90	2	-			
1006 259	*Sus domesticus*	pig	teeth	I frag.	left	80-90	3	-			
1006 260	*Sus domesticus*	pig	teeth	I frag.	left	80-90	3	-			
1006 261	*Sus domesticus*	pig	cranium, teeth	frag. with M3s, M2s, M1s	left	-	31	-		16-24 (1/2-u, a, c)	
1006 262	*Sus domesticus*	pig	teeth	I frag.	left	90	2	-			

1006 263	*Sus domesticus*	pig	teeth	I frag.	right	90	3	-			
1006 264	*Sus domesticus*	pig	teeth	I frag.	right	90	2	-			
1006 265	*Sus domesticus*	pig	teeth	I frag.	left	90	4	-			
1006 266	*Sus domesticus*	pig	teeth	I frag.	-	90	3	-			
1006 267	*Sus domesticus*	pig	teeth	I frag.	left	90	3	-			
1006 268	*Sus domesticus*	pig	teeth	I frag.	right	40	2	-			
1006 269	*Sus domesticus*	pig	teeth	I frag.	-	30-40	2	-			
1006 270	*Sus domesticus*	pig	cranium, teeth	frag. with Pm4i, Pm3i	right	-	2	-		12-16 m (a, V)	
1006 271	*Sus domesticus*	pig	cranium, teeth	frag. with M2s	-	-	8	-			
1006 272	*Sus domesticus*	pig	cranium, teeth	frag. with M1s, Pm4s, Pm3s	right	-	12	-		>24 m (k, d-e)	
1006 273	*Sus domesticus*	pig	mandibula, teeth	frag. with M1i, dPm4i	left	-	8	-		6-10 m (a, e-f)	
1006 274	*Ovis aries/Capra hircus*	sheep/goat	mandibula, teeth	frag. with Pm2i	left	-	3	-			
1006 275	*Sus domesticus*	pig	teeth	frag.	-	-	2	-			
1006 276	*Sus domesticus*	pig	teeth	Pm4i frag.	-	70-80	3	-			
1006 277	*Ovis aries/Capra hircus*	sheep/goat	teeth	Pm3i frag.	-	80-90	2	-			
1006 278	*Ovis aries/Capra hircus*	sheep/goat	teeth	Pm4i frag.	left	80-90	3	-		(g)	
1006 279	*Sus domesticus*	pig	teeth	C frag.	-	-	3	-			female
1006 280	*Sus domesticus*	pig	teeth	C frag.	right	-	2	-			
1006 281	*Ovis aries/Capra hircus*	sheep/goat	teeth	I frag.	right	80-90	1	-			
1006 282	*Ovis aries/Capra hircus*	sheep/goat	teeth	I frag.	right	90	2	-			
1006 283	*Sus domesticus*	pig	cranium, teeth	frag with M3s, M2s	left	-	19	M3: L=26 B=17		24 m (a,c)	
1006 284	*Sus domesticus*	pig	teeth	I frag.	-	10-20	1	-			
1006 285	*Bos taurus*	cattle	teeth	M frag.	-	10-20	4	-			
1006 286	*Bos taurus*	cattle	teeth	M frag.	-	10	3	-			
1006 287	*Bos taurus*	cattle	teeth	M frag.	-	10	3	-			
1006 288	*Bos taurus*	cattle	teeth	M frag.	-	10	4	-			
1006 289	*Sus domesticus*	pig	teeth	I frag.	left	70-80	1	-			
1006 290	*Sus domesticus*	pig	teeth	Pm4i frag.	-	-	<1	-			
1006 291	*Sus domesticus*	pig	teeth	frag.	-	-	<1	-		fetus	
1006 292	*Sus domesticus*	pig	teeth	I.i frag.	-	-	<1	-			
1006 293	*Sus domesticus*	pig	teeth	frag.	-	-	<1	-			
1006 294	*Sus domesticus*	pig	mandibula, teeth	frag. with M1i, dPm4i	left	-	16	-		6-10 m (a,j)	
1006 295	*Sus domesticus*	pig	teeth	frag.	-	-	<1	-			
1006 296	*Sus domesticus*	pig	teeth	C frag.	-	-	<1	-			
1006 297	*Sus domesticus*	pig	teeth	C frag.	-	-	4	-			female
1006 298	*Sus domesticus*	pig	teeth	I1s frag.	right	-	2	-			
1006 299	*Sus domesticus*	pig	mandibula, teeth	frag. with M1i, Pm4i, Pm3i, Pm2i	left	-	25	P4-P2=36		24 m (k,b)	

US nr.	Taxon	Animal	Skeletal element	Bone element	Body side	conservation (%)	weight (g)	Measurements (mm)	Epiphyseal fusion	Dental Age	Notes
1006 300		fish	vertebra	com.	-	-	1	GL=9 SC=14			
1006 301		fish	mandibula	frag.	-	-	2	-			
1006 302	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E. with spur	left	80	3	Bp=14	Fused		male
1006 303	*Galliformes sp.*	galliforms	tarsometatarsus	frag. with D.E.frag.	right	70	1	-			
1006 304	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E.frag. with D.E.frag. with spur	left	80-90	4	SC=7	fused		male
1006 305	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with P.E.	left	35-40	3	Dip=17	fused		
1006 306	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with D.E.	left	50	2	Bd=10 Dd=10	fused		
1006 307	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with D.E.frag.	right	15-20	2	-	fused		
1006 308	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with D.E.	left	15	1	Bd=10,5 Dd=9,5	fused		
1006 309	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with D.E.	right	20-30	2	Bd=12 Dd=12	fused		
1006 310	*Gallus gallus domesticus*	chicken	tibiatarsus	frag. with D.E.	left	30-40	2	Bd=11 Dd=10,5	fused		
1006 311	*Galliformes sp.*	galliforms	tibiatarsus	dis. frag.	-	20-30	1	-			
1006 312	*Galliformes sp.*	galliforms	tibiatarsus	dis. frag.	-	20-30	2	-			
1006 313	*Galliformes sp.*	galliforms	tarsometatarsus	frag. with P.E. with D.E.frag.	left	90	2	Bp=11	Fused		
1006 314		bird	tibiatarsus	dis. frag. without D.E.	-	60-70	<1	SC=2	Unfused		
1006 315	*Gallus gallus domesticus*	chicken	femur	com.	right	95-100	4	GL=80 Lm=76 Bp=15 Dp=10,5 SC=10,5 Bd=15 Dd=13	fused		
1006 316	*Gallus gallus domesticus*	chicken	femur	dis. frag.	left	40-50	2	Bd=14 Dd=11	fused		
1006 317	*Gallus gallus domesticus*	chicken	femur	frag. with P.E.frag.	left	20	2	-	fused		
1006 318	*Gallus gallus domesticus*	chicken	femur	frag. with P.E.	left	15-20	2	Bp=15 Dp=10			
1006 319	*Galliformes sp.*	galliforms	coracoid	frag. with P.E.	left	80	<1	-			
1006 320	*Gallus gallus domesticus*	chicken	coracoid	com.	right	95-100	2	Gl=54 Lm=50 BF=11	fused		
1006 321	*Galliformes sp.*	galliforms	coracoid	frag. with P.E.frag.	right	30	<1	-			
1006 322	*Gallus gallus domesticus*	chicken	coracoid	body frag.	left	70-80	1	-			
1006 323	*Gallus gallus domesticus*	chicken	coracoid	frag. with P.E. with D.E.frag.	right	90	1	-	fused		
1006 324	*Galliformes sp.*	galliforms	tarsometatarsus	frag. with P.E. with D.E.	right	95-100	2	Bp=10,5 GL=66 SC=6 Bd=12	Fused		
1006 325	*Gallus gallus domesticus*	chicken	coracoid	dis. frag.	-	50	2	-			
1006 326	*Gallus gallus domesticus*	chicken	coracoid	frag. with P.E.frag.	right	80	1	-			
1006 327	*Gallus gallus domesticus*	chicken	coracoid	frag.	left	95	2	Lm=54 BF=9	fused		
1006 328	*Gallus gallus domesticus*	chicken	scapula	pr. frag.	left	50	1	Dic=11	fused		
1006 329	*Gallus gallus domesticus*	chicken	fibula	frag. with P.E.	-	50-60	<1	-			
1006 330	*Galliformes sp.*	galliforms	ulna	frag. with P.E. with D.E.	right	95-100	2	GL=57 Dip=11 Bp=7 SC=3,5 Did=8			
1006 331	*Galliformes sp.*	galliforms	radius	com.	-	95-100	<1	GL=52 SC=2,5 Bd=5,5			
1006 332	*Gallus gallus domesticus*	chicken	humerus	com.	left	95-100	3	GL=62 Bp=16,5 SC=6 Bd=13	fused		
1006 333	*Gallus gallus domesticus*	chicken	humerus	frag. with D.E.	r	60-70	2	Bd=12,5 SC=6	fused		
1006 334	*Gallus gallus domesticus*	chicken	sternum	frag.	-	5-10	1	-			

1006 335	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with D.E. and spur	left	-	2	Bd=14	Fused		male
1006 336		bird	phalanx	frag.	-	95-100	<1	GL=42 SC=3 BP=9 Bd=4			
1006 337		bird	costa	frag.	-	-	1	-			
1006 338		bird	costa	frag.	-	-	<1	-			
1006 339	*Galliformes sp.*	galliforms	tarsometatarsus	body frag.	right	70-80	2	-			
1006 340	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E.	right	50-55	2	Bp=12	fused		
1006 341	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E.	left	40	2	Bp=12,5	fused		
1006 342	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E. with spur	right	80	4	Bp=14	fused		male
1006 343	*Gallus gallus domesticus*	chicken	tarsometatarsus	frag. with P.E.	right	70-80	3	Bp=14	fused		

APPENDIX 2. SKELETAL ELEMENT DISTRIBUTION

The identified remains per species are grouped according to skeletal elements. Grouped under teeth are the loose, separate teeth, teeth which were still attached to (a fragment of) the mandible or cranium were included under mandibula or cranium. When no elements of a species were present in a context, then the corresponding context is not included in the table. Additionally, the elements of sheep/goat, cattle and pig are grouped according to the major parts of the body (head, torso, front legs, hind legs, leg extremities).

	cranium	horn	mandibula	teeth	vertebrae	costae	scapula	humerus	radius	ulna	carpalia	metacarpus	phalanx 1	phalanx 2	phalanx 3	pelvis	femur	tibia	tarsalia	metatarsus
US 1135						1							1					1		
US 1156				1		2	1	2	2	2		2	2			2				3
US 1124	7	5	17	20	12	6	5	5	4	3	1	5	4		1	6	6	11		4
US 1006	1	7	3	15	6	2	3	3	9			6	1	1		5	3	7	2	5
Total	**8**	**12**	**20**	**36**	**18**	**11**	**9**	**10**	**15**	**5**	**1**	**13**	**8**	**1**	**1**	**13**	**9**	**19**	**2**	**12**

Skeletal element distribution of sheep/goat remains

Head	76
Torso	51
Front legs	31
Hind Legs	30
Leg extremities	35

Body part distribution of sheep/goat remains

	cranium	mandibula	teeth	vertebrae	costae	Scapula	humerus	radius	ulna	carpalia	metacarpus	metapode	phalanx 1	phalanx 2	phalanx 3	pelvis	femur	patella	tibia	tarsalia	metatarsus
US 1135					1																1
US 1156	2	6	2		2			1					1			1	4			1	1
US 1124	7	5	10	11	4	5	7	3	1	2	4		4	2	1	5	3	2	2	2	2
US 1006	2	2	11	5	7	2	3	2		2	1	3	4	2		1			1	1	1
Total	**11**	**13**	**23**	**16**	**14**	**7**	**10**	**6**	**1**	**4**	**5**	**3**	**9**	**4**	**1**	**7**	**7**	**2**	**3**	**4**	**5**

Skeletal element distribution of cattle remains

Head	47
Torso	44
Front legs	21
Hind Legs	16
Leg extremities	27

Body part distribution of cattle remains

	cranium	mandibula	teeth	Vertebrae	costae	scapula	humerus	radius	ulna	metacarpus	metapode	phalanx 1	phalanx 2	phalanx 3	pelvis	femur	tibia	fibula	Tarsalia	metatarsus
US 1135			2									1					1	1		
US 1194			1		1														1	
US 1156	1	1	3	1		4	3	2	4	3	1				5				1	3
US 1124	12	12	29	16	4	15	14	5	6	7	2	7	1	2	8	8	5	1	6	10
US 1006	10	10	37	17	16	6	9	6	4	8	5	6			2	2	6	5	4	8
Total	**23**	**23**	**72**	**34**	**21**	**25**	**26**	**13**	**14**	**18**	**8**	**14**	**1**	**2**	**15**	**10**	**12**	**7**	**12**	**21**

Skeletal element distribution of pig remains

Head	47
Torso	44
Front legs	21
Hind Legs	16
Leg extremities	27

Body part distribution of pig remains

	teeth	radius	metacarp	Metapode	phalanx 1	pelvis	femur	Tibia	tarsalia	metatarsu
US 1156		1								
US 1124	3		7	2	3	1	2	1	5	4
Total	**3**	**1**	**7**	**2**	**3**	**1**	**2**	**1**	**5**	**4**

Skeletal element distribution of horse remains

	mandibul	humerus	radius	femur	Tibia
US 1124	1			1	1
US 1006		1	1		
Total	**1**	**1**	**1**	**1**	**1**

Skeletal element distribution of cat remains

	mandibul	teeth	pelvis	metatarsu
US 1124	1			
US 1006		1	1	1
Total	**1**	**1**	**1**	**1**

Skeletal element distribution of dog remains

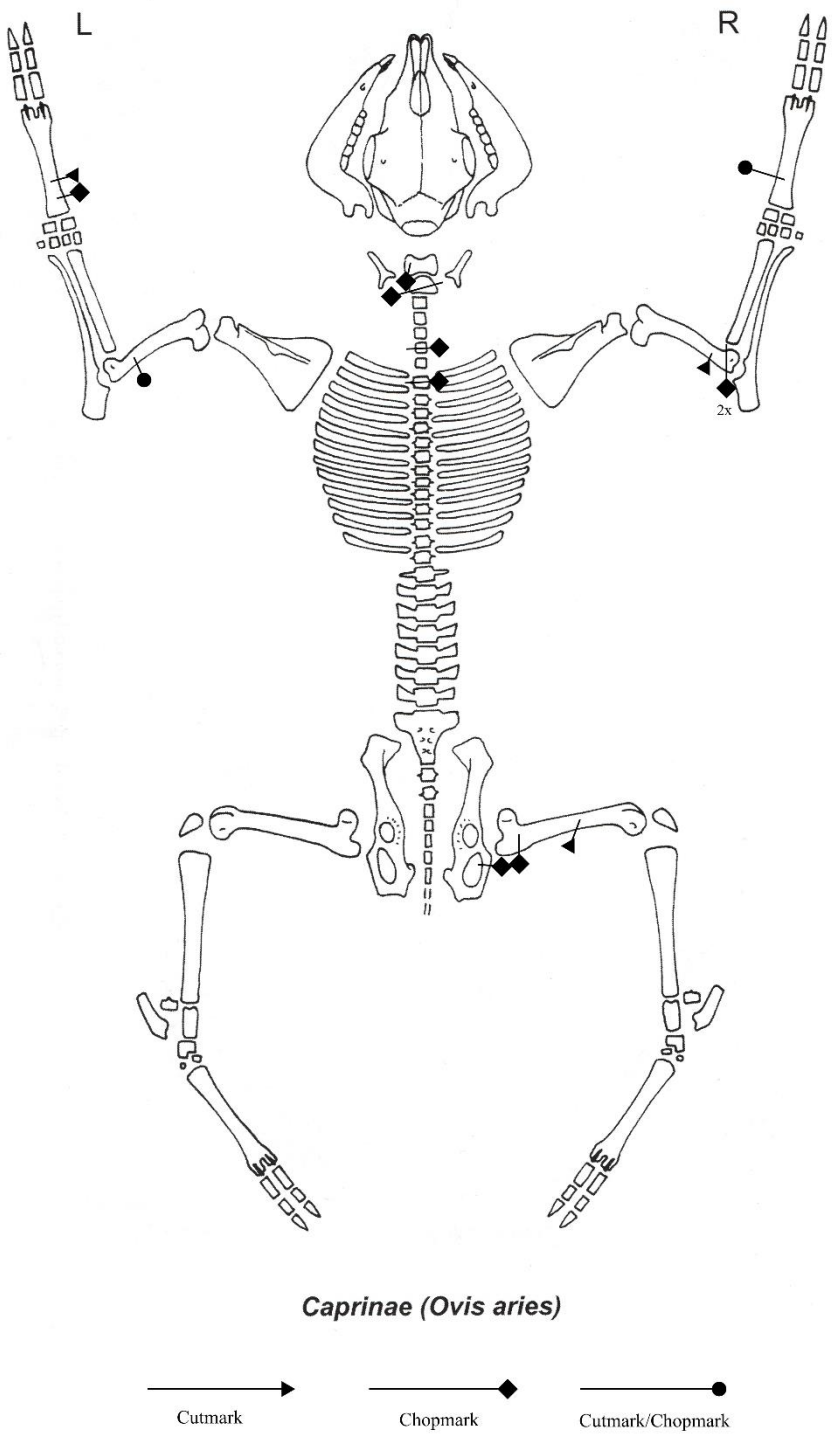
	vertebrae	scapula	coracoid	humerus	radius	ulna	caropmetacarpu	femur	tibiotarsus	fibula	Tarsometatarsus
US 1135				1							
US 1156			1			1		3	2		1
US 1124	1			3	1	5	1	3	4		2
US 1006	1	1	8	2	1	1		4	8	1	11
Total	**2**	**1**	**9**	**6**	**2**	**7**	**1**	**10**	**14**	**1**	**14**

Skeletal element distribution of bird remains (including chicken)

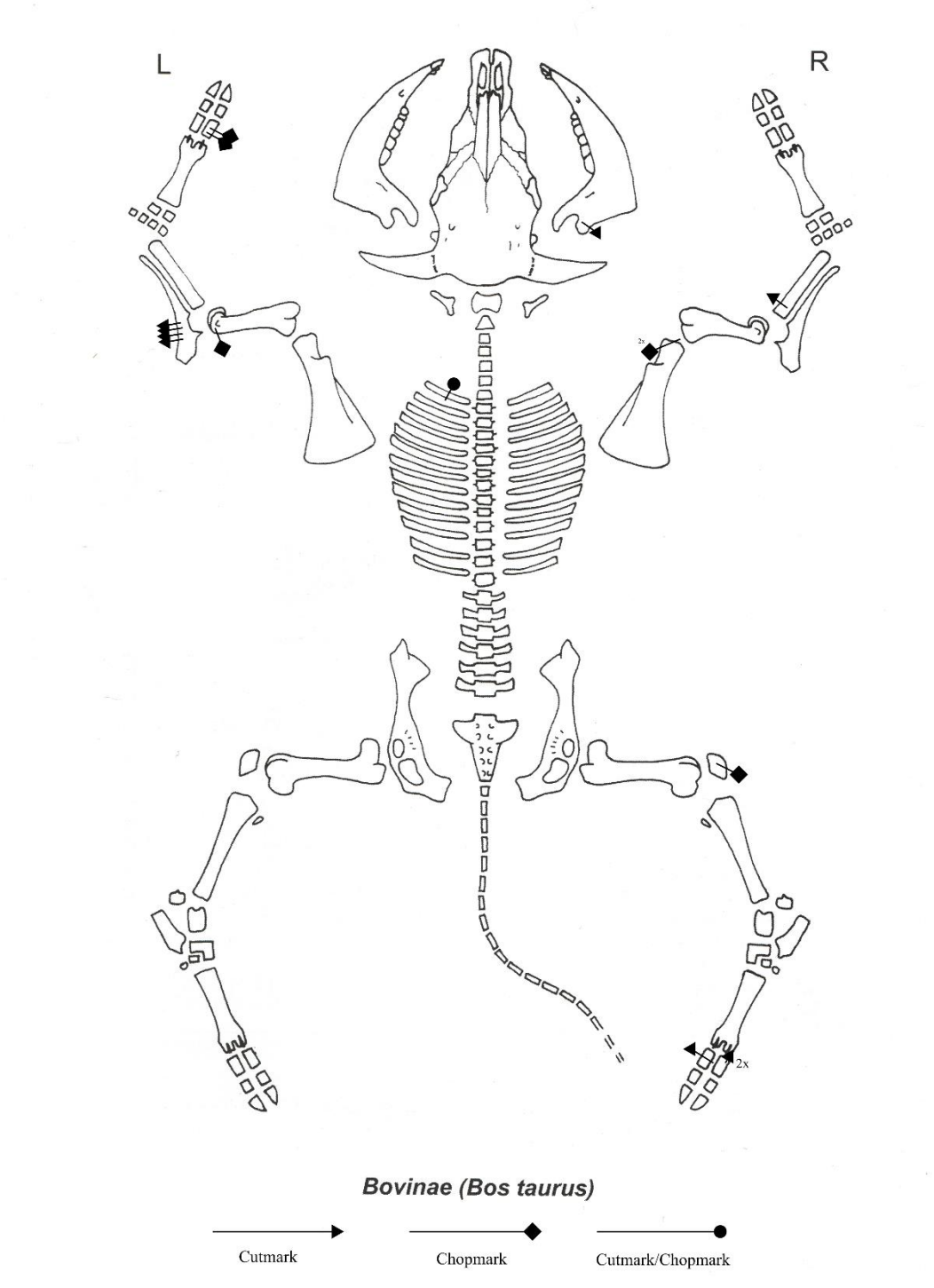
	vertebrae	scapula	coracoid	Humerus	radius	ulna	caropmet	femur	tibiotarsu	fibula	tarsometa
US 1135				1							
US 1194											
US 1156			1					2	1		1
US 1124	1			3		5	1	3	4		2
US 1006	1	1	6	2				4	6	1	7
Total	**2**	**1**	**7**	**6**	**0**	**5**	**1**	**9**	**11**	**1**	**10**

Skeletal element distribution of (only) chicken remains

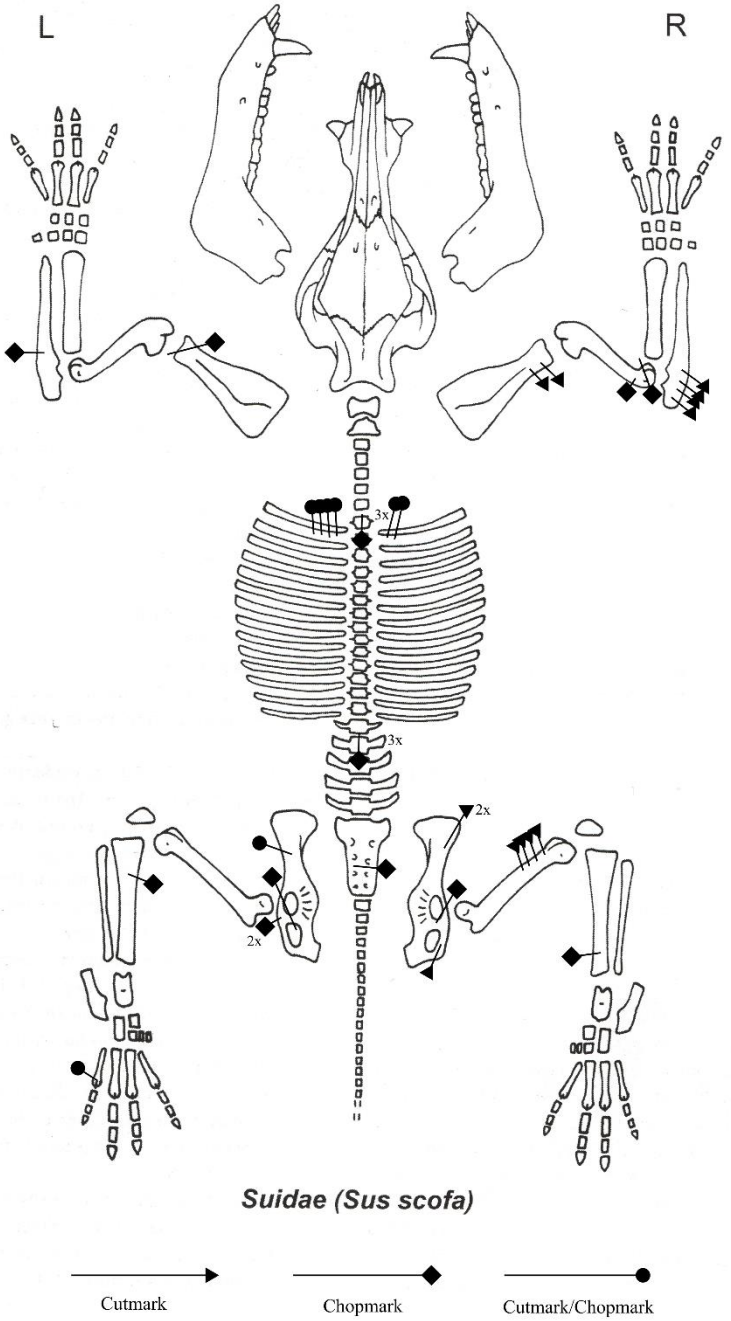
APPENDIX 3. BUTCHERY MARKS



Butchery marks identified on sheep/goat remains (n=14)



Butchery marks identified on cattle remains (n=10)



Butchery marks identified on pig remains (n=29)

APPENDIX 4. MEASUREMENTS OF PIG REMAINS

Measurements of pig elements are compared to a standard value derived from a modern wild boar population (Payne, Bull 1988) using the logarithmic size index method.

Measurement	Value	Standard value (Payne, Bull 1988)	Ratio	Log ratio
Astragalus GL1	35	48.70	0.72	-0.14
Astragalus GL1	44	48.70	0.90	-0.04
Humerus Bd	47	50.00	0.94	-0.03
Pelvis LAR	27	36.30	0.74	-0.13
Pelvis LAR	30	36.30	0.83	-0.08
Pelvis LAR	31	36.30	0.85	-0.07
Radius Bp	29	34.20	0.85	-0.07
Scapula SLC	23	29.80	0.77	-0.11
Scapula GLP	33	42.60	0.77	-0.11
Ulna DPA	28	47.30	0.59	-0.23
Ulna DPA	34	47.30	0.72	-0.14
Ulna DPA	35	47.30	0.74	-0.13
Humerus Bd	37	50.00	0.74	-0.13
Humerus Bd	41	50.00	0.82	-0.09
Pelvis LAR	31	36.30	0.85	-0.07
Radius Bp	29	34.20	0.85	-0.07
Radius Bp	30	34.20	0.88	-0.06
Radius Bp	31	34.20	0.91	-0.04
Scapula SLC	21	29.80	0.70	-0.15
Scapula SLC	21	29.80	0.70	-0.15
Scapula SLC	22	29.80	0.74	-0.13
Scapula GLP	32	42.60	0.75	-0.12
Scapula SLC	22	29.80	0.74	-0.13
Scapula GLP	33	42.60	0.77	-0.11
Scapula SLC	23	29.80	0.77	-0.11
Scapula GLP	32	42.60	0.75	-0.12
Scapula SLC	23	29.80	0.77	-0.11
Scapula GLP	33	42.60	0.77	-0.11
Scapula SLC	25	29.80	0.84	-0.08
Scapula GLP	40	42.60	0.94	-0.03
Tibia Bd	27	34.60	0.78	-0.11
Ulna DPA	37	47.30	0.78	-0.11
Ulna DPA	37	47.30	0.78	-0.11
Astragalus GL1	43	48.70	0.88	-0.05
Humerus Bd	35	50.00	0.70	-0.15

Radius Bd	35	41.30	0.85	-0.07
Radius Bp	28	34.20	0.82	-0.09
Radius Bp	32	34.20	0.94	-0.03
Scapula GLP	34	42.60	0.80	-0.10
Scapula SLC	22	29.80	0.74	-0.13
Scapula SLC	23	29.80	0.77	-0.11
Tibia Bd	25	34.60	0.72	-0.14
Tibia Bd	27	34.60	0.78	-0.11
Tibia Bd	30	34.60	0.87	-0.06
Tibia Bd	30	34.60	0.87	-0.06

Additionally, withers height of pig was calculated using the multiplication factor of Teichert (Von den Driesch, Boessneck 1974, 341).

Skeletal Element	**Measurement GL1**	**Multiplication factor (Teichert)***	**Withers height**
Astragalus, left	43	17.90	76.97
Astragalus, right	44	17.90	78.76
Astragalus, right	35	17.90	62.65

*The multiplication factors from Teichert are derived from Von den Driesch, Boessneck 1974.

APPENDIX 5. ARCHAEOZOOLOGICAL SITES IN CENTRAL ROMAN ITALY

For a clarification of the types of sites and the period divisions, see Chapter 4.1. The M in the last column indicates that the site is derived from the list of Italian archaeozoological sites composed by Michael MacKinnon (MacKinnon 2004).

	Site	Type	Period, date	Location	Bibliography	
1	A26	urb2: Samnite settlement	1: Samnite	Molise, inland	Barker and Clark 1995	M
2	Alife, criptoportico	urb1: urban settlement	2: 1st-3rd century CE	Campania, inland	Carannante et al. 2012	
	Alife, criptoportico	urb1: urban settlement	3: 3rd-7th century CE	Campania, inland		
3	Blera	urb2: Etruscan settlement	1: 4th-3rd century BCE	Lazio, inland	Scali 1987	M
4	Bolsena	urb1: urban settlement	1: 2nd century BCE - mid 1st century CE	Lazio, inland	Tagliacozzo 1995	M
5	Borgo Le Ferriere	sp: votive deposit	1: 8th-3rd century BCE	Lazio, coast	Prummel, Bouma 1997	
6	C36	sp: Samnite sanctuary	1: Samnite	Molise, inland	Barker and Clark 1995	M
7	Campochiaro	sp: Samnite sanctuary	1: Samnite	Molise, inland	Barker and Clark 1995	M
	Campochiaro	sp: sanctuary	3: 4th-5th century CE	Molise, inland	Barker and Clark 1995	
8	Cantone	sp: necropolis	2: 1st century BCE - 1st century CE	Abruzzo, inland	Sorrentino 1989	M
9	Capua, Carillo	urb1: urban settlement	2: 2nd-3rd century CE	Campania, inland	King 1987	M
	Capua, Carillo	urb1: urban settlement	3: 5th-6th century CE	Campania, inland		
10	Case Nuove	r: rural site	1: 1st century BCE	Toscana, inland	Vaccaro, MacKinnon 2013	
	Case Nuove	r: rural site	2: 1st - mid 3rd century CE	Toscana, inland		
	Case Nuove	r: rural site	3: late 4th - mid 5th century CE	Toscana, inland		
11	Cosa, cisterne	sp: dog burials	3: 4th century CE	Toscana, coast	Scali 1993b	M
12	Cosa, houses	urb1: Roman city	1: early 2nd century BCE	Toscana, coast	Scali 1993a	M
13	Cosa, lagoon	urb1: port settlement	2: 1st-2nd century CE	Toscana, coast	Hesse and Wapnish 1987	M
14	Ferento, fossa 1918	urb1: urban settlement	3: 4th-5th century CE	Lazio, inland	Alhaïque, De Bernardis, Fortunato 2011	
15	Ferento, fossa 3258	sp: ritual deposit	2: 1ste century CE	Lazio, inland	Rizzo, Fortunato, Pavolini 2013	
16	Ferento, pozzo 593	urb1: urban settlement	1: 2nd century BCE - mid 1st century CE	Lazio, inland	Alhaïque, De Bernardis, Fortunato 2011	
17	Ferento, Saggio III	urb1: urban settlement	2: 1st century CE	Lazio, inland	Alhaïque, De Bernardis, Fortunato 2011	
18	Ferento, SU 038	sp: dog burial	3: 4th century CE	Lazio, inland	Alhaique, Fortunato 2015	
19	Fidene	sp: dog burials	2: 2nd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2000; De Grossi Mazzorin 2001	
20	Filattiera	urb2: settlement	2: 1st-3rd century CE	Toscana, inland	Giovinazzo 1998	
	Filattiera	urb2: settlement	3: 4th-6th century CE	Toscana, inland		
21	Gabii, Tincu House	urb1: settlement	1: 5th-6th century CE	Lazio, inland	Alhaique 2018	
	Gabii, Tincu House	urb1: settlement	2: 1st century CE	Lazio, inland	Alhaique 2018	

22	Le Colonne	r: rural villa	2: 1st century BCE – 2nd century CE	Toscana, coast	King 1985; MacKinnon 2004 (King n.d. 1, unpublished report)	M
23	Lugnano	r: rural villa	2: 1st-3rd century CE	Umbria, inland	MacKinnon 1999	M
	Lugnano	r: rural villa	3: 5th century CE	Umbria, inland		
24	Lugnano, cemetery	sp: infant cemetery	3: 5th century CE	Umbria, inland	MacKinnon 1999	M
25	Luni, Domus presso Porta Marina	urb1: urban settlement	3: 5th-8th century CE	Liguria, coast	Menchelli, Sangriso, Genovesi 2016; Menchelli et al. Forthcoming(a); Chapter 3	
26	Luni, Forum	urb1: urban settlement	2: 3th century CE	Liguria, coast	Barker 1977	M
	Luni, Forum	urb1: urban settlement	3: 4th-8th century CE	Liguria, coast		
27	Mansio ad Vacanas	r: mansio	2: 1st-4th century CE	Lazio, inland	Cerilli 2005	
28	Matrice	r: rural settlement	1: Samnite	Molise, inland	Barker and Clark 1995; Mackinnon 2004 (Clark unpublished)	M
	Matrice	r: rural villa	2: 1st-3rd century CE	Molise, inland		
	Matrice	r: rural villa	3: 4th-5th century CE	Molise, inland		
29	Monte Gelato	r: rural complex (vicus, villa?)	2: 1st-2nd century CE	Lazio, inland	King 1997	M
	Monte Gelato	r: rural villa	3: 4th-5th century CE	Lazio, inland		
30	Monte Vairano	urb2: samnite oppidum	1: late 4th-2nd century BCE	Molise, inland	Barker and Clark 1995	M
31	Montecatino	urb2: Etruscan settlement	1: 6th-4th century BCE	Toscana, inland	Wilkens 1991	M
32	Musarna	r/urb2: settlement	1: 3rd century BCE - 1st century CE	Lazio, inland	Tagliacozzo 1990	M
33	Naples, Carminiello	urb1: urban settlement	2: 2nd-4th century CE	Campania, coast	King 1994; Rielly 1994; Rhodes 1994	M
	Naples, Carminiello	urb1: urban settlement	3: mid 5th-6th century CE	Campania, coast		
	Naples, Carminiello	urb1: urban settlement	1: 1st century BCE - 1st century CE	Campania, coast		
34	Naples, Girolamini	urb1: urban settlement	3: late 4th century CE	Campania, coast	MacKinnon 2004 (Albarella and Frezza 1988a, unpublished report)	M
35	Naples, Santa Maria la Nova	urb1: urban settlement	3: 6th century CE	Campania, coast	MacKinnon 2004 (King n.d. 2, unpublished report)	M
36	Naples, Santa Patrizia	urb1: urban settlement	3: 4th century CE	Campania, coast	MacKinnon 2004 (Albarella and Frezza 1988b, unpublished report)	M
37	Naples, Santa Sofia	urb1: urban settlement	2: early first century CE	Campania, coast	MacKinnon 2004 (King n.d. 5, unpublished report)	M
38	Naples, Via San Paolo	urb1: urban settlement	3: 5th-6th century CE	Campania, coast	MacKinnon 2004 (Albarella and Frezza 1988b)	M
39	Narce	r: rural complex	1: 4st-2nd century BCE	Lazio, inland	Barker 1976	M
40	Nemi, santuario di Diana	sp: sanctuary	1: 4th-1st century BCE	Lazio, inland	Fortunato 2013	
41	Nomentana	sp: dog burials	2: mid 2nd century - early 3rd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2001a	
42	Ossaia	r: rural villa	2: 1st-4th century CE	Toscana, inland	MacKinnon 2010 (Bökönyi n.d., unpublished report)	
43	Ostia, bath	urb1: urban settlement	2: 1st - mid 3rd century CE	Lazio, coast	Instituto di Paleontologia Umano 1968; Instituto di Paleontologia Umano 1973; Instituto di	M
	Ostia, bath	urb1: urban settlement	3: late 3rd – 5th century CE	Lazio, coast		

					Paleontologia Umano 1977	
44	Ostia, castrum	urb1: urban settlement	1: 3rd-1st century BCE	Lazio, coast	King 1985; MacKinnon 2004 (King n.d. 4, unpublished report)	M
	Ostia, castrum	urb1: urban settlement	2: 1st-5th century CE	Lazio, coast		
45	Pescorocchiano	sp: votive deposit	1: late 4th - mid 2nd century BCE	Lazio, inland	De Grossi Mazzorin 1995b	M
46	Pietrabbondante	sp: Samnite sanctuary	1: Samnite	Molise, inland	Barker and Clark 1995	M
47	Pievina	r: rural settlement	2: Imperial period	Toscana, inland	MacKinnon 2010; MacKinnon 2011	
	Pievina	r: rural settlement	3: Late Antique period	Toscana, inland		
48	Pisa, navi antiche	sp: ship wrecks	2: 1st century BCE - 5th century CE	Toscana, coast	Sorrentino, Giuseppe, Manzi, 2000	
48	Pistoia	urb1: urban settlement	2: 1st-3rd century AD	Toscana, inland	Giorgetti and Campodoni 1985	M
	Pistoia	urb1: urban settlement	3: 4th-7th century AD	Toscana, inland		
50	Poggio Picenze, Varranone	sp: tomb	1: 3rd century BCE	Abruzzo , inland	De Grossi Mazzorin 2014a	
51	Pompeii 94	urb1: urban settlement	1: Republican	Campania, coast	Richardson 1995; Richardson, Thompson, Genovese 1997; MacKinnon 2004 (Richardson 1994, unpublished report)	M
52	Pompeii 95	urb1: urban settlement	1: Republican	Campania, coast	Richardson 1995; Richardson, Thompson, Genovese 1997; MacKinnon 2004 (Richardson 1994, unpublished report)	M
53	Pompeii, Casa di Ganimede	urb1: urban settlement	1: 6th century BCE	Campania, coast	Kokabi 1982	M
54	Pompeii, Forum	urb1: urban settlement	2: 1st century CE	Campania, coast	King, Rielly, Thomas 1985; King 1994; MacKinnon 2004 (King n.d. 3, unpublished report)	M
	Pompeii, Forum	urb1: urban settlement	1: late 6th century BCE - early 1st century CE	Campania, coast		
55	Pompeii, Gardens	urb1: urban settlement	2: late 1st century CE	Campania, coast	Jashemski 1973a; Jashemski 1973b; Jashemski 1979; Jashemski 1993	M
56	Pompeii, House of Amaranthus	urb1: urban settlement	1: 4th-1st century BCE	Campania, coast	Clark 1999	M
	Pompeii, House of Amaranthus	sp: ritual deposit	1: 4th-1st century BCE	Campania, coast		
57	Populonia	urb1: urban settlement	1: 3th century BCE	Toscana, coast	De Grossi Mazzorin 1985	M
58	Populonia, cisterne	sp: ritual deposit	1: 2nd century BCE	Toscana, coast	De Grossi Mazzorin, Mascione 2010	
59	Populonia, fossa 12618	sp: ritual deposit	1: late 3rd - mid 2nd century BCE	Toscana, coast	De Grossi Mazzorin, Minniti 2015	
60	Populonia, necropoli delle Grotte	sp: necropolis	1: 4th-1st century BCE	Toscana, coast	De Grossi Mazzorin, Minniti 2009	
61	Populonia, saggio IX	urb1: urban settlement	1: mid 2nd - early 1st century BCE	Toscana, coast	De Grossi Mazzorin, Minniti 2008; De Grossi Mazzorin, Minniti 2010b	
	Populonia, saggio IX	urb1: urban settlement	2: mid 1st century BCE - mid 1st century CE	Toscana, coast		
62	Quintili	r: suburban rural	2: 1st-2nd century CE	Lazio, inland	De Grossi Mazzorin 1987	M
63	Roma, Anphitheatro Flavio	urb1: urban settlement	2: 1st-3rd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
	Roma, Anphitheatro Flavio	urb1: urban settlement	3: 4th-5th century CE	Lazio, inland		

64	Roma, Aqua Marcia	urb1: city	1: 2nd century BCE	Lazio, inland	De Grossi Mazzorin 1996	M
	Roma, Aqua Marcia	urb1/ sp: city and ritual deposit	2: 1st century BCE - 3rd century CE	Lazio, inland		
65	Roma, Arco di Costantino	urb1: urban settlement	2: 1st-2nd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
66	Roma, Caput Africae	urb1: city	2: 1st-3rd century CE	Lazio, inland	Tagliacozzo 1993	M
67	Roma, Centocello	sp: ritual deposit	1: 4th-3rd century BCE	Lazio, inland	De Grossi Mazzorin 2004b	
68	Roma, Crypta Balbi esedra	urb1: urban settlement	3: 7th-8th century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2001b	
69	Roma, Crypta Balbi Mitreo	sp: mithreum	3: 4th century CE	Lazio, inland	De Grossi Mazzorin 2004a	
	Roma, Crypta Balbi Mitreo	urb1: urban settlement	3: 5th century CE	Lazio, inland	De Grossi Mazzorin 2004a	
70	Roma, Forum Ilium	urb1: urban settlement	1: late 6th century BCE	Lazio, inland	De Grossi Mazzorin 2014b	
71	Roma, Forum Transitorium	urb1/ sp: urban deposit, ritual?	2: 1st century CE	Lazio, inland	De Grossi Mazzorin 1989	M
72	Roma, Meta Sudans	urb1: urban settlement	3: 5th-6th century CE	Lazio, inland	De Grossi Mazzorin 1995a	M
73	Roma, Meta Sudans US 3399	urb1: city	2: 1st century BCE - 1st century CE	Lazio, inland	De Grossi Mazzorin, Minniti 1995; De Grossi Mazzorin, Minniti 2010	
74	Roma, Palatino area temenos	urb1: city	1: 6th-3th century BCE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
75	Roma, Palatino capanna Puglisi	urb1: city	1: 5th-3th century BCE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
76	Roma, Passaggio di Commodo	urb1: urban settlement	2: 3rd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
	Roma, Passaggio di Commodo	urb1: urban settlement	3: 4th century CE	Lazio, inland		
77	Roma, Piazza Celimontana	sp: horse burial	3: 5th century CE	Lazio, inland	Bistolfi, De Grossi Mazzorin 2005	
78	Roma, San Omobono	urb1/ sp: urban temple, ritual deposit	1: 6th-5th century BCE	Lazio, inland	Ioppolo 1972; Tagliacozzo 1989	M
79	Roma, Schola Praeconum	urb1: urban settlement	3: 5th century CE	Lazio, inland	Barker 1982	M
80	Roma, Terme di Traiano	urb1: urban settlement	2: 2nd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
	Roma, Terme di Traiano	urb1: urban settlement	3: 6th-7th century CE	Lazio, inland		
81	Rome, Vesta Area Sacra	sp: ritual deposit	1: Republican	Lazio, inland	Costantini, Giorgi 2009	
82	Roma, Via Gaetano Sacchi	urb1: urban settlement	2: mid 1st century BCE - 2nd century CE	Lazio, inland	De Grossi Mazzorin, Coppola 2008	
83	Roma, Via Sacchi	urb1: urban settlement	2: 2nd century CE	Lazio, inland	De Grossi Mazzorin, Minniti 2010a	
84	Roma, Via Sacra	urb1: city	1: Early Roman	Lazio, inland	Blanc 1960	M
85	S. Angelo di Civitella	sp: votive warehouse	1: 4th-2nd century BCE	Lazio, inland	Santini 2013	
86	Saepinum	urb1: urban settlement	2: 2nd-3rd century CE	Molise, inland	Barker and Clark 1995	M
87	San Costanzo	sp: sanctuary, church	2: 3rd-4th century CE	Campania, Capri, Bay of Naples	Albarella 1992	M
88	San Giacomo	r: rural villa	3: early 5th century CE	Molise, inland	Albarella 1993	M
89	San Giovenale	urb2: settlement	1: 3rd-1st century BCE	Lazio, inland	Sorrentino 1981a; Sorrentino 1981b	M
90	San Giovenale, cult	sp: sanctuary	1: 3rd-1st century BCE	Lazio, inland	Sorrentino 1981a; Sorrentino 1981b	M
91	San Potito	r: rural villa	2: Imperial period	Abruzzo, inland	Bökönyi 1986	M
92	Schiavi d'Abruzzo	sp: sanctuary	1: 4th-1st century BCE	Abruzzo, inland	De Grossi Mazzorin 1997	M

93	Settefinestre	r: rural villa	1: late 1st century BCE - early 1st century CE	Toscana, coast	King 1985	M
	Settefinestre	r: rural villa	2: late 1st-3rd century CE	Toscana, coast		
	Settefinestre	r: rural villa	3: 4th century CE	Toscana, coast		
94	Sperlonga	sp: cave deposit	2: 1st century CE	Lazio, coast	Azzaroli 1979	M
95	Subiaco, Le Camere	sp: cave deposit	1: mid 3rd century BCE	Lazio, inland	Fiore et al. 2012	
96	Tarquinia	urb1: Etruscan urban settlement	1: 3th-2nd century BCE	Lazio, inland	Bedini 1997	M
97	Tenuta di Vallerano	r: rural settlement	2: 1st-2nd century CE	Lazio, inland	Minniti 2005	
98	Via Gabina, site 10	r: suburban villa	1,2: 3rd century BCE - 3rd century CE	Lazio, inland	Clark 1990; Widrig 2002	
99	Via Gabina, site 11	r: suburban villa	1,2: 3rd century BCE - 3rd century CE	Lazio, inland	Clark 1990; Widrig 2002	

APPENDIX 6. NISP DATA FOR ANALYSED CONTEXTS

Site	Period	Type	Total Sample	NISP sample	NISP mammal	NISP bird	NISP fish	NISP reptile	NISP amphibian
A26	1	urb2	51	24	24	0	0	0	0
Alife, criptoportico2	2	urb1	na	384	335	49	na	0	0
Alife, criptoportico3	3	urb1	na	742	642	100	na	0	0
Blera	1	urb2	31	18	15	3	0	0	0
Bolsena	1	urb1	2615	1172	1110	48	14	0	0
Borgo Le Ferriere	1	sp	4323	1547	1546	1	0	0	0
C36	1	sp	850	234	233	1	0	0	0
Campochiaro1	1	sp	2203	671	671	0	0	0	0
Campochiaro3	3	sp	3155	676	652	24	na	2	na
Cantone	2	sp	1607	1607	824	507	276	0	0
Capua, Carillo2	2	urb1	132	57	46	0	11	0	0
Capua, Carillo3	3	urb1	58	41	41	0	0	0	0
Case Nuove1	1	r	na	15	15	0	0	0	0
Case Nuove2	2	r	na	199	113	54	0	3	29
Case Nuove3	3	r	na	220	197	20	0	3	0
Cosa, cistern	3	sp	100	100	100	na	na	na	na
Cosa, houses	1	urb1	142	112	112	na	na	na	na
Cosa, lagoon	2	urb1	45	38	28	1	0	10	0
Ferento, fossa 1918	3	urb1	304	187	187	0	0	0	0
Ferento, fossa 3258	2	sp	142	73	69	3	0	0	0
Ferento, pozzo 593	1	urb1	293	109	94	14	1	0	0
Ferento, Saggio III	2	urb1	519	206	198	8	0	0	0
Ferento, SU 038	3	sp	131	112	112	0	0	0	0
Fidene	2	sp	na	na	na	na	na	na	na
Filattiera2	2	urb2	65	65	0	0	0	0	0
Filattiera3	3	urb2	96	96	0	0	0	0	0
Gabii, Tincu House1	1	urb1	1600	548	507	37	3	0	1
Gabii, Tincu House2	2	urb1	2225	664	594	66	0	0	4
Le Colonne	2	r	966	547	547	0	0	0	0
Lugnano, cemetery	3	sp	2467	1026	822	177	1	0	26
Lugnano2	2	r	134	45	41	4	0	0	0
Lugnano3	3	r	144	56	39	17	0	0	0
Luni, Domus presso Porta Marina	3	urb1	1674	877	796	76	4	0	0
Luni, Forum2	2	urb1	180	114	107	7	0	0	0
Luni, Forum3	3	urb1	3425	1742	1543	195	0	4	0
Mansio ad Vacanas	2	r	na	232	136	0	0	0	0
Matrice1	1	r	na	na	70	na	na	na	na
Matrice2	2	r	1466	689	689	na	na	na	na

Matrice3	3	r	2019	894	894	na	na	na	na
Monte Gelato2	2	r	1029	612	532	56	17	0	7
Monte Gelato3	3	r	899	532	496	33	1	1	1
Monte Vairano	1	urb2	344	322	321	1	0	0	0
Montecantino	1	urb2	708	290	290	na	na	na	na
Musarna	1	r	2500	na	na	na	na	na	na
Naples, Carminiello1	1	urb1	474	241	236	5	0	0	0
Naples, Carminiello2	2	urb1	282	142	110	32	0	0	0
Naples, Carminiello3	3	urb1	5858	3390	2378	990	22	0	0
Naples, Girolamini	3	urb1	1638	743	741	1	0	1	0
Naples, Santa Maria la Nova	3	urb1	179	98	74	15	7	2	0
Naples, Santa Patrizia	3	urb1	1416	607	560	30	16	0	1
Naples, Santa Sofia	2	urb1	46	46	46	na	na	na	na
Naples, Via San Paolo	3	urb1	173	173	164	8	0	0	0
Narce	1	r	138	87	87	0	0	0	0
Nemi, santuario di Diana	1	sp	391	142	132	10	0	0	0
Nomentana	2	sp	na	na	na	na	na	na	na
Ossaia	2	r	na	2080	1950	130	na	na	na
Ostia, bath2	2	urb1	2599	2599	2566	29	3	1	0
Ostia, bath3	3	urb1	171	171	151	20	0	0	0
Ostia, castrum1	1	urb1	107	107	107	na	na	na	na
Ostia, castrum2	2	urb1	125	125	125	na	na	na	na
Pescorocchiano	1	sp	423	423	100	na	na	na	na
Pietrabbondante	1	sp	400	139	102	29	8	0	0
Pievina2	2	r	76	27	26	1	0	0	0
Pievina3	3	r	940	292	285	2	0	5	0
Pisa, navi antiche	2	sp	5111	3042	2916	78	34	12	0
Pistoia2	2	urb1	250	30	26	4	0	0	0
Pistoia3	3	urb1	1812	258	244	14	0	0	0
Poggio Picenze, Varranone	1	sp	111	111	111	0	0	0	0
Pompeii 94	1	urb1	1420	na	na	na	na	na	na
Pompeii 95	1	urb1	1853	253	148	12	93	0	0
Pompeii, Casa di Ganimede	1	urb1	1038	936	909	16	11	0	0
Pompeii, Forum1	1	urb1	2686	2686	2686	na	na	na	na
Pompeii, Forum2	2	urb1	504	504	504	na	na	na	na
Pompeii, Gardens	2	urb1	297	207	205	2	na	na	na
Pompeii, House of Amaranthus	1	urb1	784	319	248	12	50	7	2
Pompeii, House of Amaranthus sp	1	sp	186	98	85	2	0	9	2
Populonia	1	urb1	8080	2054	2014	23	13	4	0
Populonia, cisterne	1	sp	383	383	383	0	0	0	0

Populonia, fossa 12618	1	sp	2185	1706	1668	1	0	0	0
Populonia, necropoli delle Grotte	1	sp	na	185	138	30	17	0	0
Populonia, saggio IX 1	1	urb1	555	260	250	5	5	0	0
Populonia, saggio IX 2	2	urb1	692	339	335	4	0	0	0
Quintili	2	r	493	225	157	61	7	0	0
Roma, Anphitheatro Flavio 2	2	urb1	na	1574	na	na	na	na	na
Roma, Anphitheatro Flavio 3	3	urb1	na	2564	na	na	na	na	na
Roma, Aqua Marcia1	1	urb1	17	5	5	0	0	0	0
Roma, Aqua Marcia2	2	urb1	1062	397	391	5	2	0	0
Roma, Arco di Costantino	2	urb1	na	342	na	na	na	na	na
Roma, Caput Africae	2	urb1	458	222	209	12	3	0	0
Roma, Centocello	1	sp	na	547	175	371	1	0	0
Roma, Crypta Balbi esedra	3	urb1	10159	7487	7056	377	46	8	0
Roma, Crypta Balbi Mitreo	3	urb1	na	374	288	85	1	0	0
Roma, Crypta Balbi Mitreo sp	3	sp	na	55	16	36	3	0	0
Roma, Forum Ilium	1	urb1	518	107	104	3	0	0	0
Roma, Forum Transitorium	2	urb1	129	73	72	1	0	0	0
Roma, Meta Sudans	3	urb1	2826	2826	2451	320	47	8	0
Roma, Meta Sudans US 3399	2	urb1	na	541	421	72	48	0	0
Roma, Palatino area temenos	1	urb1	na	709	na	na	na	na	na
Roma, Palatino capanna Puglisi	1	urb1	na	73	na	na	na	na	na
Roma, Passaggio di Commodo2	2	urb1	na	282	na	na	na	na	na
Roma, Passaggio di Commodo3	3	urb1	na	71	na	na	na	na	na
Roma, Piazza Celimontana	3	sp	64	64	64	0	0	0	0
Roma, San Omobono	1	sp	2096	2096	2080	9	5	1	1
Roma, Schola Praecononum	3	urb1	4000	1741	1604	132	5	0	0
Roma, Terme di Traiano2	2	urb1	na	19	na	na	na	na	na
Roma, Terme di Traiano3	3	urb1	na	1114	na	na	na	na	na
Roma, Vesta Area Sacra	1	sp	45	45	29	16	0	0	0
Roma, Via Gaetano Sacchi	2	urb1	1755	1061	1043	16	2	0	0
Roma, Via Sacchi	2	urb1	na	981	na	na	na	na	na
Roma, Via Sacra	1	urb1	132	106	106	0	0	0	0
S. Angelo di Civitella	1	sp	3240	na	na	na	na	na	na
Saepinum	2	urb1	87	39	39	na	0	na	na
San Costanzo	2	sp	109	83	47	8	27	0	1
San Giacomo	3	r	563	460	434	24	0	0	2
San Giovenale	1	urb2	166	61	52	9	0	0	0

San Giovenale, cult	1	sp	135	39	39	0	0	0	0
San Potito	2	r	500	315	311	4	0	0	0
Schiavi d'Abruzzo	1	sp	15	15	15	0	0	0	0
Settefinestre1	1	r	544	241	230	8	0	3	0
Settefinestre2	2	r	6742	3033	2630	335	37	29	2
Settefinestre3	3	r	2023	1015	910	20	1	83	1
Sperlonga	2	sp	31	31	31	**n.a.**	**n.a.**	**n.a.**	**n.a.**
Subiaco, Le Camere	1	sp	1620	698	696	0	0	0	2
Tarquinia	1	urb1	108	88	88	0	0	0	0
Tenuta di Vallerano	2	r	929	471	463	7	1	0	0
Via Gabina, site 10	1,2	r	4495	1984	1757	213	9	5	0
Via Gabina, site 11	1,2	r	262	125	106	14	1	4	0

APPENDIX 7. PERCENTAGES OF MAMMALS BASED ON NISP

site	**Period**	**Type**	**NISP mammal**	**% cattle**	**% sheep/goat**	**% pig**	**% equid**	**% dog**	**% cat**	**% wild**	**% rodent**
A26	1	urb2	24	0.0	20.8	75.0	0.0	0.0	0.0	4.2	0.0
Alife, criptoportico2	2	urb1	335	5.1	12.2	80.6	0.0	0.3	0.0	1.8	0.0
Alife, criptoportico3	3	urb1	642	6.4	8.1	81.8	0.2	1.2	0.0	2.3	0.0
Blera	1	urb2	12	50.0	8.3	41.7	0.0	0.0	0.0	0.0	some
Bolsena	1	urb1	1110	12.1	49.2	37.2	0.1	0.1	0.0	1.4	0.0
Borgo Le Ferriere	1	sp	1546	12.7	79.8	7.2	0.0	0.2	0.0	0.1	0.0
C36	1	sp	233	6.0	45.5	43.8	0.0	1.7	0.0	1.7	1.3
Campochiaro1	1	sp	671	0.2	27.2	72.1	0.0	0.0	0.0	0.0	0.0
Campochiaro3	3	sp	652	17.3	33.4	40.2	0.0	0.2	0.0	5.2	3.7
Cantone	2	sp	824	0.6	32.5	66.9	0.0	0.0	0.0	0.0	0.0
Capua, Carillo2	2	urb1	46	6.5	28.3	60.9	0.0	4.3	0.0	0.0	0.0
Capua, Carillo3	3	urb1	41	12.2	17.1	68.3	2.4	0.0	0.0	0.0	0.0
Case Nuove1	1	r	15	46.7	20.0	26.7	0.0	0.0	0.0	6.7	0.0
Case Nuove2	2	r	113	0.0	23.0	46.0	0.0	0.0	0.0	0.9	30.1
Case Nuove3	3	r	197	16.2	40.6	31.5	0.0	4.1	0.0	7.6	0.0
Cosa, cistern	3	sp	na	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Cosa, houses	1	urb1	112	5.3	55.4	38.4	0.9	0.0	0.0	0.0	0.0
Cosa, lagoon	2	urb1	28	32.1	7.1	10.7	10.7	39.3	0.0	0.0	0.0
Ferento, fossa 1918	3	urb1	187	27.8	54.5	17.6	0.0	0.0	0.0	0.0	0.0
Ferento, fossa 3258	2	sp	69	30.4	34.8	33.3	1.4	0.0	0.0	0.0	0.0
Ferento, pozzo 593	1	urb1	94	7.4	40.4	52.1	0.0	0.0	0.0	0.0	0.0
Ferento, Saggio III	2	urb1	198	19.7	31.8	46.0	2.0	0.0	0.0	0.5	0.0
Ferento, SU 038	3	sp	112	0.0	9.8	0.0	0.0	89.3	0.0	0.9	0.0
Fidene	2	sp	na	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Filattiera2	2	urb2	65	12.3	33.8	53.8	0.0	0.0	0.0	0.0	0.0

Filattiera3	3	urb2	96	4.2	46.9	46.9	1.0	0.0	0.0	0.0	0.0
Gabii, Tincu House1	1	urb1	507	23.3	32.1	38.7	0.6	0.8	0.0	0.2	4.3
Gabii, Tincu House2	2	urb1	594	8.4	32.3	44.8	1.0	6.1	0.0	0.5	6.9
Le Colonne	2	r	547	21.0	26.7	45.2	2.4	0.2	0.0	4.6	0.0
Lugnano, cemetery	3	sp	822	5.7	9.7	33.8	2.4	42.2	0.0	1.8	4.3
Lugnano2	2	r	41	7.3	12.2	31.7	2.4	0.0	0.0	46.3	0.0
Lugnano3	3	r	39	7.7	15.4	46.2	7.7	17.8	0.0	2.6	2.6
Luni, Domus presso Porta Marina	3	urb1	796	19.5	28.0	46.7	3.9	0.5	0.6	0.4	0.1
Luni, Forum2	2	urb1	107	37.4	23.3	38.3	0.9	0.0	0.0	0.0	0.0
Luni, Forum3	3	urb1	1543	13.7	43.0	42.2	0.3	0.2	0.1	0.3	0.3
Mansio ad Vacanas	2	r	136	37.5	14.7	47.8	0.0	0.0	0.0	0.0	0.0
Matrice1	1	r	70	5.7	55.7	37.1	0.0	0.0	0.0	1.4	0.0
Matrice2	2	r	689	14.7	30.3	50.5	0.3	0.5	0.1	3.8	0.0
Matrice3	3	r	894	10.3	35.1	46.1	2.7	0.3	3.9	1.5	0.0
Monte Gelato2	2	r	532	3.8	12.0	39.5	0.2	43.4	0.0	1.1	0.0
Monte Gelato3	3	r	496	5.4	35.5	56.5	0.2	1.0	0.0	0.6	0.8
Monte Vairano	1	urb2	321	44.5	24.6	29.0	1.9	0.0	0.0	0.0	0.0
Montecantino	1	urb2	290	29.3	33.4	27.6	0.0	2.8	0.0	6.9	0.0
Musarna	1	r	na	na	na	na	na	na	na	na	na
Naples, Carminiello1	1	urb1	236	5.1	27.5	66.5	0.4	0.4	0.0	0.0	0.0
Naples, Carminiello2	2	urb1	110	1.8	31.8	60.0	0.9	5.5	0.0	0.0	0.0
Naples, Carminiello3	3	urb1	2378	7.6	47.9	32.3	0.2	3.7	5.9	0.4	2.0
Naples, Girolamini	3	urb1	741	6.6	35.2	57.2	0.1	0.1	0.0	0.8	0.0
Naples, Santa Maria la nova	3	urb1	74	9.5	25.7	59.5	0.0	0.0	0.0	2.7	2.7
Naples, Santa Patrizia	3	urb1	560	1.6	19.0	77.0	0.0	1.3	0.9	0.2	0.0
Naples, Santa Sofia	2	urb1	46	21.7	26.1	52.2	0.0	0.0	0.0	0.0	0.0
Naples, Via San Paolo	3	urb1	176	17.0	30.7	45.5	1.1	5.1	0.6	0.0	0.0
Narce	1	r	86	19.8	51.2	18.6	2.3	3.4	0.0	0.0	4.7
Nemi, santuario di Diana	1	sp	132	14.4	18.9	62.1	0.0	3.8	0.0	0.8	0.0
Nomentana	2	sp	na	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Ossaia	2	r	1950	14.3	18.6	55.4	0.8	0.5	0.1	10.4	0.0
Ostia, bath2	2	urb1	2566	10.0	32.5	55.6	0.3	1.2	0.1	0.2	0.0
Ostia, bath3	3	urb1	151	11.9	19.9	65.5	0.7	1.3	0.7	0.0	0.0
Ostia, castrum1	1	urb1	107	11.2	1.9	84.1	2.8	0.0	0.0	0.0	0.0
Ostia, castrum2	2	urb1	125	0.8	26.4	68.8	4.0	0.0	0.0	0.0	0.0
Pescorocchiano	1	sp	423	1.9	84.9	12.8	0.5	0.0	0.0	0.0	0.0
Pietrabbondante	1	sp	102	33.4	17.6	49.0	0.0	0.0	0.0	0.0	0.0
Pievina2	2	r	26	11.5	23.1	53.8	0.0	3.8	0.0	7.7	0.0
Pievina3	3	r	285	21.1	40.4	33.0	1.4	0.4	0.0	3.9	0.0
Pisa, navi antiche	2	sp	2916	25.3	20.5	48.6	1.5	3.3	**0.03**	0.7	0.0
Pistoia2	2	urb1	26	40.0	12.0	48.0	0.0	0.0	0.0	0.0	0.0

Pistoia3	3	urb1	244	31.1	20.1	44.3	2.9	0.0	0.0	1.6	0.0
Poggio Picenze, Varranone	1	sp	111	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Pompeii 94	1	urb1	na	na	na	na	na	na	na	na	na
Pompeii 95	1	urb1	148	3.4	44.6	51.4	0.0	0.7	0.0	0.0	0.0
Pompeii, Casa di Ganimede	1	urb1	909	31.5	45.0	22.9	0.2	0.1	0.0	0.3	0.0
Pompeii, forum1	1	urb1	2686	19.0	22.3	54.4	0.4	1.9	0.2	0.7	1.1
Pompeii, forum2	2	urb1	504	10.5	26.9	62.1	0.2	0.0	0.0	0.2	0.0
Pompeii, Gardens	2	urb1	205	30.7	17.1	39.0	3.9	7.3	1.4	0.5	0.0
Pompeii, House of Amaranthus	1	urb1	248	2.7	18.1	62.5	2.3	0.8	0.0	0.2	13.5
Pompeii, House of Amaranthussp	1	sp	85	0.0	1.2	65.9	0.0	0.0	0.0	0.0	32.9
Populonia	1	urb1	2014	10.2	42.4	46.1	0.1	0.0	0.0	1.2	0.0
Populonia, cisterne	1	sp	383	1.0	0.0	99.0	0.0	0.0	0.0	0.0	0.0
Populonia, fossa 12618	1	sp	1668	0.4	22.7	76.9	0.0	0.0	0.0	0.0	0.0
Populonia, necropoli delle Grotte	1	sp	138	0.0	49.3	44.9	0.0	5.8	0.0	0.0	0.0
Populonia, saggio IX 1	1	urb1	250	10.4	39.2	43.6	0.0	1.6	0.0	5.2	0.0
Populonia, saggio IX 2	2	urb1	335	22.7	36.4	35.5	0.0	1.2	0.0	4.2	0.0
Quintili	2	r	157	0.0	11.5	72.6	0.0	0.0	0.0	0.0	15.9
Roma, Anphitheatro Flavio2	2	urb1	na	na	na	na	na	na	na	na	Na
Roma, Anphitheatro Flavio3	3	urb1	na	na	na	na	na	na	na	na	Na
Roma, Aqua Marcia1	1	urb1	5	60.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0
Roma, Aqua Marcia2	2	urb1	391	13.8	12.3	68.5	1.3	3.6	0.0	0.5	0.0
Roma, Arco di Costantino	2	urb1	na	na	na	na	na	na	na	na	Na
Roma, Caput Africae	2	urb1	209	2.7	17.3	76.5	0.0	1.5	0.0	0.3	1.8
Roma, Centocello	1	sp	175	5.7	22.3	58.3	0.0	2.9	0.0	0.0	10.9
Roma, Crypta Balbi esedra	3	urb1	7056	8.3	32.0	52.2	1.9	1.3	0.7	2.6	1.0
Roma, Crypta Balbi Mitreo	3	urb1	288	5.6	15.6	76.0	1.7	0.0	0.0	1.0	0.0
Roma, Crypta Balbi Mitreo sp	3	sp	16	0.0	25.0	75.0	0.0	0.0	0.0	0.0	0.0
Roma, Forum Ilium	1	urb1	104	1.0	38.5	59.6	0.0	1.0	0.0	0.0	0.0
Roma, Forum Transitorium	2	urb1	72	12.5	9.7	77.8	0.0	0.0	0.0	0.0	0.0
Roma, Meta Sudans	3	urb1	2451	14.7	20.3	42.3	13.7	6.1	1.5	1.5	0.0
Roma, Meta Sudans US 3399	2	urb1	421	5.9	17.1	67.7	0.2	0.2	0.0	0.5	8.3
Roma, Palatino area temenos	1	urb1	na	na	na	na	na	na	na	na	Na
Roma, Palatino capanna Puglisi	1	urb1	na	na	na	na	na	na	na	na	Na
Roma, Passaggio di Commodo2	2	urb1	na	na	na	na	na	na	na	na	Na
Roma, Passaggio di Commodo3	3	urb1	na	na	na	na	na	na	na	na	Na
Roma, Piazza Celimontana	3	sp	64	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Roma, San Omobono	1	sp	2080	6.0	62.2	30.0	0.0	1.8	0.0	0.0	0.0

Roma, Schola Praeconum	3	urb1	1604	9.4	35.9	52.5	0.6	1.5	0.1	0.1	0.0
Roma, Terme di Traiano2	2	urb1	na	na	na	na	na	na	na	na	Na
Roma, Terme di Traiano3	3	urb1	na	na	na	na	na	na	na	na	Na
Roma, Vesta Area Sacra	1	sp	29	0.0	37.9	55.2	0.0	0.0	0.0	6.9	0.0
Roma, Via Gaetano Sacchi	2	urb1	1043	20.9	38.1	39.3	0.2	0.1	0.1	1.3	0.0
Roma, Via Sacchi	2	urb1	na	na	na	na	na	na	na	na	Na
Roma, Via Sacra	1	urb1	106	48.1	19.8	32.1	0.0	0.0	0.0	0.0	0.0
S. Angelo di Civitella	1	sp	na	na	na	Na	na	na	na	na	Na
Saepinum	2	urb1	39	15.4	46.1	38.5	0.0	0.0	0.0	0.0	0.0
San Costanzo	2	sp	47	0.0	12.8	46.8	0.0	0.0	0.0	0.0	40.4
San Giacomo	3	r	434	7.1	25.5	14.5	14.3	34.0	1.6	2.1	0.9
San Giovenale	1	urb2	52	9.6	21.1	59.6	1.9	0.0	0.0	7.7	0.0
San Giovenale, cult	1	sp	39	15.3	51.3	25.6	2.6	0.0	0.0	5.1	0.0
San Potito	2	r	311	19.3	18.6	38.9	3.5	0.3	0.0	19.0	0.3
Schiavi d'Abruzzo	1	sp	15	0.0	0.0	33.3	0.0	0.0	0.0	66.7	0.0
Settefinestre1	1	r	230	8.3	32.4	35.8	0.0	3.9	0.0	14.4	5.2
Settefinestre2	2	r	2630	9.2	14.2	61.7	0.4	0.9	0.3	11.3	2.0
Settefinestre3	3	r	910	13.8	25.6	43.7	1.8	3.8	0.0	10.3	0.9
Sperlonga	2	sp	31	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Subiaco, Le Camere	1	sp	696	29.5	48.3	14.9	0.0	7.3	0.0	0.0	0.0
Tarquinia	1	urb1	88	26.1	30.7	39.8	0.0	2.3	0.0	1.1	0.0
Tenuta di Vallerano	2	r	463	25.1	17.9	6.9	37.6	10.6	0.0	1.9	0.0
Via Gabina, site 10	1,2	r	1757	10.3	21.6	40.2	2.7	13.5	0.1	3.1	8.5
Via Gabina, site 11	1,2	r	106	7.5	17.0	47.2	16.0	0.9	0.0	0.0	11.3

APPENDIX 8. PERCENTAGES OF MAMMALS BASED ON MNI

Site	**Period**	**Type**	**MNI mammal**	**% cattle**	**% sheep/goat**	**% pig**	**% equid**	**% dog**	**% cat**	**% wild**	**% rodent**
Alife, criptoportico	2	urb1	46	6.5	21.7	65.2	0.0	2.2	0.0	4.3	0.0
Alife, criptoportico	3	urb1	46	8.7	15.2	65.2	2.2	2.2	0.0	6.5	0.0
Bolsena	1	urb1	57	15.8	42.1	35.1	1.8	1.8	0.0	3.5	0.0
C36	1	sp	13	15.4	15.4	38.5	0.0	7.7	0.0	15.4	7.7
Campochiaro	3	sp	28	3.6	32.1	64.3	0.0	0.0	0.0	0.0	0.0
Cantone	2	sp	65	1.5	21.5	76.9	0.0	0.0	0.0	0.0	0.0
Capua, Carillo	3	urb1	6	16.7	33.3	33.3	16.7	0.0	0.0	0.0	0.0
Capua, Carillo	2	urb1	8	12.5	37.5	37.5	0.0	12.5	0.0	0.0	0.0
Case Nuove	1	r	4	25.0	25.0	25.0	0.0	0.0	0.0	25.0	0.0
Case Nuove	2	r	10	0.0	40.0	50.0	0.0	0.0	0.0	10.0	0.0
Case Nuove	3	r	19	15.8	31.6	26.3	0.0	10.5	0.0	15.8	0.0
Ferento, pozzo 593	1	urb1	13	30.8	23.1	38.5	7.7	0.0	0.0	0.0	0.0

Ferento, SU 038	3	sp	4	0.0	50.0	0.0	0.0	25.0	0.0	25.0	0.0
Fidene	2	sp	8	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Gabii, Tincu House	1	urb1	72	18.1	30.6	44.4	4.2	2.8	0.0	0.0	0.0
Gabii, Tincu House	2	urb1	140	14.3	30.0	45.0	2.9	7.9	0.0	0.0	0.0
Le Colonne	2	r	33	12.1	18.2	48.5	3.0	3.0	0.0	15.2	0.0
Lugnano	3	r	11	9.1	27.3	27.3	9.1	0.0	0.0	27.3	0.0
Lugnano	2	r	12	8.3	16.7	41.7	8.3	8.3	0.0	8.3	8.3
Lugnano, cemetery	3	sp	70	2.9	10.0	38.6	4.3	18.6	0.0	10.0	15.7
Luni, Domus presso Porta Marina	3	urb1	61	14.8	26.2	37.7	6.6	3.3	3.3	4.9	1.6
Matrice	*1*	*r*	6	16.7	33.3	33.3	0.0	0.0	0.0	16.7	0.0
Matrice	3	r	41	12.2	29.2	31.7	4.9	4.9	4.9	12.2	0.0
Matrice	2	r	42	12.9	23.6	32.7	5.6	5.6	1.8	18.1	0.0
Monte Gelato	2	r	16	6.3	18.8	31.2	6.2	18.8	0.0	18.8	0.0
Monte Gelato	3	r	23	4.3	47.8	21.7	4.3	4.3	0.0	8.7	8.7
Monte Vairano	1	urb2	38	28.9	28.9	39.5	2.6	0.0	0.0	0.0	0.0
Montecantino	1	urb2	26	15.4	26.9	26.9	0.0	7.7	0.0	23.1	0.0
Naples, Carminiello	2	urb1	8	12.5	25.0	37.5	12.5	12.5	0.0	0.0	0.0
Naples, Carminiello	1	urb1	18	11.1	33.3	44.4	5.6	5.6	0.0	0.0	0.0
Naples, Carminiello	3	urb1	120	7.4	25.7	20.7	1.6	10.7	18.2	2.5	13.2
Naples, Girolamini	3	urb1	23	8.7	30.4	47.9	4.3	4.3	0.0	4.3	0.0
Naples, Santa Maria la Nova	3	urb1	7	14.3	28.6	14.3	0.0	0.0	0.0	28.6	14.3
Naples, Santa Patrizia	3	urb1	19	10.5	26.3	36.8	0.0	15.8	5.3	5.3	0.0
Naples, Via San Paolo	3	urb1	35	22.9	25.7	34.3	2.9	11.4	2.9	0.0	0.0
Nemi, santuario di Diana	1	sp	16	18.8	31.3	37.5	0.0	6.3	0.0	6.3	0.0
Nomentana	2	sp	4	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Pescorocchiano	1	sp	35	8.6	71.4	20.0	0.0	0.0	0.0	0.0	0.0
Pievina	2	r	7	14.3	14.3	28.6	0.0	14.3	0.0	28.6	0.0
Pievina	3	r	22	13.6	22.7	36.4	4.5	4.5	0.0	18.2	0.0
Pistoia	2	urb1	17	35.3	17.6	47.1	0.0	0.0	0.0	0.0	0.0
Pistoia	3	urb1	89	25.8	25.8	41.6	3.4	0.0	0.0	3.4	0.0
Pompeii, Casa di Ganimede	1	urb1	41	17.1	46.3	24.4	4.9	2.4	0.0	4.9	0.0
Populonia	1	urb1	93	10.8	33.3	46.2	1.1	0.0	0.0	8.6	0.0
Populonia, cisterne	1	sp	7	14.3	0.0	85.7	0.0	0.0	0.0	0.0	0.0
Populonia, fossa 12618	1	sp	52	7.7	38.5	53.8	0.0	0.0	0.0	0.0	0.0
Quintili	2	r	21	0.0	23.8	47.6	0.0	0.0	0.0	0.0	28.6
Roma, Aqua Marcia	1	urb1	3	33.3	33.3	33.3	0.0	0.0	0.0	0.0	0.0
Roma, Aqua Marcia	2	urb1	42	11.9	23.8	45.2	7.1	7.1	0.0	4.8	0.0
Roma, Caput Africae	2	urb1	41	9.0	20.2	61.7	0.0	5.4	0.0	1.9	1.9
Roma, Centocello	1	sp	41	9.8	29.3	53.7	0.0	7.3	0.0	0.0	0.0
Roma, Crypta Balbi Mitreo	3	sp	4	0.0	25.0	75.0	0.0	0.0	0.0	0.0	0.0

Roma, Crypta Balbi Mitreo	3	urb1	29	17.2	17.2	51.7	6.9	0.0	0.0	6.9	0.0
Roma, Forum Ilium	1	urb1	21	4.8	23.8	66.7	0.0	4.8	0.0	0.0	0.0
Roma, Forum Transitorium	2	urb1	10	10.0	20.0	70.0	0.0	0.0	0.0	0.0	0.0
Roma, Meta Sudans	3	urb1	132	18.2	16.7	26.5	15.1	10.6	5.3	7.6	0.0
Roma, Meta Sudans US 3399	2	urb1	27	14.8	33.3	37.0	3.7	3.7	0.0	7.4	0.0
Roma, Piazza Celimontana	3	sp	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Roma, San Omobono	1	sp	177	5.1	62.1	27.7	0.0	5.1	0.0	0.0	0.0
Roma, Schola Praecononum	3	urb1	53	11.3	32.1	45.3	1.9	5.7	1.9	1.9	0.0
Roma, Via Gaetano Sacchi	2	urb1	102	13.7	52.0	25.5	1.0	1.0	1.0	5.9	0.0
San Giacomo	3	r	29	10.3	24.1	24.1	13.8	6.9	3.5	13.8	3.5
San Giovenale	1	urb2	14	21.5	21.5	35.7	7.1	0.0	0.0	14.2	0.0
San Giovenale, cult	1	sp	7	14.3	28.6	28.6	14.3	0.0	0.0	14.3	0.0
Schiavi d'Abruzzo	1	sp	10	0.0	0.0	40.0	0.0	0.0	0.0	60.0	0.0
Settefinestre	1	r	34	14.7	23.5	17.6	0.0	8.8	0.0	23.5	11.8
Settefinestre	3	r	37	10.8	27.0	32.4	2.7	2.7	0.0	18.9	5.4
Settefinestre	2	r	102	12.7	15.7	25.5	2.9	2.9	1.0	27.5	11.7
Sperlonga	2	sp	4	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0
Subiaco, Le Camere	1	sp	34	17.6	55.9	14.7	0.0	11.8	0.0	0.0	0.0
Tarquinia	1	urb1	33	24.2	36.4	30.3	0.0	6.1	0.0	3.0	0.0
Tenuta di Vallerano	2	r	45	20.0	22.2	17.8	17.8	15.6	0.0	6.7	0.0
Via Gabina, site 10	1,2	r	49	14.3	24.5	26.5	6.1	14.3	2.0	12.2	0.0
Via Gabina, site 11	1,2	r	10	10.0	20.0	40.0	20.0	10.0	0.0	0.0	0.0

APPENDIX 9. PERCENTAGES OF SHEEP/GOAT, CATTLE AND PIG BASED ON NISP

Site	**Period**	**Type**	**Region**	**inland/coast**	**Total Sample**	**NISP total**	**NISP mammal**	**% cattle**	**% sheep/goat**	**% pig**
A26	1	urb2	Molise	Inland	51	24	24	0.0	21.7	78.3
Alife, criptoportico	2	urb1	Campania	inland	Na	384	335	5.2	12.5	82.3
Alife, criptoportico	3	urb1	Campania	inland	Na	742	642	6.6	8.4	85.0
Blera	1	urb2	Lazio	inland	31	18	15	50.0	8.3	41.7
Bolsena	1	urb1	Lazio	inland	2615	1172	1110	12.3	49.9	37.8
Borgo Le Ferriere	1	sp	Lazio	coast	4323	1547	1546	12.7	80.0	7.3
C36	1	sp	Molise	inland	850	234	233	6.3	47.7	46.0
Campochiaro	1	sp	Molise	inland	2203	671	671	0.2	27.3	72.5
Campochiaro	3	sp	Molise	inland	3155	676	652	19.0	36.7	44.2
Cantone	2	sp	Abruzzo	inland	1607	1607	824	0.6	32.5	66.9

Capua, Carillo	2	urb1	Campania	inland	132	57	46	6.8	29.6	63.6
Capua, Carillo	3	urb1	Campania	inland	58	41	41	12.5	17.5	70.0
Case Nuove	1	r	Toscana	inland	Na	15	15	50.0	21.4	28.6
Case Nuove	2	r	Toscana	inland	Na	199	113	0.0	33.3	66.7
Case Nuove	3	r	Toscana	inland	Na	220	197	18.4	46.0	35.6
Cosa, cistern	3	sp	Toscana	coast	100	100	100	na	na	na
Cosa, houses	1	urb1	Toscana	coast	142	112	112	5.3	55.9	38.7
Cosa, lagoon	2	urb1	Toscana	coast	45	38	28	64.3	14.2	21.4
Ferento, fossa 1918	3	urb1	Lazio	inland	304	187	187	27.8	54.5	17.6
Ferento, fossa 3258	2	sp	Lazio	inland	142	73	69	30.9	35.3	33.8
Ferento, pozzo 593	1	urb1	Lazio	inland	293	109	94	7.4	40.4	52.1
Ferento, Saggio III	2	urb1	Lazio	inland	519	206	198	20.2	32.6	47.2
Ferento, SU 038	3	sp	Lazio	inland	131	112	112	0.0	100.0	0.0
Filattiera	2	urb2	Toscana	inland	65	65	na	12.3	33.8	53.8
Filattiera	3	urb2	Toscana	inland	96	96	na	4.2	47.4	47.4
Gabii, Tincu House	1	urb1	Lazio	inland	1600	548	507	24.7	34.2	41.1
Gabii, Tincu House	2	urb1	Lazio	inland	2225	664	594	9.8	37.8	52.4
Le Colonne	2	r	Toscana	coast	966	547	547	22.6	28.7	48.7
Lugnano, cemetery	3	sp	Umbria	inland	2467	1026	822	11.6	19.7	68.7
Lugnano	2	r	Umbria	inland	134	45	41	14.3	23.8	61.9
Lugnano	3	r	Umbria	inland	144	56	39	11.1	22.2	66.7
Luni, Domus presso Porta Marina	3	urb1	Liguria	coast	1674	877	796	20.7	29.7	49.6
Luni, Forum	2	urb1	Liguria	coast	180	114	107	37.8	23.5	38.7
Luni, Forum	3	urb1	Liguria	coast	3425	1742	1543	13.8	43.5	42.7
Mansio ad Vacanas	2	r	Lazio	inland	Na	232	136	37.5	14.7	47.8
Matrice	1	r	Molise	inland	Na	na	70	5.8	56.5	37.7
Matrice	2	r	Molise	inland	1466	689	689	15.4	31.7	52.9
Matrice	3	r	Molise	inland	2019	894	894	11.3	38.4	50.4
Monte Gelato	2	r	Lazio	inland	1029	612	532	6.9	21.7	71.4
Monte Gelato	3	r	Lazio	inland	899	532	496	5.5	36.4	58.0
Monte Vairano	1	urb2	Molise	inland	344	322	321	45.4	25.1	29.6
Montecantino	1	urb2	Toscana	inland	708	290	290	32.4	37.0	30.6
Naples, Carminiello	1	urb1	Campania	coast	474	241	236	5.1	27.7	67.1
Naples, Carminiello	2	urb1	Campania	coast	282	142	110	1.9	34.0	64.1
Naples, Carminiello	3	urb1	Campania	coast	5858	3390	2378	8.7	54.6	36.8
Naples, Girolamini	3	urb1	Campania	coast	1638	743	741	6.7	35.6	57.8
Naples, Santa Maria la Nova	3	urb1	Campania	coast	179	98	74	10.0	27.1	62.8

Naples, Santa Patrizia	3	urb1	Campania	coast	1416	607	560	1.6	19.5	78.9
Naples, Santa Sofia	2	urb1	Campania	coast	46	46	46	21.7	26.1	52.2
Naples, Via San Paolo	3	urb1	Campania	coast	173	173	164	18.2	32.9	48.8
Narce	1	r	Lazio	inland	138	87	87	22.1	57.1	20.8
Nemi, santuario di Diana	1	sp	Lazio	inland	391	142	132	15.1	19.8	65.1
Ossaia	2	r	Toscana	inland	Na	2080	1950	16.2	21.0	62.8
Ostia, bath	2	urb1	Lazio	coast	2599	2599	2566	10.2	33.1	56.7
Ostia, bath	3	urb1	Lazio	coast	171	171	151	12.2	20.5	67.3
Ostia, castrum	1	urb1	Lazio	coast	107	107	107	11.5	2.0	86.5
Ostia, castrum	2	urb1	Lazio	coast	125	125	125	0.8	27.5	71.7
Pescorocchiano	1	sp	Lazio	inland	423	423	100	1.9	85.2	12.9
Pietrabbondante	1	sp	Molise	inland	400	139	102	33.4	17.6	49.0
Pievina	2	r	Toscana	inland	76	27	26	13.0	26.1	60.9
Pievina	3	r	Toscana	inland	940	292	285	22.3	42.8	34.9
Pisa, navi antiche	2	sp	Toscana	coast	5111	3042	2916	26.8	21.7	51.5
Pistoia	2	urb1	Toscana	inland	250	30	26	32.6	21.0	46.4
Pistoia	3	urb1	Toscana	inland	1812	258	244	40.0	12.0	48.0
Poggio Picenze, Varranone	1	sp	Abruzzo	inland	111	111	111	0.0	100.0	0.0
Pompeii 95	1	urb1	Campania	coast	1853	253	148	3.4	44.9	51.7
Pompeii, Casa di Ganimede	1	urb1	Campania	coast	1038	936	909	31.7	45.3	23.0
Pompeii, Forum	1	urb1	Campania	coast	2686	2686	2686	19.9	23.3	56.8
Pompeii, Forum	2	urb1	Campania	coast	504	504	504	10.6	27.0	62.4
Pompeii, Gardens	2	urb1	Campania	coast	297	207	205	35.4	19.7	44.9
Pompeii, House of Amaranthus	1	urb1	Campania	coast	784	319	248	3.2	21.7	75.0
Pompeii, House of Amaranthus	1	sp	Campania	coast	186	98	85	0.0	1.8	98.2
Populonia	1	urb1	Toscana	coast	8080	2054	2014	10.3	43.0	46.7
Populonia, cisterne	1	sp	Toscana	coast	383	383	383	1.0	0.0	99.0
Populonia, fossa 12618	1	sp	Toscana	coast	2185	1706	1668	0.4	22.7	76.9
Populonia, necropoli delle Grotte	1	sp	Toscana	coast	Na	185	138	0.0	52.3	47.7
Populonia, saggio IX	1	urb1	Toscana	coast	555	260	250	11.2	42.1	46.8
Populonia, saggio IX	2	urb1	Toscana	coast	692	339	335	24.0	38.5	37.5
Quintili	2	r	Lazio	inland	493	225	157	0.0	13.7	86.3
Roma, Anphitheatro Flavio	2	urb1	Lazio	inland	Na	1574	na	2.7	11.6	85.7
Roma, Anphitheatro Flavio	3	urb1	Lazio	inland	Na	2564	na	5.4	19.7	74.9
Roma, Aqua Marcia	1	urb1	Lazio	inland	17	5	5	60.0	20.0	20.0

Roma, Aqua Marcia	2	urb1	Lazio	inland	1062	397	391	14.6	13.0	72.4
Roma, Arco di Costantino	2	urb1	Lazio	inland	Na	342	na	9.2	15.2	75.6
Roma, Caput Africae	2	urb1	Lazio	inland	458	222	209	2.8	17.9	79.3
Roma, Centocello	1	sp	Lazio	inland	Na	547	175	6.6	25.8	67.5
Roma, Crypta Balbi esedra	3	urb1	Lazio	inland	10159	7487	7056	9.0	34.6	56.5
Roma, Crypta Balbi Mitreo	3	urb1	Lazio	inland	Na	374	288	5.7	16.1	78.2
Roma, Crypta Balbi Mitreo	3	sp	Lazio	inland	Na	55	16	0.0	25.0	75.0
Roma, Forum Ilium	1	urb1	Lazio	inland	518	107	104	1.0	38.8	60.2
Roma, Forum Transitorium	2	urb1	Lazio	inland	129	73	72	12.5	9.7	77.8
Roma, Meta Sudans	3	urb1	Lazio	inland	2826	2826	2451	19.0	26.3	54.7
Roma, Meta Sudans US 3399	2	urb1	Lazio	inland	Na	541	421	6.5	18.8	74.6
Roma, Palatino area temenos	1	urb1	Lazio	inland	Na	709	na	5.3	32.1	62.7
Roma, Palatino capanna Puglisi	1	urb1	Lazio	inland	Na	73	na	28.6	26.1	45.4
Roma, Passaggio di Commodo	2	urb1	Lazio	inland	Na	282	na	2.6	14.9	82.5
Roma, Passaggio di Commodo	3	urb1	Lazio	inland	Na	71	na	3.0	9.1	87.9
Roma, Piazza Celimontana	3	sp	Lazio	inland	64	64	64	0.0	40.7	59.3
Roma, San Omobono	1	sp	Lazio	inland	2096	2096	2080	6.1	63.3	30.5
Roma, Schola Praecononum	3	urb1	Lazio	inland	4000	1741	1604	9.6	36.7	53.7
Roma, Terme di Traiano	2	urb1	Lazio	inland	Na	19	na	25.0	8.3	66.7
Roma, Terme di Traiano	3	urb1	Lazio	inland	Na	1114	na	16.9	22.0	61.0
Roma, Vesta Area Sacra	1	sp	Lazio	inland	45	45	29	0.0	40.7	59.3
Roma, Via Gaetano Sacchi	2	urb1	Lazio	inland	1755	1061	1043	21.3	38.7	40.0
Roma, Via Sacchi	2	urb1	Lazio	inland	Na	981	na	13.5	44.6	41.9
Roma, Via Sacra	1	urb1	Lazio	inland	132	106	106	48.1	19.8	32.1
Saepinum	2	urb1	Molise	inland	87	39	39	15.4	46.1	38.5
San Costanzo	2	sp	Campania	coast	109	83	47	0.0	21.5	78.5
San Giacomo	3	r	Molise	inland	563	460	434	15.1	54.1	30.8
San Giovenale	1	urb2	Lazio	inland	166	61	52	10.6	23.4	66.0
San Giovenale, cult	1	sp	Lazio	inland	135	39	39	16.6	55.6	27.8
San Potito	2	r	Abruzzo	inland	500	315	311	25.1	24.2	50.7
Schiavi d'Abruzzo	1	sp	Abruzzo	inland	15	15	15	0.0	0.0	100.0
Settefinestre	1	r	Toscana	coast	544	241	230	10.8	42.4	46.8
Settefinestre	2	r	Toscana	coast	6742	3033	2630	10.8	16.7	72.5
Settefinestre	3	r	Toscana	coast	2023	1015	910	16.6	30.8	52.6
Sperlonga	2	sp	Lazio	coast	31	31	31	na	na	na
Subiaco, Le Camere	1	sp	Lazio	inland	1620	698	696	31.8	52.1	16.1
Tarquinia	1	urb1	Lazio	inland	108	88	88	27.0	31.8	41.2

Tenuta di Vallerano	2	r	Lazio	inland	929	471	463	50.2	35.9	13.9
Via Gabina, site 10	2	r	Lazio	inland	4495	1984	1757	14.3	29.9	55.8
Via Gabina, site 11	2	r	Lazio	inland	262	125	106	10.5	23.7	65.8

APPENDIX 10. PERCENTAGES OF SHEEP/GOAT, CATTLE, PIG AND CHICKEN BASED ON NISP

Site	Period	Type	NISP total	NISP chicken	%cattle	%sheep/goat	%pig	%chicken
Alife, criptoportico	2	urb1	384	14	5.0	12.0	78.9	4.1
Alife, criptoportico	3	urb1	742	41	6.2	7.9	79.7	6.2
Cantone	2	sp	1607	507	0.4	20.1	41.4	38.1
Case Nuove	2	r	220	20	0.0	20.5	40.9	38.6
Case Nuove	3	r	199	49	16.5	41.2	32.0	10.3
Ferento, fossa 3258	2	sp	73	2	30.0	34.3	32.9	2.9
Gabii, Tincu House	1	urb1	548	13	24.1	33.3	40.0	2.7
Gabii, Tincu House	2	urb1	664	25	9.4	36.0	49.9	4.7
Luni, Domus presso Porta Marina	3	urb1	877	53	19.3	27.8	46.3	6.6
Luni, Forum	2	urb1	114	7	35.4	22.1	36.3	6.2
Luni, Forum	3	urb1	1742	195	12.3	38.6	37.8	11.3
Nemi, santuario di Diana	1	sp	142	10	14.0	18.4	60.3	7.4
Ossaia	2	r	2080	112	15.2	19.7	58.9	6.1
Pievina	2	r	292	2	12.5	25.0	58.3	4.2
Pievina	3	r	27	1	22.1	42.4	34.7	0.7
Pisa, navi antiche	2	sp	3042	49	26.4	21.3	50.5	1.7
Pompeii, Casa di Ganimede	1	urb1	936	6	31.5	45.0	22.9	0.7
Populonia	1	urb1	2054	7	10.3	42.8	46.6	0.4
Populonia, necropoli delle Grotte	1	sp	185	30	0.0	42.5	38.8	18.8
Populonia, saggio IX	1	urb1	339	2	10.9	41.2	45.8	2.1
Populonia, saggio IX	2	urb1	260	5	23.8	38.2	37.3	0.6
Quintili	2	r	225	47	0.0	10.1	63.7	26.3
Roma, Anphitheatro Flavio	2	urb1	1574	Na	2.5	10.7	79.1	7.7
Roma, Anphitheatro Flavio	3	urb1	2564	Na	4.5	16.2	61.9	17.4
Roma, Aqua Marcia	2	urb1	5	15	14.0	12.5	69.6	3.9
Roma, Arco di Costantino	2	urb1	342	Na	9.1	15.1	74.7	1.3
Roma, Centocello	1	sp	547	357	2.0	7.7	20.1	70.3
Roma, Crypta Balbi esedra	3	urb1	7487	339	8.5	32.9	53.7	4.9
Roma, Crypta Balbi Mitreo	3	sp	374	68	0.0	7.8	23.5	68.6
Roma, Crypta Balbi Mitreo	3	urb1	55	35	4.6	12.9	62.9	19.5
Roma, Forum Transitorium	2	urb1	73	1	12.3	9.6	76.7	1.4

Roma, Meta Sudans	3	urb1	2826	253	20.4	6.8	58.6	14.3
Roma, Meta Sudans US 3399	2	urb1	541	32	6.0	17.4	68.8	7.7
Roma, Palatino area temenos	1	urb1	709	Na	5.1	31.0	60.6	3.2
Roma, Passaggio di Commodo	2	urb1	71	Na	2.4	13.9	77.0	6.7
Roma, Passaggio di Commodo	3	urb1	282	Na	2.9	8.7	84.1	4.3
Roma, Piazza Celimontana	3	sp	64	15	0.0	26.2	38.1	35.7
Roma, Schola Praecononum	3	urb1	1741	132	8.8	33.9	49.5	7.8
Roma, Terme di Traiano	3	urb1	1114	Na	16.6	21.7	60.0	1.8
Roma, Via Gaetano Sacchi	2	urb1	1061	11	21.0	38.3	39.6	1.1
Roma, Via Sacchi	2	urb1	106	Na	13.3	44.0	41.4	1.2
Tenuta di Vallerano	2	r	471	7	48.7	34.9	13.4	2.9